WE&T

water environment and technology

Filtration

Meters & valves

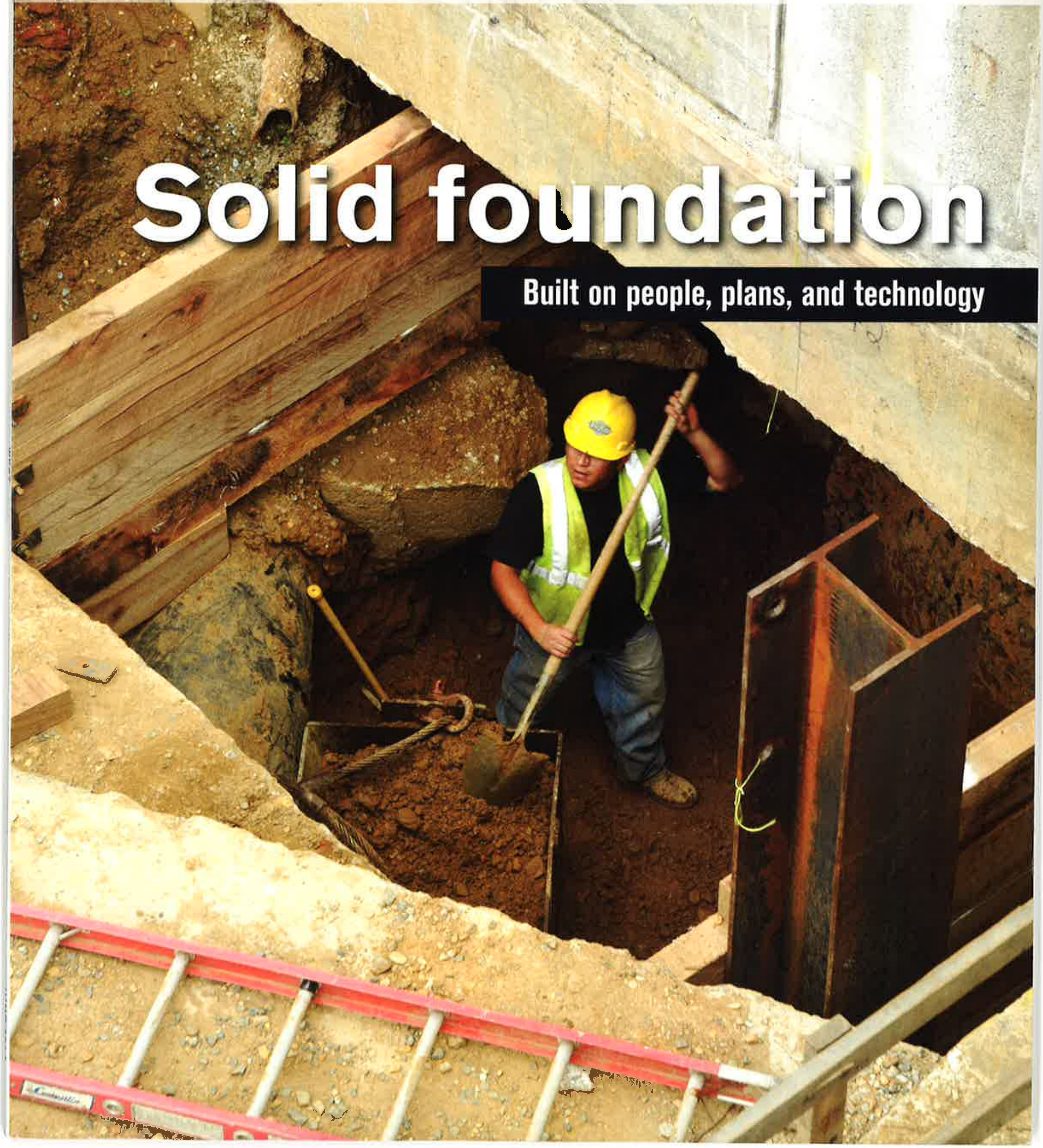
Water reclamation

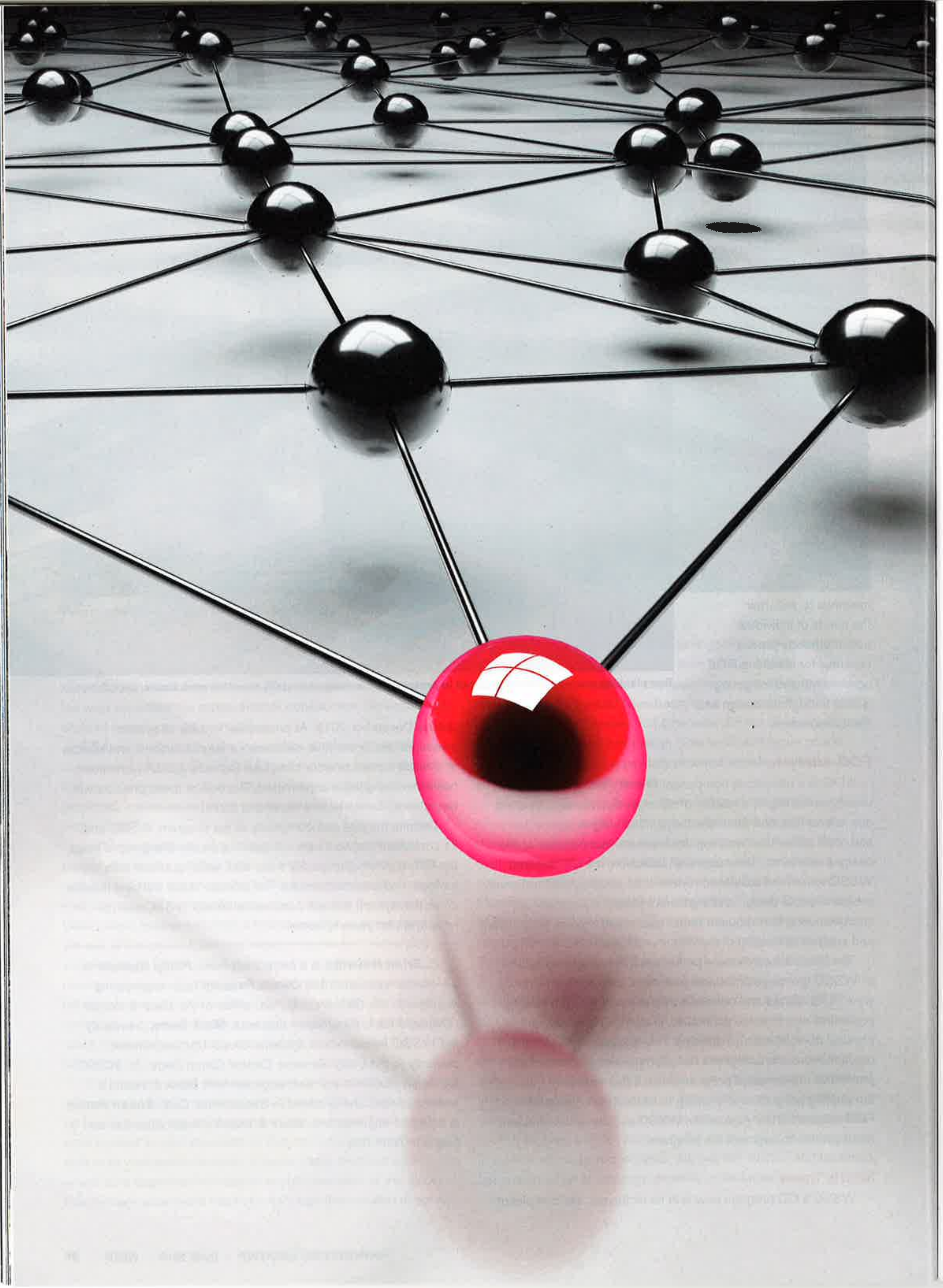
Thickening & dewatering

June 2014

Solid foundation

Built on people, plans, and technology





Smart grid, smarter use of infrastructure

Better data gathered through smart grid technologies relieves capacity needs and defers capital expenditures

Graham Symmonds

Supply-side management emphasizes generating new water through increased diversions, massive engineering works, or water creation schemes such as desalination. However, finding the capital to execute these projects increasingly is difficult for municipalities. Consumers also are becoming more concerned about the effect of these projects on their water rates.

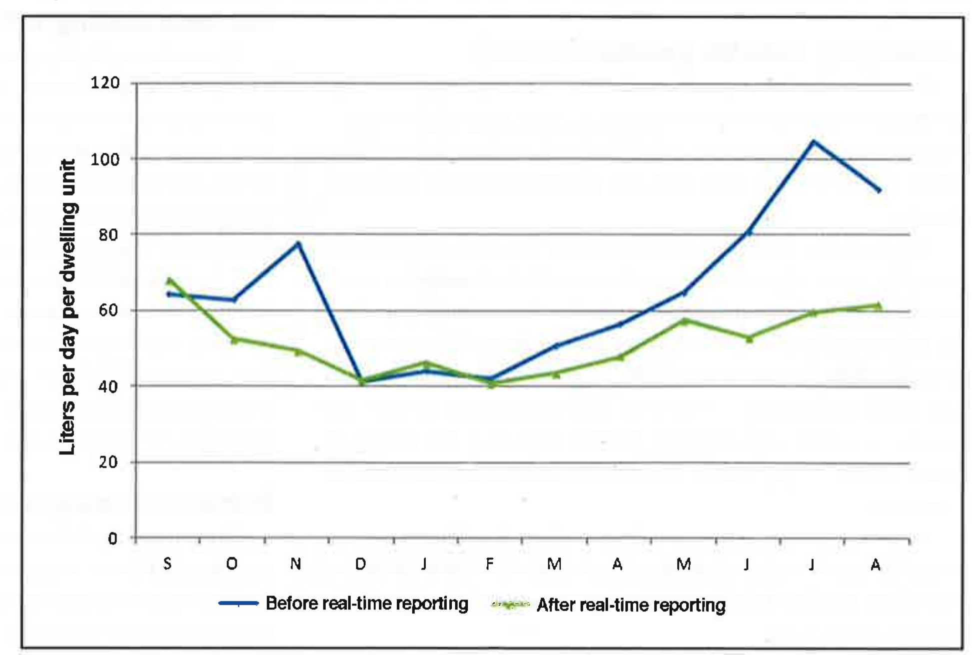
Smart grid technologies can offer real solutions for these problems. By providing real-time consumption information to consumers, utilities can realize significant water savings, which easily translate into the deferral of construction and water acquisition costs. Ensuring data systems are complete also can enhance significantly the financial performance of utilities, allowing projects to be funded at lower cost of capital.

Infrastructure benefits of data

Our 21st century water systems are not designed as data-rich enterprises. In many places, water is unmeasured or is reported arbitrarily to consumers annually, semiannually, quarterly, or monthly. These frequencies are insufficient to enable a consumer to recognize the "water impact" of his or her decisions.

However, advanced metering infrastructure can provide data at near-real-time intervals for consumers. For the first time, consumers can access consumption data that they can connect to their choices and activities (see Figure 1, below). In addition, these technologies allow utilities to push that information to the consumer in a proactive way. For example, immediate high-usage alerts enable consumers to correlate to their water bill such activities as draining and refilling a pool or lawn overseeding. The availability of this data reinforces the meaning of water for the consumer.

Figure 1. Household demand reduction as a function of increased data



By delivering water usage data to consumers in real time, utilities can both emphasize the value of water and encourage conservation. Conservation can enable deferring capital projects and, thus, extend infrastructure life.

And every time consumers conserve water, they effectively extend the life of the systems. Conservation leverages existing infrastructure to serve future needs. Because water infrastructure typically scales in a linear fashion with population, demand reduction can be translated into direct availability for new consumers and into significant capital expenditure savings.

Leveraging data for greater capacity

Data from the smart grid for water can "find capacity." Understanding where and when water is used, reducing leakage through real-time monitoring of consumption, ensuring all water is billed, and eliminating water theft can provide immediate additional capacity.

For example, reducing overall demand not only allows existing pumping capacity to serve more homes, it also translates to a reduction in the storage requirements for the existing population. By extension, this creates capacity for the future in the existing infrastructure. These data impacts on real capacity calculations can result in significant deferral or even elimination of near- and long-term capital requirements. Further, reducing the volume of water delivered can realize significant reductions in operational expenses.

As demonstrated in a recent Ceres report, this "found capacity" means more customers can be serviced with the existing resources and the life of the civil infrastructure can be extended (see Figure 2, p. 41).

Similarly, reducing water loss can significantly reduce the peak-hour demand. For example, if a utility services 100,000 homes, reducing water loss by 20% reduces the peak hour demand by 4000 L/min (1000 gal/min). In real terms, the utility could serve an additional 1786 units with the same infrastructure.

Demand shifting with off-peak strategies

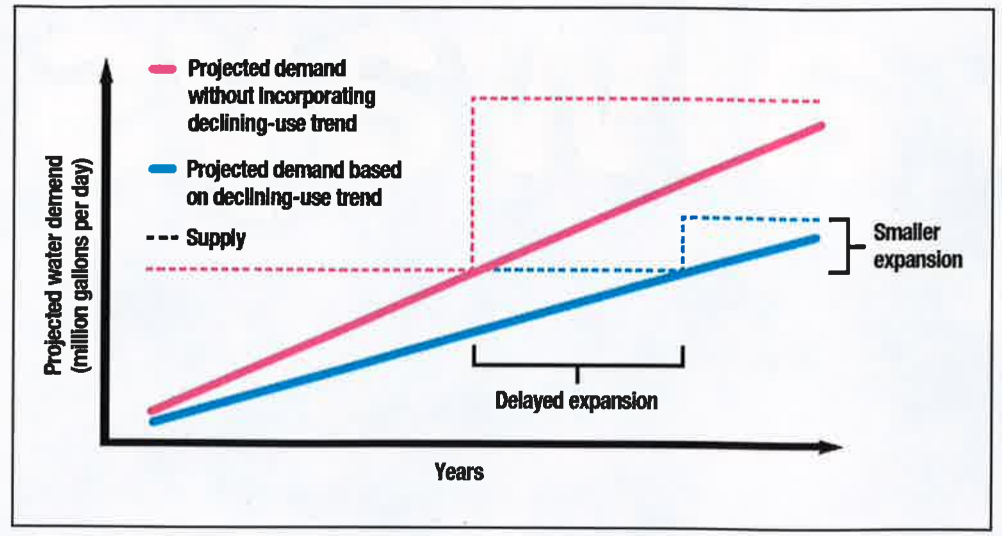
By combining highly granular data with time-of-use incentives, a utility can spread existing capacity over a larger timescale. This is particularly useful where commercial or industrial users are driving peak demand. By shifting demand through rates and incentives, utilities can leverage existing capacity, serving some consumers during off-peak hours and freeing existing infrastructure for use during peak hours (see Figure 3, p. 41).

In order to be successful, the utility must be able to demonstrate that the shift makes financial sense to the customer, and can do so by implementing a time-of-use tariff offering incentives to shift. Clearly, time-of-use tariffs only can work in the context of understanding consumption within a period of time. This demands more granular data on water consumption.

Pressure management

Operational capital investments such as main repairs can benefit significantly from smart-grid installations. Pressure management – reducing pressure to reduce water loss through leakage – has become an established leak control methodology for water systems.

Figure 2. Impact of reduced demand on infrastructure requirements



Source: Ceres, *Water Ripples: Expanding risks for U.S. water providers*, December 2012.

Reducing these leaks is an important aspect of "finding capacity," but pressure management also can reduce the occurrence of bursts in systems, adding years to the life of existing infrastructure.

By reducing flow requirements, two benefits are apparent:

- The pressure required to maintain that flow is reduced by a factor of the square of the flow reduction fraction. That is, a 5% reduction in flow reduces the pressure requirements by 9.75%.
- As line losses typically are directly proportional to velocity, reducing the flow reduces the pressure requirement further.

Leak control via pressure management

Leaks from distribution systems can be modeled as the equivalent to an orifice in a pipe or tank. The flow in such cases largely is dependent on the pressure (head) and the orifice coefficient. Accordingly, a simple relationship can be built that compares the idealized impact of pressure reductions with respect to leak flow reductions.

In practice, there is a wide variation in orifice condition, and as a result, the impact of reducing pressure varies considerably. For instance, reducing the operating pressure of the distribution system from 517 to 448 kPa (75 to 65 lb/in.^{2}), a 13.3% reduction, can produce a leak flow reduction ranging from 10% to 30% depending on the leak characteristics, laminar/turbulent flow regimes, and the soil/water interface characteristics.

Reducing main breaks

Determining the longevity of pipeline systems in utilities is a complex task, because of the often unique conditions of the installations and the various environmental conditions that exist dynamically in the systems. For pipes, failure can be modeled as a function of such factors as operating pressure, residual strength, bedding factor, pipe wall thickness, etc. For utilities, only two of these variables can be directly controlled: residual strength (that is, implementing a pipeline replacement program to offset the effect of age and wall thickness deterioration) and pressure.

Obviously replacing pipelines is an enormous and time-consuming task – and fantastically expensive. However, by allowing a pressure reduction, the longevity of pipeline systems can be extended.

The benefits from data for the utility are manifold. From an infrastructure perspective, there are significant opportunities for smart-grid-for-water technologies to expand and extend the use of existing systems. For the consumer, there are opportunities to reengage with water consumption and to understand use in real time, increasing awareness and conservation. Both these benefits result in increased sustainability and resource efficiency while ensuring that utilities remain fiscally and functionally viable for many years.

***Graham Symmonds** is the chief knowledge officer at Global Water Resource's FATHOM Water Management in Phoenix.*

Figure 3. Demand shifting