Rainwater Harvesting, Condensate Reuse and Gray Water Use

Background

The purpose of this BMP is to highlight ways of creating water efficiency through the use of rainwater harvesting, condensate reuse and/or the use of recycled water for irrigation or other applicable purposes.

In addition to providing water use efficiency, use of rainwater harvesting methods, such as cisterns, can also count as stormwater treatment devices. Development projects that use rainwater harvesting methods for rooftop runoff can receive stormwater reduction credit. This credit can be used to reduce, or possibly eliminate, other types of stormwater treatment devices such as wet ponds. This document does not provide details on the design techniques to achieve stormwater credit but that information is available in the Stormwater BMP Manual provided by the N.C. Division of Water Quality. It can be found in Chapter 19, "Rooftop Runoff Management" and is available at http://portal.ncdenr.org/web/wq/ws/su/bmp-ch19.

Applicability

This BMP is intended for use by a water system ("utility") concerned with reducing outdoor irrigation demands on the potable water system.

Calculation of potential savings will depend on regional climate patterns. Rainwater harvesting and condensate reuse are applicable to industrial, commercial and institutional (ICI) buildings, while private homes can benefit from rainwater harvesting. Utilities may benefit by targeting this BMP to help shave peak demand through customer education. For maximum water-use efficiency benefit, the utility should adhere closely to the measures described below. Gray water use will not be discussed in this BMP until the N.C. Division of Water Quality has established an approved gray water use system as directed by the North Carolina General Assembly.

Description

Rainwater harvesting and condensate reuse ("RWH/CR") conservation programs are an effective method of reducing potable water usage while maintaining healthy landscapes and avoiding problems due to excessive run-off. Using this BMP, the utility provides customers with support, education, incentives and assistance in proper installation and use of RWH/CR systems. RWH/CR systems will be most effective if implemented in conjunction with other water efficiency measures including water-saving equipment and practices. Rainwater harvesting is based on ancient practices of collecting, usually from rooftops, and storing rainwater close to its source, in cisterns or surface impoundments, and using it for nearby needs. ICI users have found it to be cost-effective to collect the condensate from large cooling systems by returning it into their cisterns as well. Facilities with large cooling demands will be in the best position to take advantage of condensate reuse, which due to its quality can potentially be used in landscape

irrigation, as cooling tower makeup water, or in some industrial processes. The variability in rate and occurrence of rainfall requires that rainwater or condensate be used with maximum efficiency. Incentives may include rebates for purchase and installation of water-efficient equipment.

Several factors should be considered in the design of rainwater harvesting and condensate reuse systems. System components include the collection area, a first flush device, a roof washer, storage structure with the capacity to meet anticipated demand and a distribution system. For above ground structures, design consideration should be given to maintaining the highest elevation feasible for collection and storage systems for the benefit of gravity flow to distribution. When using drip irrigation systems, filters are necessary to prevent particulates from clogging drip nozzles. Regular maintenance of RWH/CR systems includes changing filter media on a regular basis and cleaning the first flush filter. The utility should consider providing participants with reminders of regular maintenance requirements for their RWH/CR systems. Maximum expected daily demand and knowledge of historical precipitation patterns, including amount, frequency and longest time between rainfall events, is important in designing the system. The Rainwater Harvesting: Guidance for Homeowners produced by North Carolina State University can be used as a resource, as well as technical assistance from professional installers of equipment for proper design and implementation of RWH systems. To see the guide, go to http://www.bae.ncsu.edu/stormwater/PublicationFiles/WaterHarvestHome2008.pdf.

While residential cooling systems are unlikely to provide significant flows of condensate, ICI installations with large cooling demands can produce significant amounts of condensate and should be evaluated for the dual RWH/CR system. Large ICI installations can implement rainwater harvesting (from roofs), as well as capture of stormwater for irrigation or other non-potable uses. Large buildings that have or need French drain systems for foundation drain water should also evaluate the potential for recovery of this resource as well.

The utility should consider sponsoring one or more demonstration sites. Potential partners include customers with educational missions such as schools, universities, botanical gardens and museums with large public landscapes.

Although rainwater is recommended for all irrigation uses, it is most appropriate for use with drip or micro irrigation systems. Utilities implementing this BMP should consider offering a landscape water-use survey to help customers ensure that RWH/CR systems are properly designed and sized.

The water-use surveys, at a minimum, should include: measurement of the total irrigated area; irrigation system checks, review of irrigation schedules or development of schedules as appropriate; and provision of a customer survey report and information packet. The utility should provide information on climate-appropriate landscape design and efficient irrigation equipment and management for new customers and change-of-

service customer accounts. See the Residential and commercial Landscape Irrigation BMP for more detail.

Implementation

Programs should consider the following elements:

Retrofit or Rain Barrel Program

- Marketing the program to the customer via bill inserts will allow the utility to target the largest summer peak users first. The utility should consider also approaching local weather announcers, radio gardening show hosts, and newspaper columnists for assistance in notifying the public about the program. The program can be marketed using public/private partnerships with non-profits such as gardening clubs, neighborhood associations, cooperative extension offices or with green industry businesses such as rainwater harvesting companies and local sustainable building groups. Using these partnerships can also be an effective way to leverage available resources.
- Incentives can include rebates for RWH/CR systems, recognition for RWH/CR systems through signage, award programs, and certification of trained landscape company employees and volunteer representatives to promote the program.
- The initial step in assisting customers with landscape irrigation systems is a thorough evaluation of the potential water captured by a RWH/CR system.
- The water customers who participate in this program will need to maintain and operate their irrigation systems efficiently. The utility should consider implementing a notification program to remind customers of the need for maintenance and adjustments in irrigation schedules and to system filters as the seasons change.
- The utility needs to ensure that RWH/CR system specifications are coordinated with local building and plumbing codes.
- The American Rainwater Catchment Systems Association lists evaluation training for RWH/CR programs. ICI customers may want to consider performance contracting as an option for financing retrofitted RWH/CR systems.

New Construction: In addition to retrofitting existing homes and buildings with RWH/CR systems, a utility may also choose to support new construction. Using this approach, the utility could:

- Adopt ordinances requiring all new ICI properties to install a RWH/CR system that collects and stores rainwater and condensate from all eligible sources and distributes it to irrigation and/or a cooling tower make-up system.
- Implement an incentive program to encourage builders and owners of new ICI properties to install a RWH/CR system that collects and stores rainwater and condensate from all eligible sources and distributes it to irrigation and/or a cooling tower make-up system. In large ICI buildings requiring cooling towers, design consideration should be given to returning condensate flows from air

conditioning coils to cooling tower make-up. It may be effective for this BMP to be part of a Green Builder-type rating system that also includes WaterWise landscaping and adequate soil depth.

- Implement an incentive program to encourage homebuilders and homeowners to install a RWH system for landscape use to reduce potable water consumption from the utility in the summer season.
- Adopt ordinances requiring that new homes or multi-unit properties install plumbing that separately collects and stores rainwater from eligible sources and distributes the rainwater through a subsurface irrigation system. The rainwater could be distributed around the foundation of the residence or building or for other landscape use.

Such programs would need to be carefully coordinated with stormwater collection programs and meet all applicable regulations for stormwater collection and reuse.

Schedule

Depending on the option(s) selected, the corresponding schedule should be followed.

Incentive Approach**:** In the first six months, plan the program including stakeholder meetings as needed. Develop a plan for educating potential homebuyers, developers, plumbers, green industry trade groups, landscape architects and realtors about this program. After six months, implement the program.

Ordinance Approach: In the first six months, hold stakeholder meetings to develop the ordinance. Consider offering incentives for the first year of implementation. Propose the ordinance or rules to the local city council for approval. Develop a plan for educating potential homebuyers, developers, plumbers and realtors about this program. After six months, implement the program.

Scope

To accomplish the goals of this BMP, the utility should do one or more of the following:

- Develop and implement an incentive program to encourage RWH/CR in new multi-unit properties and certain new commercial developments such as office parks.
- Develop and implement an incentive program to encourage RWH/CR in existing multi-unit properties and certain existing commercial developments such as office parks.
- Develop and implement an incentive program to encourage residential customers to install rainwater harvesting systems.
- Develop and implement an ordinance requiring condensate recovery in new non-residential construction as applicable.

Documentation

To track this BMP, the utility should gather and have available the following documentation for each year of operation:

- The number of new RWH/CR developments for which design planning started after adoption of this BMP.
- The number and type of RWH/CR installations completed each year.
- The estimated rainwater and condensate use in each RWH/CR installation.
- Aggregate water capacity of RWH/CR sites.
- The number, type and dollar value of incentives, rebates or loans offered to and accepted by customers.
- Estimated water savings achieved through customer surveys.

Determination of Water Savings

Water savings from a RWH/CR program is determined by water volume harvested and used to replace other potable water sources. In programs which target new construction, the water savings should be estimated based upon known water consumptions for the proposed end use. A number of sources, including other BMPs, can be helpful in estimating potential water savings. A method for estimating potential water catchment and a monthly water balance equation for estimating water storage capacity are:

Catchment Potential (gals) = Area x 0.62 x 0.8 x [Rainfall]

Where Area = total area of catchment surface in square feet.
0.62 = coefficient for converting inches per square feet to gallons
(unit conversion from 7.48 gallons per cubic feet).
0.8 = collection efficiency factor.
0.9 Rainfall = average rainfall in inches.

Note: Median and lowest recorded rainfall can also be calculated in order to develop a range of expected values.

Storage Capacity: A simple assumption is that up to three weeks may lapse without significant rainfall. As such, it's recommended that storage structures are sized to maintain three weeks' worth of water use.

- More precise methods of estimating needed storage capacity or additional information for estimating water balance of RWH/CR systems and of accounting for the variability in seasonal rainfall pattern is available at the Rainwater Harvesting website of NCSU at http://www.bae.ncsu.edu/topic/waterharvesting/model.html.

- For condensate recovery, storage should be based on the anticipated maximum holding time before the condensate is reused for irrigation or other purposes.

Cost-Effectiveness

The costs of this BMP to the utility will include administrative program management costs and incentives to customers for implementing rainwater harvesting or condensate reuse projects. Depending on program design and whether project inspections are required, staff labor costs should range from $50-to-$100 per project. Marketing and outreach costs range from between $20 and $50 per project. Administrative and overhead costs range from 10-to-20 percent of labor costs. For rain barrel installations, labor costs range from $8 to $12 per project and warehouse storage costs may be an additional consideration.

For comments or questions on the Rainwater Harvesting and Condensate Reuse BMP, please contact the water efficiency specialist of the Water Supply Planning Branch at 919-707-9021.

References

- American Rainwater Catchment Systems Association. http://www.arsca-usa.org/
- *First American Rainwater Harvesting Conference Proceedings*, Gerston, J. and Krishna, H., editors, ARCSA, August 2003.
- *Rainwater Harvesting Design and Installation,* Save the Rain saverain@gvtc.com
- *Texas Guide to Rainwater Harvestin*g, Texas Water Development Board and Center for Maximum Potential Building Systems, 2nd Edition, 1997. http://www.twdb.state.tx.us/publications/reports/RainwaterHarvestingManual_3rdedition.pdf
- *Waste Not, Want Not: The Potential for Urban Water Conservation in California,* Pacific Institute, November 2003. http://www.pacinst.org/reports/urban_usage/waste_not_want_not_full_report.pdf
- Rainwater Harvesting at North Carolina State University http://www.bae.ncsu.edu/topic/waterharvesting/
- http://www.bae.ncsu.edu/stormwater/PublicationFiles/WaterHarvestHome2008.pdf

Case Studies for Rainwater Harvesting and Water Reuse

North Guilford Middle and High School Greensboro, North Carolina

Background

Greensboro is in Guilford County in north central North Carolina and has a population of 263,000 people. North Guildford Middle and High School have a total student population of 2,344. The schools were constructed in 2007. The design of the rainwater harvesting infrastructure for the school took place at the time of the school design.

The goal for the project was to collect enough water to flush the toilets in the facility and also to irrigate the school grounds. This goal was met on completion of the project.

Cistern size – 360,000 gallons
Water saved per year – 4 million gallons
Cost – $500,000 or $1.39/gallon
Cost Savings – 4 million gallons at a cost of $1.50/gallon which = $6,000/year

The project's design was driven by location, number of students and faculty, weekly and seasonal schedule of the schools, available collection area, plumbing fixture efficiency, rain water supply and other factors.

The rainwater harvesting project has also been used as an educational resource for the school. Other system benefits include the elimination of stormwater runoff from the site and the reduction of utility bills.

For more details on this project, go to
http://innovativedesign.net/files/Download/NMS%2085x11.pdf.

University of North Carolina at Chapel Hill Chapel Hill, North Carolina

Background

Chapel Hill is in Orange County, where water is provided by Orange Water and Sewer Authority. The University of North Carolina at Chapel Hill has a population of more than 28,000 students.

The facilities service division of the University of North Carolina noted the limited local water supplies and recent droughts. This highlighted the need to reduce water consumption across the UNC campus. Planning and construction of cisterns and the use of reclaimed water have reduced the overall need for potable water. In 2009, operations started on a reclaimed water system that further reduced potable water consumption by more than 200 million gallons per year.

The first project the university undertook was using reclaimed water to irrigate some athletic fields and to help cool the chilled water plants. In 2009, all five chilled water plants, which use 200 million gallons of water per year, were using reclaimed water as their water source.

In 2012, a 350,000-gallon cistern is being constructed in the former UNC Bell Tower parking lot. Water from the roof of the new Genome Sciences building will be stored here and then used to irrigate Kenan Stadium and flush the stadium's toilets. Other cisterns installed in front of Hanes Hall and beneath the parking structure at Boshamer Stadium collect water from the roofs of these structures and this water is then used to irrigate the baseball field at Boshamer Stadium. Overflow irrigation is collected and recycled into the cistern.

UNC has worked closely with OWASA on this process. The reclaimed water used on the campus is highly treated wastewater that is pumped to the university after being treated at Mason Farm Sewage Treatment Plant.

UNC continues to look for opportunities to use reclaimed water and harvested rainwater. The expansion of the campus to the north will be designed using the information gained from these existing projects.

For information on home rainwater harvesting, please see the following links:

http://sustainability.unc.edu/Initiatives/WaterManagement.aspx
http://www.bae.ncsu.edu/topic/waterharvesting/

For more information at UNC's reclaimed water use, please see the following links:

http://www.owasa.org/whatwedo/reclaimed-water.aspx
http://sustainability.unc.edu/Initiatives/WaterManagement.aspx

Case Study for Rainwater Harvesting

North Carolina Aquarium at Pine Knoll Shores, NC

Background

The design and construction of this rainwater harvesting cistern took place after the aquarium was built.

The goal for the project was to prevent stormwater runoff from the site. The collected water is used to irrigate the greenhouse and plant nursery and for maintenance purposes such as deck and vehicle washing. This goal was met on completion of the project.

Cistern size – 18,000 gallons held in six tanks
Water saved per year – 4 million gallons
Purpose – stormwater runoff abatement and conservation of municipal water

The rainwater harvesting project has also been used as an education resource for the aquarium. A major benefit of the system is that stormwater runoff on the site has been reduced and utility bills have been lowered.

For more details on this project, go to
http://www.nccoastaltraining.net/uploads/Rainwater%20-%20KATHY%20DeBUSK.pdf.