Rainwater Harvesting Becomes a Mainstream Sustainable Practice

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The past few years have seen a surge in commercial applications of rainwater harvesting. From the King Street Center office building in Seattle to MIT's Stata Center for computer information in Boston, building owners are collecting rainwater for a variety of purposes and a variety of reasons.

A well-designed rainwater harvesting system integrates several design disciplines, including civil, mechanical and electrical engineering, architecture and landscape architecture, toward the common goal of using one of nature's most renewable resources. Depending on the application, rainwater becomes the sole or partial source of water for water closets and urinals, landscape irrigation, hose bibs, water features, cooling towers or secondary fire suppression.

From a building owner's perspective, rainwater harvesting offers the opportunity to decrease water and wastewater costs, which are rising faster than energy costs in some parts of the country. It can ease the burden of system development charges that often are assessed on new buildings to help pay for expanding municipal infrastructure and separate storm water management systems. Rainwater harvesting also can turn a potential liability—runoff and resulting erosion—into an asset.

Perhaps the best, and most prevalent reason, for integrating rainwater harvesting into a new building's design is increasing interest in green building. Rainwater harvesting is a relatively easy and excellent way to demonstrate environmental stewardship to the community and stakeholders. And, depending on the design, rainwater harvesting can help a project garner up to seven points toward the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED™) rating, making it easier to achieve LEED Silver, Gold or Platinum levels.

Candidate Buildings and Locations

What types of buildings are candidates for rainwater harvesting, and where? The good news is that much of the country has sufficient rainfall for some type of harvesting system, even if used strictly for irrigation. Even areas that are perceived as dry, such as Arizona and Texas, often are candidates because they receive periodic, intense downpours that allow concentrated collection. Additional details on balancing the amount of rainfall against system size appear under System Components below.

Similarly, the sky's the limit on the type of building that can accommodate a rainwater harvesting system. The simplest and most common point of collection is the roof; so the larger the roof footprint, the more rainwater that can be collected. This makes low-to-mid rise commercial and residential buildings good candidates because the ratio of roof area to water closets and urinals is greater. Even so, rainwater can and is being collected on high-rise buildings, including dormitories. The rainwater is simply pumped to water closets and urinals on the lower floors only, or is used for other purposes such as irrigation, water features or secondary fire suppression. Taller buildings have the advantage of collecting less debris, such as leaves, in the rainwater.

The most important prerequisite for a successful system is that the building owner has a passion for harvesting and using rainwater. It doesn't matter if that passion is driven by a desire to have the building LEED certified, to demonstrate environmental stewardship, to achieve lower long-term life-cycle cost, or a combination. Rainwater harvesting systems currently do not meet most building owners' investment criterion of a three-to-five year payback. But a building owner who is a champion of rainwater harvesting as a sustainable practice will appreciate the added value the system brings and shepherd it through design and construction.

System Design and Components

The system components and parameters of a rainwater harvesting system include:

- **Collection area.** As mentioned, this usually is the roof.[1] Unless the rainwater will be used for potable water (see Regulatory Environment below), any type of roof material and design will work if it allows rain to be conveyed by gutter or downspout to the storage tank. Buildings that are less than two-to-three stories may require screens, debris excluders and other measures to keep out leaves and debris. Most systems have a roof washer that removes big debris and dirt and pollutants that have "collected" on the roof since the last rainfall.
- **Storage tank or cistern.** This is the heart of the system, and also the most expensive. Tanks can be above or below ground and made of epoxy steel, fiberglass, pre-cast concrete, polyethylene or poured-in-place concrete. The type of tank is job specific and highly dependent on its location and associated engineering and construction costs. The tank type (and size) also is influenced by whether it's doing double duty for the sprinkler system. Tanks can be located creatively in areas such as under plazas, in parking garages and under driveways. Special care is needed to shade fiberglass tanks so they don't promote algae growth.
- **Tank size.** Sizing the tank is a mathematical exercise that balances the available collection (roof) area, annual rainfall, intended use of rainwater and cost. In other words, you balance what you *can* collect against how the rainwater will be used and the financial and spatial costs of storing it. In most areas of the country, it's possible to collect 80 percent of the rain that falls on the available roof area. (The 20 percent reduction accounts for loss due to mist and heavy storms that release more rain than the tank can accommodate.) A good rule of thumb is that it's possible to collect 600 gallons of water per inch of annual rainfall per 1,000 square feet of roof area.
- **Pumps, filters, treatment, valves, piping and controls**. In most applications, a duplex pump system is necessary to distribute the harvested rainwater from the storage tank to designated fixtures. Filtering and ultraviolet treatment occur prior to delivery. A bag-type polyethylene filter results in less pressure loss than a cartridge filter. Installation of a reduced pressure backflow assembly protects the connection to downstream domestic water. Control valves monitor the level of rainwater in the tank against pump operation. Many

[1] Some rainwater harvesting systems collect rainwater from parking lots. This requires a primary settling tank, oil-water separation and additional filtering that are beyond the scope of this article.

municipalities require that piping to water closets, urinals, irrigation systems and hose bibs be continuously labeled with “Harvested rainwater, do not drink.” It should be noted that the pumps, filters, valves and controls require on-going maintenance, although the time and sophistication required are relatively minor.

Economics

The cost of rainwater harvesting systems varies considerably with the application, but generally runs about $1 per gallon of storage capacity. Paybacks often range from 10? to 15 years. The case studies below, which were engineered by Interface Engineering in Portland, Ore., illustrate various system approaches and their costs. Each of these systems is being metered to measure harvested rainwater and domestic water use, making it easier to quantify cost and savings data in the future.

Regulatory Environment

When considering a system, it is critical to work within the framework of local regulatory requirements and guidelines. States and municipalities are rapidly gaining familiarity with rainwater harvesting systems. As they outline and refine their regulatory parameters, they often are flexible in helping make systems work within their communities. For example, some localities prohibit the use of harvested rainwater in water closets because of the potential that untreated tank water could be mistaken for potable water. In these situations, locking tanks and sealed flushometer-type water closets can be viable options as can signage. With proper treatment, rainwater is even being used for hand washing, such as at the Chesapeake Bay Foundation’s Philip Merrill Environmental Center, in Annapolis, Maryland (LEED v. 1.0 Platinum-certified project).

LEEDing Opportunities

A building with a rainwater harvesting system has the potential to garner up to seven LEED points as follows:

- 1 point for installing above-code measures that result in 20 percent water savings.
- 1 point for installing above-code measures that result in 30 percent water savings (typically waterless urinals or other unusual measures).
- 1 point (innovation credit) for installing above-code measures that result in 40 percent water savings (rainwater harvesting system or other water re-use).
- Up to 2 points for storm water reduction (storm water management practices).
- Up to 2 points for water-efficient irrigation
- 1 point for reducing the project’s sewage generation from use of potable water by 50% or more.

Case Study Examples

Station Place, Portland, Oregon

Building type:	Elderly housing, 170 units in three connected towers: 14-story, 12-story, 9-story
Completion date:	2003
Collection area/amount:	12,000 sq. ft. total from three towers, with expected rainwater harvesting of 250,000 gallons per year.
System description:	Rain collects into a gravity tank on each tower, feeding into the common fire sprinkler storage tank, located under a ramp in the parking garage
Rainwater application:	Support flushing of 75 water closets on the 2nd through 5th floors, as well as secondary fire suppression.
Comments:	Rainwater plumbed to 41 percent of project water closets, which have locking-type lids. This is the first project to use tank-type locking covers in the City of Portland, which hasn't previously allowed rainwater use in water closets. Portland officials will visit the project annually to spot check maintenance on locking lids.
Engineer:	Interface Engineering, Portland, Oregon

Epler Hall, Portland State University, Portland, Oregon

Building type:	65,000 sq. ft., six-story dormitory, housing 130 students; offices and classrooms on ground floor.
Completion date:	2003
Collection area/amount:	10,000 sq. ft., with expected rainwater harvesting of 230,000 gallons per year.
System description:	Rain collects into an undergound tank, located in an adjacent plaza.
Rainwater application:	Supports flushing of water closets and urinals in ground-floor public restrooms, with excess used for landscape irrigation.
Tank:	5,600 gallons, polyethylene.
Comments:	This project is located in a highly urban storm water management zone. To ease the burden on Portland's storm water management system, the tank was sized for a two-year intensity rain event. City of Portland plumbing code restrictions mandated use of tankless, flushometer-type fixtures.
Total Project Cost:	$7.4 million
LEED status:	Certified, pending
Engineer:	Interface Engineering, Portland, Oregon

Block 25, Oregon Health Sciences University, Portland, Oregon

Building type:	350,000 sq. ft., 17-story mixed use, with office, clinics, health club and ground floor retail.
Completion date:	Anticipated 2005
Collection area/amount:	21,400 sq. ft., with expected rainwater harvesting of 444,000 gallons per year.
System description:	Rain collects into the storage tank, located on the lowest parking level. This tank is also used for cooling energy, groundwater reclamation (via pumping of wells) and fire-sprinkler system backup.
Water system application:	Supports flushing of 100 percent of building core water closets and urinals.
Tank:	30,000 gallons concrete tank, with 15,000 designated for groundwater reclamation.
Comments:	This project is located adjacent to the Willamette River in an urban storm water management zone
Total Project Cost:	$50 million (anticipated)
LEED Status:	Registered, Gold-certified goal
Rainwater System Cost:	$60,000
Payback:	15 years

Engineer: Interface Engineering, Portland, Oregon