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Challenges in the Water Industry: Infrastructure and its Role in Water Supply

Every day, millions of U.S. residents rely on water for basic needs such as drinking, showering, cleaning, cooking and fire protection. Yet beyond simply turning on the faucet, very few people today think about what it takes to fill a glass of water.

From the times when massive aqueducts were built by the Romans to when American settlers started digging wells, and up until the 19th century, obtaining a glass of water required a trip outside with a bucket. A hot bath necessitated the additional task of splitting wood and building a fire. Developments such as cast iron and steam and electric power enabled both large pipes to be constructed and for water to increase in flow and quantity.[1] By the late 1800s, pipes were being laid underground in the U.S. and the first water infrastructure system was established.

Today, this massive water supply system, serving 240 million Americans, is in serious need of replacement, upgrading and maintenance if it is to continue to support a growing U.S. population. According to the American Society of Civil Engineers Report Card for America's Infrastructure, national drinking water/wastewater systems received a grade of a D.[2] In addition, the substantial investment required to update this system will increase the cost of water. Indeed, a sobering EPA projection is that some $384.2 billion is required to replace aging water infrastructure over the next 20 years.[3]

In order for people to better understand the need for these increasing costs, it is essential to develop an appreciation for the value of water. Understanding how the infrastructure system works, its current challenges and how best to address these challenges, will help to develop this appreciation.

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[1] "Aqueduct." Encyclopædia Britannica. 2007. Encyclopædia Britannica Online. Retrieved 13 Mar. 2007 http://search.eb.com/eb/article-9008127
[2] American Society of Civil Engineers 2013 Report Card on Infrastructure. http://www.infrastructurereportcard.org/a/#p/drinking-water/overview
3 Environmental Protection Agency 2007 Drinking Water Infrastructure Needs Survey and Assessment, presented March 2009. http://www.epa.gov/ogwdw000/needssurvey/index.html

HOW DOES IT WORK?

The water infrastructure system is relatively straightforward. From source to tap, water travels through three main channels: the pumping station, the treatment facility and the distribution system.[4]

Pumping Station

The pumping station serves two primary purposes. The first is to extract raw (untreated) water from a source, such as an aquifer or river, using large pumps, pipes and a power source to drive the pumps. Its second purpose is to transport the water from the treatment facility to distribution system (discussed below). The pumping station, usually situated above ground, requires regular maintenance and upgrades, as well as sophisticated equipment, in order to perform its function.

Treatment Facility

After raw water is pumped from its source, it is sent to a treatment facility. This is where water is treated to meet the levels of purity and quality set forth by the U.S. Environmental Protection Agency (EPA). Increasingly stringent EPA regulations require treatment processes to be continually updated and tested, advancing the levels of technology, skill and chemical solutions used. Treatment facilities are designed by engineers to meet the specific consumption and quality needs of the communities they serve. As those needs increase, treatment resources must be provided so that the facilities can remain in compliance with established standards.

Distribution System

Once the water has been treated it is then ready to enter the distribution system.[5] The distribution system is the network of pipes that span fields, mountains and highways so that it can reach homes, businesses, fire hydrants and a multitude of other destinations. The U.S. water pipe network stretches across 700,000 miles and is more than four times the length of the National Highway System.[6]

In order to ensure that adequate supply is delivered to different recipients, engineers run computer simulations of the hydraulic activity of the water in order to determine proper pressure, pipe sizing and other factors. A fire-hydrant, for example, will require high levels of pressure and larger piping. Generally, pipe sizes can range from forty-eight to six inches in diameter. Booster pumps are often attached to the pipes to help further regulate water pressure.

CHALLENGES

While appearing deceptively simple, much planning and investing goes into supporting this infrastructure system. And much more needs to be done if this system is to continue meeting the demands of the U.S. population. As the population increases, so does the demand for water, placing further stress on an already strained system. The main challenges facing water infrastructure are outlined below.

An Aging System

The vast majority of the nation's pipes were laid in three phases: in the late 1800s, the 1920s and just after World War II.[7] Many of these pipes were made to last 50-75 years. Their constant use and age compounded by their low rate of replacement means that most of the pipes in the U.S. are in critical need of repair.

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[4] For the purposes of this paper, the discussion on infrastructure will center on supply water and not other water services such as wastewater management or stormwater runoff systems, both of which are worthy of their own discussion on how to best manage and upgrade.
[5] In some cases, water will first enter a storage facility or reservoir so that it can be supplied when demand exceeds pumping capabilities.
[6] The American Water Works Association. Online. Retrieved 13 Mar. 2007. http://www.drinktap.org/consumerdnn/Default.aspx?tabid=198
[7] The American Water Works Association. Online. Retrieved 13 Mar. 2007. http://www.drinktap.org/consumerdnn/Default.aspx?tabid=198

Among the different problems plaguing the pipes, corrosion ranks amongst the most perilous. This is caused by a natural reaction between water and metal. Likewise, soil properties can corrode pipes from the outside. This leads to leaks and creates two subsequent issues. First, it allows contaminants to enter the pipe and thus, the water supply. Second, it allows treated water to seep (and sometimes steadily flow) out of the system and be wasted. And while even the best-run water systems seep water between the treatment plant and the tap,[8] more can be done to avoid unnecessary loss of this precious resource.

Once a severe leak is discovered, the pipes are unearthed and then repaired or replaced. In many instances, this requires digging up city streets or highways to access the pipe. Such a procedure can temporarily shut down a community's water system and disrupt service. Additional costs accompany this process as well. Roads must be repaved at the expense of the responsible water authority, traffic must be redirected, the public must be notified of potential water boil advisories, and so on.

These problems persist throughout the country, with residents in almost every major city feeling the effects. In Baltimore aging pipes now burst approximately 1,000 times per year, and every day an incredible 20 percent of the water drawn from nearby reservoirs is simply lost in transmission before ever making it to homes and businesses. In Houston an estimated 40 percent of the city's water pipes have already reached the end of their intended operational lives, and last summer's heat wave and drought conditions caused the city's aging water system to sprout an overwhelming 11,000 leaks, resulting in a quarter of the city's water being lost or unaccounted for in September and October 2011. The dilapidated sewer system that serves Miami was recently found to have ruptured some 65 times in just the past two years, discharging more than 47 million gallons of untreated sewage into waterways and streets.[9]

Financing the Upgrades

In its 2012 Value of Water Index, manufacturing company Xylem Inc. found that 77 percent of Americans are concerned about the nation's water infrastructure system, 88 percent believe it needs reform, and 85 percent support additional investment. Despite this overwhelming public support, the federal role in funding water infrastructure has declined steadily over the past two decades[10].

In fact, municipal expenditures for water and wastewater infrastructure are one of the highest expenditure categories, second only to education.[11] The distribution system is generally thought to be the area that needs the most attention and investment, directing much of the financing towards the pipes underground.[12]

The problem, however, is that the cost of water infrastructure replacement far exceeds the financial capabilities of many local water utilities.[13] Many municipalities, for example, believe that the federal and/or state governments will make available grants and other low-cost funding as a means of dealing with this infrastructure challenge.[14] Local governments spent $93 billion in 2008 on water and wastewater systems.[15] Despite spending billions each year, there is an annual gap of $19 billion in what we need to invest and what we actually do invest to replace aging facilities that are near the end of their useful life and to comply with existing and future federal water regulations.[16] The shortfall does not account for any growth in the demand for drinking water over the next 20 years.[17] Furthermore, money that has been earmarked towards building new infrastructure often gets diverted to other projects, aggravating the challenge.[18] Why does this happen? Because these events generate little interest and are considered to be low visibility activities.

[8] LeChevallier, Mark W. Ph.D. Director, Innovation & Environmental Stewardship, American Water. Interview. 21 Nov. 2006.
9 Center for American Progress: "How to Upgrade and Maintain Our Nation's Wastewater and Drinking Water Infrastructure."
[10] Xylem Inc., 2012 Value of Water Index. http://www.xyleminc.com/valueofwater/#
[11] Anderson, Richard, Ph.D. "Major Capital Investment in Water and Wastewater Infrastructure." 25 Jun. 2006 *US Conference of Mayors. Mayors Water Council.*
[12] Naumick, Gary. Director of Capital Program Management/Asset Planning & Strategy, American Water. Interview. 09 Mar. 2007
[13] The American Water Works Association. Online. Retrieved 13 Mar. 2007. http://www.drinktap.org/consumerdnn/Default.aspx?tabid=198
[14] Long, Colleen. "Water pipelines across US breaking; repair costs at nearly $300B." 08 April 2008 Associated Press
[15] U.S. Conference of Mayors. "Trends in Local Government Expenditures on Public Water and Wastewater Services and Infrastructure: Past, Present and Future." February 2010
[16] National League of Cities 2010 Research Brief on America's Cities
[17] American Society of Civil Engineers 2005 Report Card on Infrastructure. Online. Retrieved 14 Mar. 2007 http://www.asce.org/reportcard/2005/page.cfm?id=24
[18] Turkopp, Richard C. "Evaluating lifetime pumping costs: how to perform life-cycle analyses for a forced system." 22 Mar. 2006 *Public Works*

"You can't easily go to a ribbon-cutting or have your picture taken in front of a new sewer line," noted Dean Marriott, director of the Portland Bureau of Environmental Services.[19] Many water industry experts agree that getting people to care about something they cannot see is a challenge. Even when a tremendous amount of capital has just been invested in a system, "people are not going to notice that their service is any better than it was,"[20] notes Gary Naumick, Senior Director of American Water Engineering.

Another issue centers on the costs of operating infrastructure. The cost of water itself is minimal, but there are a host of other expense drivers associated with the planning, design, construction, operation and maintenance of a pipeline. The electricity used to pump the water from its source and across terrain, for example, is one of the largest recurring costs.[21] Another significant driver is the purchase and installation of pipes.[22] And additional costs continuing to increase include that of building, replacing or improving treatment plants; protecting water from pollution or terrorist attacks; accessing new water sources, just to name a few.[23]

American Water supports various types of funding to help improve the nation's water and wastewater infrastructure. One key solution is attracting additional private capital for public water infrastructure projects from investor-owned companies, as well as private capital that is already in infrastructure funds, pension funds, and other sources eager for the long-term, reliable investments that well-run water utilities provide. The U.S. government can help bring additional private capital into communities to bridge the funding gap and flood millions of dollars and thousands of new jobs into our economy. *See American Water White Paper: Financing Solutions for Water Infrastructure Investment.*

Nationwide, American Water, through its 15 state subsidiaries, has spent about $1.5 billion in the past three years on infrastructure improvements across the country The company has a strong and ongoing commitment to investing in infrastructure and keeping it updated, while delivering excellent service customers depend upon at an exceptional value.

ADDRESSING THE CHALLENGES

While the challenges outlined above are daunting, they are not insurmountable. Some of the ways in which industry experts propose to meet these challenges are outlined below.

Rehabilitation and Replacement

One of the more basic ways to address the infrastructure challenge is to focus on the pipes. The developments and improvements that have been made can be broken down into two categories: rehabilitation and replacement.

Rehabilitation is often the preferred method of fixing a broken pipe. One such rehabilitation solution is called cleaning and lining, whereby a cleaning device is sent inside corroded pipes to scour off the accumulated mineral build up. Once a pipe has been scoured, it can then be lined with several types of inert material. The lining can serve two functions. First, it protects the pipe from further internal corrosion caused by water reacting with a metal pipe. Second, it may strengthen the pipe, which is particularly useful as the scouring sometimes weakens its structure.

To support the rehabilitation process, acoustic monitoring technologies can help detect if and where a pipe is leaking. These devices use computer analysis to listen to a pipe during quiet hours (i.e., before dawn) and pinpoint exactly where a leak is occurring. The pipe can then be uncovered, examined and repaired accordingly.

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[19] Yardley, William. "Gaping Reminders of Aging and Crumbling Pipes." 08 Feb. 2007 *The New York Times*
[20] Naumick, Gary. Director of Capital Program Management/Asset Planning & Strategy, American Water. Interview. 09 Mar. 2007
[21] Turkopp, Richard C. "Evaluating lifetime pumping costs: how to perform life-cycle analyses for a forced system." 22 Mar. 2006 *Public Works*
[22] Turkopp, Richard C. "Evaluating lifetime pumping costs: how to perform life-cycle analyses for a forced system." 22 Mar. 2006 *Public Works*
[23] "Infrastructure." Water Encyclopedia. Online. Retrieved 13 Mar. 2007. http://www.waterencyclopedia.com/Hy-La/Infrastructure-Water-Supply.html

If a pipe can not be rehabilitated, it must be replaced. Examples of such cases are pipes that have multiple leaks or are structurally very weak. Replacement is usually a last resort, as this process is more costly and labor intensive, particularly since it requires installing brand new pipes.

Other steps have also been taken to increase the general longevity of current and future pipes. For example, most pipes today are lined with cement so that the water does not react directly with the metal and produce corrosion. Water can also be treated so that it is less reactive with metal. In addition, metal pipes can be wrapped with plastic to prevent external corrosion from aggressive soils. But while there are technologies and methods to repair these pipes, it is still a vast and expensive undertaking.

Finding the Funds

Funding this undertaking has become one of the most critical factors in addressing the infrastructure challenge. With 85 percent of the nation's water serviced by the public sector, the burden to finance the upgrades rests mainly on municipalities, local communities, and ultimately, state and local governments. But as noted before, the billions of dollars needed to upgrade infrastructure make the cost burden more than local political structures can sustain.

To assist, the government has set up funds to help finance the upgrades, such as the State Revolving Fund (SRF), which was established in 1987. SRF enables state and local governments to get low interest loans in order to fix aging water infrastructure.

The American Recovery and Reinvestment Act of 2009 provides significant funding for states to finance high priority infrastructure projects needed to ensure clean water and safe drinking water. The Clean Water State Revolving Fund program, in place since 1987, received $4 billion, including funds for Water Quality Management Planning Grants. The Drinking Water State Revolving Fund program, in place since 1997, received $2 billion. States must provide at least 20 percent of their grants for green projects, including green infrastructure, energy or water efficiency, and environmentally innovative activities.[24] Ultimately, rate increases help finance some of the infrastructure upgrades.

Additional measures have been proposed to help communities fix their antiquated infrastructure. Finally, cities also have the option to apply for municipal bonds in order to finance their work. The problem however, is that these funds are still not enough to finance upgrades, with their estimated price tag of up to $1 trillion over the next twenty years.

Other solutions point to the private-sector, which is currently serving 15 percent of the U.S.'s water services. The problem is there are barriers impeding the private-sector's investment in the U.S. water infrastructure, such as caps placed on private activity bonds (PABs) in 1986 that have never been updated. Meaning, there is a limit to how much private sector money can be made available to municipalities. Water and wastewater utilities could benefit from greater access to PABs for all public-purpose drinking water and wastewater projects. The proposed Sustainable Water Infrastructure Investment Act, H.R. 1802, would do just that by removing water projects from state volume caps for private activity bonds, thus spurring increased private investment in systems throughout the country.

Public-Private Partnerships have also been touted as solutions, whereby private-sector water companies assist in the design, rebuilding and operation of publicly-owned water systems. Public-Private-Partnerships offer one of the most viable ways in which cities, towns and communities can access the capital and industry expertise of the private-sector. It is believed that such partnerships will play an increasingly critical role in helping the U.S. overcome its water infrastructure challenges.[25]

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[24] http://water.epa.gov/aboutow/eparecovery/index.cfm
[25] For more information on Public-Private Partnerships, please refer to another American Water authored white paper: "Challenges in the Water Industry: Public-Private Partnerships as a Solution." http://www.amwater.com/awpr1/web_resources/aww/pdf/011807.WhitePaper.PPP.Final.pdf

CONCLUSION

A glass of clean and safe water is the product of thousands of miles of pipes, enormous amounts of planning, countless hours of labor, the latest in technology and water testing and significant capital investment. But if the U.S. is to prepare its water infrastructure for the 21st century, a significant amount of work, planning, coordination and funding is required. And doing so requires a strong commitment from not only utilities, but rate-payers and government as well.[26] It is essential that these players see how all these pieces fit together. This means appreciating the value of water and understanding what is at stake, but also, more critically, acknowledging that the key players must work together in generating viable solutions. The U.S. cannot afford to have this water system fail.

[26] The American Water Works Association. Online. Retrieved 13 Mar. 2007. http://www.drinktap.org/consumerdnn/Default.aspx?tabid=198