Water and the New Urgency

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As the planet's population and industrial output continues to grow, water scarcity and water stress will be experienced in more and more regions of the United States and the world in general. Conservation can take us so far but beyond there will be a need for creative thinking and the development of alternative sources of water.

It is expected this increase in water demand will be accompanied by a rapid rise in water and sewer costs. Exhibit #1 indicates the rise in water and sewer costs is predicted to exceed all other costs. Where in previous years, the cost of water has been a minor part of an operating budget, looking toward the future; it will become an important component to operating costs.

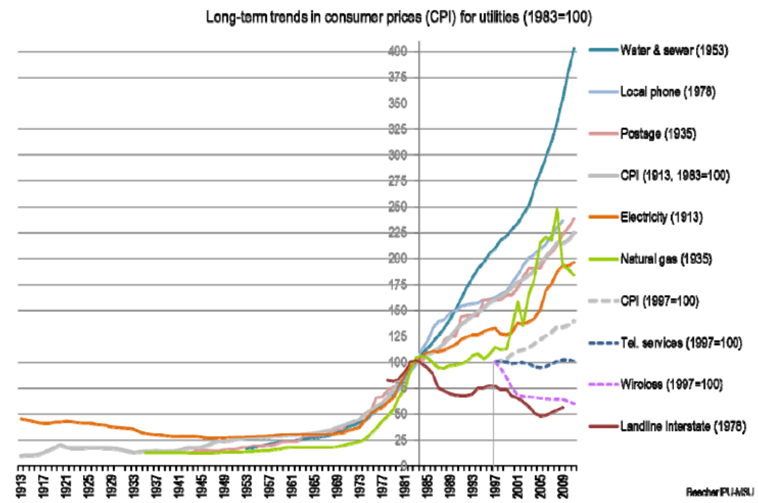

Exhibit 1. Long-term trends in the Consumer Price Index (CPI) for utilities (1913-2011).
The index is set to 100 for 1982-1984 except for telephone and wireless services, where the index is set to 100 for 1997.

How to anticipate this cost, and developing plans of action to minimize the impact, will become the difference between success or failure of managing future business and facilities.

Where are we now?

The first step to managing a facilities water budget is to survey how much water comes into a facility, how it is used and how it is disposed of. For combined sewer bills, the sewer bill is generally based on water consumption. Unless metered separately, water used for irrigation includes a charge for sewage disposal that is not used. A water audit, much like an energy audit, summarizes sources and uses and identifies opportunities for conservation and reuse.

A good first step is to increase the water use efficiency by reducing waste and phasing in high efficiency plumbing fixtures and systems. Typically that will only save 15%-20%, which is a good start but still leaves you vulnerable to price increases from cost and increased demand, which will reduce or eliminate the savings. To really get ahead of the water and sewer cost issue, the prudent facility manager should look to more creative options for water and waste management.

Some simple options available for consideration include:

- Rainwater Collection
- Stormwater collection
- Air conditioning Condensate reclaim
- Greywater Reclaim

Rainwater Collection:

Collecting rainwater predates the bible. As it falls from the sky, it approximates distilled water, being mostly devoid of minerals and chemicals. It makes an ideal source of water for laundries, (where less soap is required), cooling tower makeup (with limited scale producing hardness), watering livestock and pets, and vehicle washing (less soap and less spotting). Once the infrastructure of storage and distribution is established, the water source is free with filter replacement and normal pump maintenance the only maintenance required. If brought into an occupied space the water is required to be maintained at water quality standards per ARCSA/ASPE/ANSI 63 /Design Standards for Rainwater Collection Systems.

Rainwater was provided to supplement the water supply for Western Virginia Regional Jail, initially as a means to gain LEED points. AECOM Engineering, working with Rain Management Solutions of Salem Virginia, utilized the 261,000 square roof as their collection surface to harvest the rain. A siphonic drainage system conveyed rainwater to four (4) 30,000 gallon underground cisterns where the water was filtered and used by the prison laundry.

Figure 1 Western Virginia Regional Jail

When the water savings from all the water conservation measures were totaled, the savings was nearly 11 million gallons of water per year, or about 62.4 percent reduction over the facility's baseline water usage. Of these 11 million gallons saved, nearly 40% was due to the rainwater harvesting system, which saved nearly 4.3 million gallons per year. With this exemplary performance, a LEED innovative design (ID) credit was achieved, making the WFRJ regional jail the first LEED-certified jail in Virginia and one of the first in the United States. This $225,000 project has an expected 2.5 year payback, or 40% Return on Investment.

Figure 2 4.3 million gallons / year are pumped from (4) 30,000 underground tanks and filtered for use in the jail laundry

Stormwater Collection

Buffering stormwater runoff is a side benefit of rainwater collection. Stormwater collection is a variant of rainwater collection, the difference being rainwater is generally considered to be harvested from a roof or other above ground relatively clean surface; while stormwater has come in contact with the ground, sidewalk or parking surface. Stormwater is not perceived as being quite as clean as rainwater, but is serviceable for landscape irrigation, toilet flushing, and area washdown. The required level of treatment is dependent upon the intended use. If brought into an occupied space, the minimal standards would be compliance with the ARCSA/ASPE/ANI 63. But for sub surface irrigation outside, simple filtering can work.

Figure 3 Rainwater Storage tank showing metered rainwater discharge available for irrigation: North Carolina State University Photo

An enhancement to the basic rainwater collection system would be the inclusion of stormwater retention in the system design. Increased development usually means less pervious surfaces and increased runoff during a storm. In the case of the Western Virginia Regional Jail project, rainwater collection system had the added benefit of providing less runoff than in predevelopment conditions, thereby gaining favor with the local building officials concerned about sewage plant overflows from their combined sewer system.

A hybrid version of the two systems uses rainwater collection as a stormwater management tool by reserving a volume in the top part of the rainwater tank equal to approximately 1” of rainfall on the collection surface. This volume is allowed to bleed out of the tank over a designated time depending on rain event frequency, to be used for irrigation, groundwater infiltration, or other use. This technique has been successfully used to answer flooding and high water table issues, along with utility reducing imposed stormwater runoff costs.

Air Conditioning Condensate Reclaim

The small trickle of water coming from a condensate drain is often overlooked, yet has potential for significant savings at the price of some plastic pipe. It is essentially distilled water, low in dissolved solids, but likely high in bacteria count and therefore needing to be treated with appropriate caution. Aerosols created from spraying have the potential to introduce bacteria such as Legionella into the occupant breathing zone. Contained distribution, such as cooling tower makeup is acceptable, but applications such as above ground spray irrigation are to be done with caution. However, depending upon the site location, Exhibit #2 shows that a significant amount of water can be obtained from what normally would be discarded to a floor drain.

Notes:

1. This estimates the annual air conditioning run time if the unit ran at 100% of capacity for the Equivalent Full Load Cooling Hours. Data used is mid range data, as shown in Figure 2, for an office building with an internal load of 1.5 watts per square foot.

2. Outside air design temperatures are a statistical selected value used to properly size air conditioning equipment. The values selected are taken from ASHRAE Fundamentals 2009, Chapter 14 for outside air not exceeding these conditions more than 1% of the time. Units are in Degree Fahrenheit.

Sample Cities	Equivalent Full Load Cooling Hours (EFLCH)@1.5 Watts / sf (NOTE 1)	Dry Bulb / Wet Bulb Design Temperature (NOTE 2).	HR oa @ Design OA Conditions (Note 3)	∆ Humidity Ratio with 20% OA (NOTE 4)	Gallons per Hour (NOTE 5)	Gallons per Year
Atlanta, Ga	1220	91 / 74	0.014	0.004800	0.972	1,186
Boston, Ma	710	88 / 72	0.014	0.004000	0.810	575
Dallas, Tx	1465	98 / 75	0.013	0.003600	0.729	1,068
Indianapolis, In	780	89 / 74	0.015	0.005100	1.033	806
Minneapolis, Mn	465	88 / 72	0.013	0.003600	0.729	339
Los Angeles, Ca	1475	80 / 65	0.010	0.000400	0.081	119
Tampa / Miami, Fl	1900	91 / 77	0.017	0.007500	1.519	2,886

Exhibit #2: Estimated condensate production for typical five (5) ton air conditioning system in various cities.

3. The Humidity Ratio (lbs. moist in 1 pound of air at the outside air condition stated above.

4. This value is a calculated value that takes the Humidity Ratio (HR) of the outside air at the design outdoor air condition minus the Humidity Ration for air coming off a cooling coil, normally approximately 58 degree Fahrenheit Dry Bulb and 90% Relative Humidity. The HR for this condition is .0094 lbs moister per 1 lb of dry air. For bringing in 20% outside air, only 20% of the difference between these values represents the amount of outside air being dehumidified.

5. Calculated using the formula: Gallons / Minute= 4.5/500 * cfm outside air * Δ Humidity Ratio
Gallons / year = Gallons / Minute * 60 Minutes / Hour * EFLCH / Year

Calculations assume a five (5) ton air conditioning system, maintaining a room condition of 75 degrees Fahrenheit and 50% Relative Humidity with 20% outside air. For other conditions and capacities, consult your air conditioning design engineer to determine local condensate recovery potential.

Grey Water

While often requiring the greater investment and system complexity, these options potentially have the greater payback. Unlike rainwater and stormwater usage that must rely on the vagaries of weather, greywater production is more predictable. Greywater systems re-use water from lavatories, showers and laundries primarily for toilet flushing but also can be used for irrigation and process makeup water. The end result is that, after being filtered, disinfected and stored for use, greywater reuse can save approximately 50% of water being consumed with a payback commonly in the 3-5 year range. For the accountants, that is a Return on Investment between 20%-33%.

Figure 4 El Paso Prison (Tx) garden uses recycled grey water to water crops (Texas A & M Agrilife photo by Kathleen Phillips

The design of a greywater system begins with a water audit. The audit is used to balance the sources and uses of greywater. For a successful design, the amount of greywater harvested should be ideally be used within 24 hours to avoid the water going septic, causing odors and potential health issues.

El Paso Prison improves its prisons self sufficiency by using the greywater produced to water the garden. (See Figure 4)

The logical extreme to these examples can be seen in the Bullet Center (Figure 5), a net zero water building newly built in Seattle Washington. This building uses rainwater as its principal source of water, recycles greywater from lavatories and showers for irrigation and groundwater replenishment. Waste is processed using composting toilets, where the compost and urine byproduct becomes a profit center. All these technologies show the possibility of being totally sustainable and if necessary, totally off grid in their building operation.

Figure 5 Bullett Center, Seattle, Wa.

Conclusion:

Resources such as energy and water, previously seen as limitless, now appear less so. Energy conservation is currently the norm. No right-thinking facility manager would claim that energy conservation is not top priority in running a facility. The new realities now include water as another limited resource a facility manager must be prepared to manage.

Adjusting a thermostat and turning off lights can be a simple answer to conserve energy. But there is no alternative if one runs out of water.

Managing water is the next new imperative. Being prepared will separate successful facility managers from those that failed to see the new reality of water shortage.

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[i] Mr Boulware is a member of the IAPMO Green Technology Committee developing national standards for water conservation and was the principal writer of the *ARCSA/ASPE/ANSI 63 Rainwater Catchment Design and Installation Standards*. He is past National President of the American Rainwater Catchment Systems Association (ARCSA.org) and current Vice President of the International Rain Harvesting Alliance (IRHA-h2o.org). Additional information on creative alternatives to utility provided water and waste systems can be found in *Alternative Water Sources and Wastewater Management (*McGraw-Hill) written by Mr. Boulware. Mr. Boulware is president of Design-Aire Engineering (www.DAEngineering.com), based in Indianapolis, Indiana, specializing in off grid and sustainable Mechanical, Plumbing and Electrical Systems.