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Alternate Building Water Systems

What is in the water in the buildings we design? Is it safe, or could it harm someone in the building? Green buildings encourage the use of alternate water sources such as rainwater and graywater. Are alternate water sources safe?

The Associated Press recently reported about new water quality concerns in facilities that receive their potable water from on-site groundwater and small water treatment facilities.[1] According to the article, groundwater in up to 10 percent of the nation's schools can contain lead and other toxins. In many cases, this water is not under federal Clean Water Act regulations for testing.

This brings to light an issue for plumbing engineers designing buildings for owners who are concerned about water conservation or obtaining USGBC LEED water-efficiency credits by using alternate water sources. How good is the quality of the water from these sources? Can it harm the occupants or damage the plumbing equipment in the building?

Plumbing engineers know that buildings have separate water streams, such as potable water and process water. Different building systems use varying qualities of water from different sources, and the new LEED rating systems place more importance on recycled water, graywater, and black water systems. What issues drive the need to separate the water systems in a new building? What are the types of water and what impact does this have on future design practices for plumbing engineers?

WHAT ARE SOME OF THE ISSUES WITH WATER?

The Amount of Water We Use

Those who have traveled to a developing country know how valuable water is and how much time is spent every day to obtain safe water. Residents of such areas know that water is valuable and should not be wasted. Many people in the United States would not be able to obtain the water they use every day without the machinery and energy it takes to get water to the tap. In most American cities, a municipal water and waste system treats about 130 gallons of water per person per day, a process that uses a large amount of energy, approximately 20 percent of the total energy usage of a typical city. As a result, turning off your faucet will save energy similar to turning off a light.

Water Quality

The AP report and others in the last few years have shown that trace pharmaceuticals and lead have been found in our drinking water. While most U.S. tap water is very safe to drink, people are still concerned about maintaining that high quality.

Storm Water Capacity

Rainwater has fallen to the ground for millions of years, and the Earth has developed a very efficient system to move and treat that water. Figure 1 shows the typical biospheric methods for cleaning and distributing water.

However, in the last 100 years, people have come to believe that rainwater must be removed from a roof, building, or site as quickly as possible. When entire cities adopt this philosophy, the first problem is that little rainwater returns to the groundwater system, resulting in surface and waterway flooding. A second problem occurs when water flowing over fertilized plants and grasses quickly moves these nutrients off the plants, into the natural water systems, and to other regions. This practice has created massive dead zones in our oceans that cannot support any life. The third problem is that many urban areas have old combined storm water and sewer systems, and during heavy rains this combined water can go to natural sources untreated.

Our Current Baseline System

Figure 2 shows the large amount of water that flows through water treatment facilities to our buildings. If you think of this water supply as a big faucet, you can start designing systems that decrease the faucet flow. Unfortunately, most of this clean, safe drinking water is turned into wastewater containing a cocktail of hazardous materials that flows through the building, which can be considered an enormous toilet. Maybe building systems can reuse some of this water with an alternate water system that separates the water streams.

SEPARATE WATER SYSTEMS

Rainwater Catchment

Before a building is constructed, the earth on the site absorbs rainwater that falls on the ground. Maybe it is a good idea to replicate the natural way water is treated by designing systems that use rainwater instead of building expensive systems to move that rainwater away from the site (see Figure 3). One way to do this is to capture rainwater and use it in the facility's landscaping system. This way, the water is distributed over the soil and re-enters the natural system. These rainwater catchment systems can be simple to design and safely maintained with few regulatory issues. The end result is that the flow from the municipal water supply faucet can be reduced. In some facilities, one-fourth of the building water goes to turf irrigation.

HVAC Condensate

Another potential building water source—condensate from the heating, ventilation, and air-conditioning system—often is overlooked and mixed with the building's waste system. HVAC condensate has few contaminates and can be safely collected with a simple piping system. One use for this water is for the cooling tower makeup, and another is irrigation. Such a system can further reduce the amount of water flowing from the municipal faucet (see Figure 4). In some facilities, mechanical systems can use one-fourth or even one-third of the building's municipal water. These systems usually have few regulatory restrictions and can be very safe and manageable.

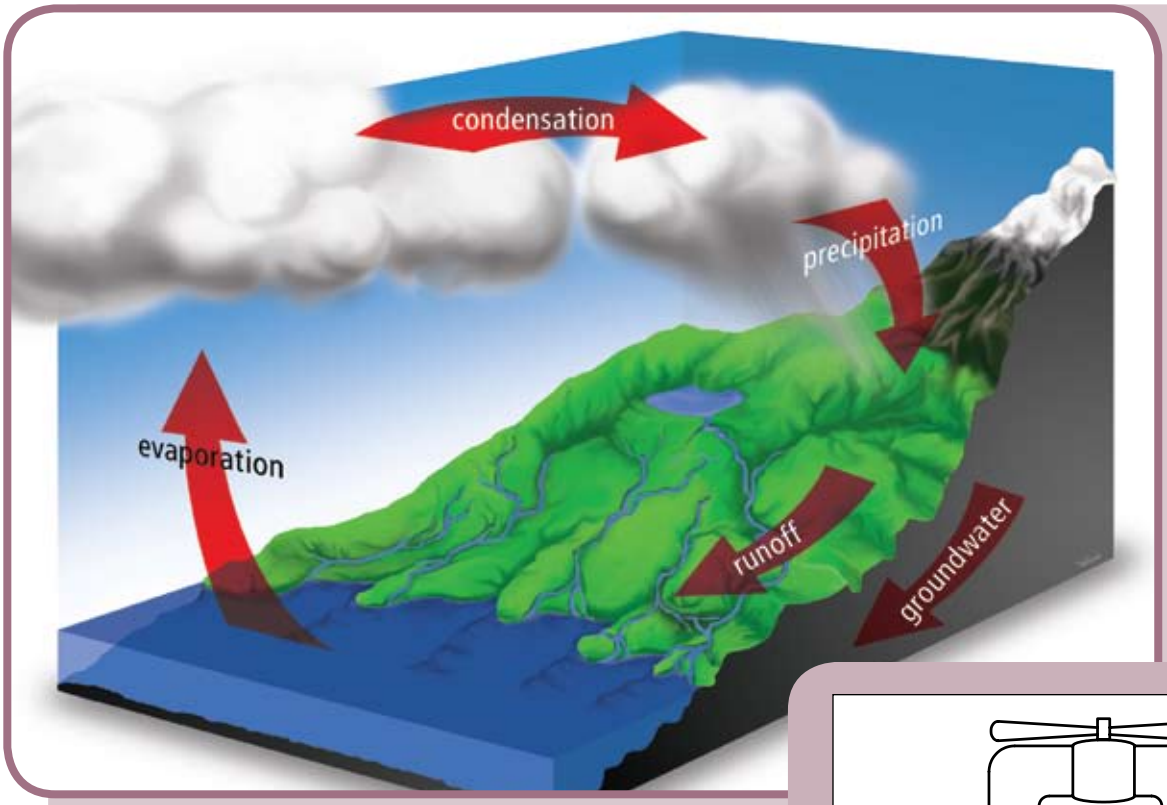

Figure 1 Biospheric methods for cleaning and distributing water

Alternate Water Source Standard Development

To address concerns about water quality from alternate sources and to respond to the lack of standardization, several groups including the National Sanitation Foundation (NSF) and the American Society of Plumbing Engineers (ASPE) are developing operation and design standards for graywater and rainwater catchment systems. Such standards will include guidelines on the quality of materials and surfaces and welding and construction practices, as well as monitoring systems for failures in alternate water systems. For example, the standard could require systems to warn the operator when it is not operating properly. The standards also will define operational procedures for performance testing and evaluation, as well as define parameters such as turbidity, pH, and biological oxygen demand.

Stress is an important design and operational issue for alternate water systems. Stresses include how the system performs in high-volume situations and low-volume situations. The standards will respond to such issues, including the dosing of treatment chemicals and schedules for sample collection.

When designers initially are confronted with these data and requirements, they may be overwhelmed and think that such systems will be too complex and expensive to operate. However, the amount of effort to design and regulate these systems can be compared to the standards for water quality and operations for public swimming pools. Swimming pools are very common because the industry developed products and procedures to accommodate owners' needs. The same thing can happen with alternate water systems.

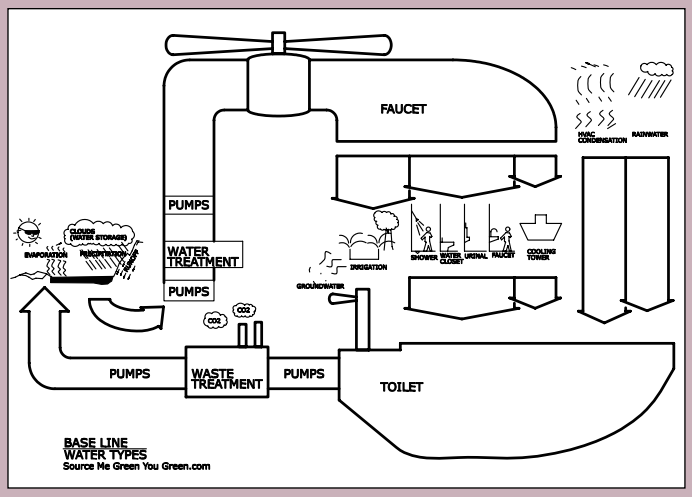

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Figure 2 This simple illustration shows the municipal water treatment process as a large faucet that supplies high-quality water to a site. It also shows the typical municipal wastewater treatment system as a big toilet that carries away wastewater and treats it. The water from the faucet goes to several systems in a building. The plumbing engineer can design systems to reduce the size of the faucet and toilet.

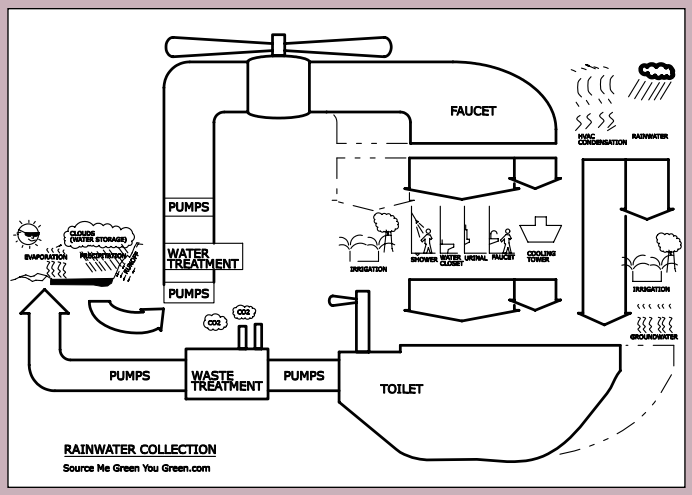

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Figure 3 The municipal faucet and toilet can be reduced by reusing rainwater in an irrigation system.

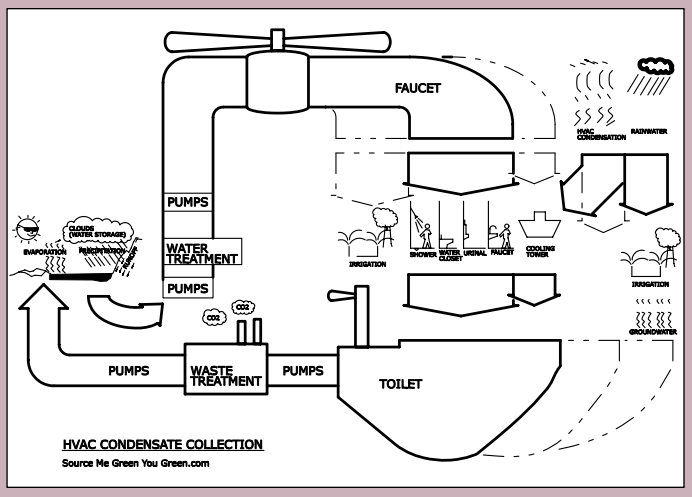

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Figure 4 Collecting, treating, and distributing HVAC condensate to the building cooling tower system can reduce the size of the municipal faucet and toilet.

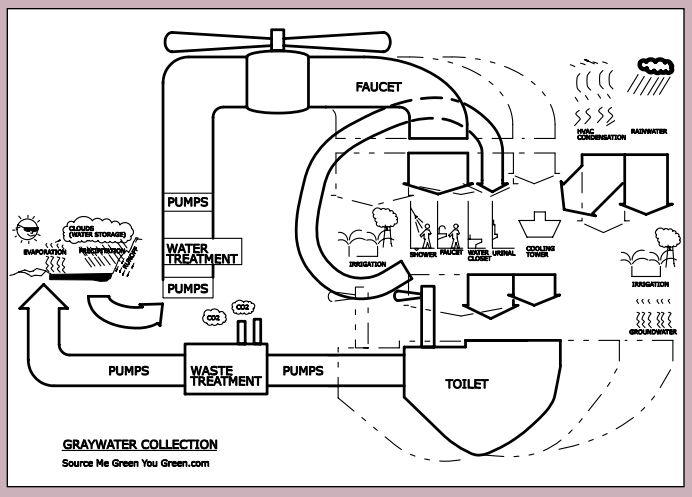

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Figure 5 Installing graywater systems further reduces the size of the municipal faucet and toilet.

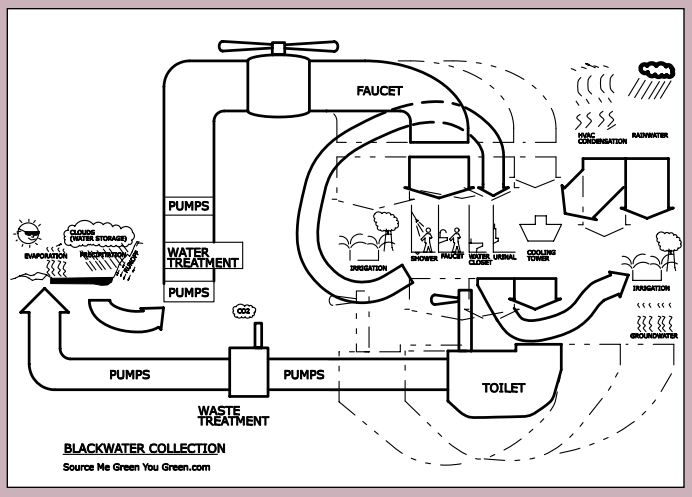

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Figure 6 Black water systems can be expensive to install and operate safely, but when they are used, they can reduce flows in the municipal faucet and toilet.

Graywater Systems

Water from lavatories, showers, bathtubs, washing machines, and sometimes sinks can be captured, treated, and reused in irrigation, mechanical, or flush systems. Installing graywater systems (see Figure 5) can greatly reduce the amount of water from the municipal faucet and into the building. These systems can be expensive and complicated to design and safely operate and gaining regulatory approvals may be difficult. However, groups such as the National Sanitation Foundation are developing standards for water quality and maintenance in graywater systems. (Refer to the sidebar.)

Black Water Systems

The USGBC LEED rating system describes black water as wastewater from toilets and urinals. While discharge from showers and bathtubs typically is considered graywater, some municipalities classify it as black water. Black water systems treat and store water from toilets and urinals and reuse it as a source for irrigation, mechanical, and flush systems (see Figure 6). Unfortunately, the expense to safely treat the wastewater and install and operate these systems is too high to include them in typical buildings.

REGULATORY ISSUES

The first major issue with alternate water systems has to do with water quality. Municipal systems use federal, state, and local guidelines, and as a result, the industry has developed products to help owners operate efficient and safe water treatment facilities. However, alternate water systems do not fall under these same guidelines. Without standards for water from alternate sources, it is hard for the industry to respond with products. Currently, some plumbing manufacturers will not warranty their products when water from alternate sources is used. If standards were consistent, the alternate water industry could make products to meet the requirements.

Another regulatory issue concerns the maintenance of such systems. Municipal systems have testing schedules and protocols to operate efficiently and safely. In contrast, alternate water systems do not have these same procedures, which makes it difficult for the market to respond with products that meet the operational needs for these systems.

LOOK TO THE FUTURE

Alternate water systems will be included in many future new construction projects. Plumbing engineers should start looking at these alternate system design practices now. PSD

REFERENCES

1. "EPA unveils new policies on water at schools." Associated Press. Dec. 8, 2009.

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