

Summary Fact Sheet

Category: 7.0 Water Conservation/Reuse

Practice: 7.1 Cisterns/Rain Barrels

General Description: Cisterns and rain barrels are rainwater catchment systems (RWCS) used to reuse roof runoff. With maximum volumes on the order of 10,000 gallons, cisterns have a much higher storage capacity than rain barrels, which typically store less than 100 gallons. RWCS reduce the runoff volume and, for small, frequently-occurring storms, the peak discharge rate. Water quality benefits will depend on the end use of collected water. In areas where high real estate prices, poor soil infiltration capacity, or little available open space preclude the use of infiltration BMPs such as bioretention, RWCS may be an especially significant BMP for water quality and quantity control.

Cisterns can serve as a secondary source of water for applications that do not require potable water, potentially lowering a building's potable water demand (and costs) and reducing the volume of stormwater that leaves the site as runoff. Applications include:

- toilet flushing
- use as air conditioner coolant, and
- landscape irrigation water.

Rainwater collected in rain barrels is primarily used for residential landscape irrigation. Landscape irrigation can account for as much as 40% of domestic water consumption. An advantage of roof water recycling is that roof water is relatively clean, compared to surface runoff, and can provide a source of chemically untreated "soft water," free of most sediment and dissolved salts. RWCS may be used with downspout disconnection (see fact sheet 4.1).

Water Quantity Controls

For any storm, the runoff volume will be reduced by an amount equal to the empty volume of the RWCS, which may be less than the total storage capacity. The peak discharge rate may be delayed or attenuated, depending on captured volume.

Rain barrel sizing is relatively simple. Rain barrels store between 55 and 60 gallons and may be connected in series. Space constraints and frequency and volume of irrigation will determine the number of rain barrels used for a rooftop.

Cistern sizing depends on the water demand and on the collection volume: in other words, an analysis of the water input and output. Storage in addition to the WQV may be needed if cistern water is not completely drawn down between storms. Per capita use of cistern water (e.g. toilet flushes per person per day) can be used to calculate the demand, i.e. the cistern outflow rate.

Water Quality Controls

To be considered a water quality BMP in Northern Virginia, a RWCS must collect the water quality volume (WQV), which is the first 0.5" of rainfall (NVPDC). Unless provided in large quantities, rain barrels may be unable to meet this requirement.

For all RWCS, settling of sediments will contribute to water quality improvements (however, resuspension during subsequent storms may be a concern). Additional pollutant removal ability will depend on the ultimate use of the water. Since rain barrel water is usually used for

landscape irrigation, pollutant removal rates approximate those of infiltration BMPs (see fact sheet 1.2, bioretention cells). The same holds true for cistern water used for landscape irrigation.

If cistern water is used for toilet flushing or other applications in which it will ultimately be discharged to the sanitary sewer, the pollutant removal rate is the same as that of the wastewater treatment plant (WWTP). This efficiency is 95 to 100% for phosphorus and many other pollutants.

NOTE: The use of cistern water for applications discharging to the sanitary sewer may be complicated by regulatory and administrative obstacles including the following (NVPDC).

- For building applications, pretreatment may be required by the Virginia Dept. of Health.
- A water quality analysis must be initially and periodically performed (see “Maintenance”).
- The Fairfax County Department of Public Works requires at least the use of an oil/grit separator as pretreatment for direct discharges to the sanitary sewer.
- A user fee may need to be paid to the WWTP operator.
- WWTP capacity, and the impact of cistern discharges on the plant, must be evaluated.

Location: RWCS can be used at any building with sufficient space and structural capacity where there will be a reliable end use for collected rainwater. Rain barrels are often, but not exclusively, used for residential applications. Cisterns may feasibly be installed for any land use.

Design Construction and Materials: Homemade rain barrels are relatively easy to construct. Basic components consist of the following:

- One or more 55-gallon barrels
- A child-resistant top that allows easy access for cleaning. Screens may be used at the inflow points to strain coarse sediment and reduce the potential for mosquito breeding.
- Connections to the downspout, runoff pipe, and spigot, and hoses to connect barrels in series

Cisterns may also be constructed from raw materials, but prefabricated systems may offer more reliability and greater ease of integration with the building’s plumbing system. If adequate structural capacity exists, cisterns can be placed on rooftops and be drained by gravity. Another common installation location is a basement, in which case pumping is needed. Flow splitters (see fact sheet 4.2) can be used to divert the WQV to the cistern. An overflow to the sanitary sewer should also be provided.

If cisterns are used to supplement a building’s potable plumbing system, a parallel plumbing system will need to be installed. The installation cost depends on the size and purpose of the system and will need to be considered in any cost-benefit analysis. Safety measures must be taken to ensure that cistern water not be used for potable purposes. Besides a parallel plumbing system, such measures include warning signs and lockable faucets.

Typical costs for RWCS are given below and may be offset by reduced potable water costs.

Item	Unit	Estimated unit cost (2005 dollars)
Rain barrel, excl. accessories and attachments	Ea.	\$100 - \$150
Prefabricated cistern, excluding plumbing	Ea.	\$150 - \$10,000

Prices for prefabricated cisterns depend on storage volume and on the material used.

Cistern material	Small system	Large system
Galvanized steel	\$225 for 200 gal.	\$950 for 2000 gal.
Polyethylene	\$160 for 165 gal.	\$1100 for 1800 gal.
Fiberglass	\$660 for 350 gal.	\$10,000 for 10K gal.
Ferro-cement	Varies by location	Varies by location
Fiberglass/steel composite	\$300 for 300 gal.	\$10,000 for 5K gal.

Cost: The cost for a series of rain barrels to treat runoff from ½ impervious acre is comprised of both the installation cost and annualized costs. These cost calculations were developed assuming the first 0.5” of rainfall is captured. A rain barrel is assumed to have a lifespan of 25 years, at which point it will be removed and replaced.

Item	Required Cost per Year (Rain Barrels) (2005 Dollars)													
	0	1	2	3	4	5	6	7	8	9	10	...	25	
Installation ¹	12,500													
Debris removal		250	250	250	250	250	250	250	250	250	250			
Minor parts replacement				500			500			500				
Remove & Replace														12,500
Total Cost	12,500	250	250	750	250	250	750	250	250	750	250			12,500
Annualized Cost	\$900 / year (includes replacement in year 25)													

¹Developer Cost (125 rain barrels). Not included in annualized cost.

The cost for a cistern to treat runoff from ½ impervious acre is comprised of both the installation cost and annualized costs. These cost calculations were developed assuming the first 0.5” of rainfall is captured. A cistern is assumed to have a lifespan of 25 years, at which point it will be removed and replaced. A wastewater treatment plant user fee has not been included.

Item	Required Cost per Year (Cistern) (2005 Dollars)													
	0	1	2	3	4	5	6	7	8	9	10	...	25	
Installation ¹	13,000													
Vacuum Debris		250	250	250	250	250	250	250	250	250	250			
Minor parts replacement				500			500			500				
Water Quality Testing		500	500	500	500	500	500	500	500	500	500			
Remove & Replace														13,000
Total Cost	13,000	750	750	1250	750	750	1250	750	750	1250	750			13,000
Annualized Cost	\$1,400 / year (includes replacement in year 25)													

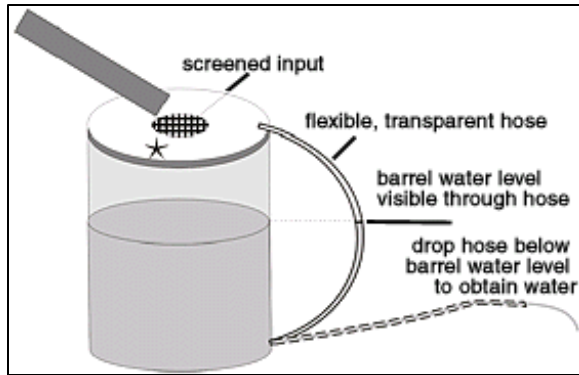
¹Developer Cost (assumes 10,000 gallon fiberglass cistern). Not included in annualized cost.

Maintenance: Rain barrels maintenance requirements are minimal. The unit and attachments should be inspected for clogging several times a year and after major storms. Minor parts such as spigots, screens, downspouts, or leaders may need to be eventually replaced.

Cisterns should undergo water quality assessments (e.g. for sediment, fecal coliform, bacteria, heavy metals) and inspections for clogging and structural soundness twice per year. Accumulated sediment should be removed once per year. A key cost component associated

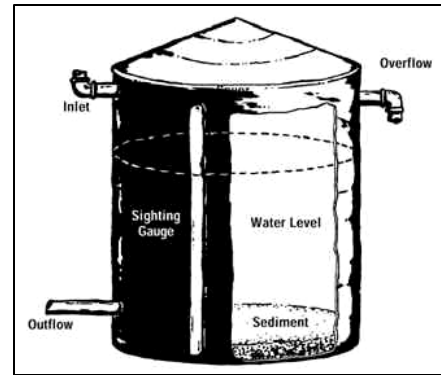
with cisterns is the distribution (i.e. parallel plumbing) system, for which inspection and repair costs are widely variable.

Performance and Inspection: Inspect rain barrel connections (e.g. inflow and outflow hoses) when removing debris. Inspect cistern(s) for structural soundness while it is being accessed for annual sediment removal. Inspection of a parallel plumbing system, if applicable, can coincide with inspection of the conventional plumbing system.



Rain Barrel

Source: Maryland DNR Green Building Program



Cistern

Source: Texas Guide to Rainwater Harvesting

Potential LEED Credits:

- Primary: Water Efficiency – Credit 1 “Water Efficient Landscaping” (1-2 Points)
- Water Efficiency – Credit 3 “Water Use Reduction” (1-2 Points)
- Sustainable Sites – Credit 6 “Stormwater Management” (1-2 Points)
- Other: Innovation & Design Process (1-4 Points)

Links to Additional Information:

Northern Virginia Planning District Commission. 1992. *Northern Virginia BMP Handbook: A Guide to Planning and Designing Best Management Practices in Northern Virginia*. Available at <http://www.novaregion.org/pdf/NVBMP-Handbook.pdf>