



Drainage Program Guide

Green Stormwater Infrastructure (GSI)

Best Management Practice: Cisterns

A cistern is a sealed tank used to collect rainwater that flows from your rooftop and is temporarily stored for non-potable, exterior uses, such as landscape irrigation and car washing. A cistern is larger than a residential rain barrel and can have capacities ranging from 100 gallons to several thousand gallons. Cisterns can be designed to collect water from several downspouts from one building's roof or from multiple roofs. Besides credits, a potential cost savings with the installation of a cistern is the savings on consumption of potable water.

What credits am I eligible for?

A cistern that manages stormwater runoff from a roof can achieve up to an 80 percent drainage charge credit, depending on the available storage and site conditions. Of the maximum 80 percent credit available, up to 40 percent can be attained for controlling how fast water is leaving the property (evaluated on a case-by-case basis) and up to 40 percent can be attained based on how much water can be permanently removed from the sewer system (through reuse practices such as landscape irrigation). See *A Guide to Credits for Commonly Used Stormwater Management Practice* for further explanation.

NOTE: Residential customers receive an automatic 25 percent credit. If practice does not exceed the 25 percent automatic credit, no additional credit will be applied.

What is the typical cost of a cistern?

The cost of a cistern is dependent on the size and type of cistern (above/below ground, tank material, etc.) and the use of the stored water (e.g., for landscape irrigation, indoor non-potable uses). Cisterns cost approximately \$1 to \$2 per gallon for commercial scale systems, not including the irrigation or gray water system.



Cistern with informational signage, Raleigh, NC

How do I estimate the size of my cistern and water demand?

A rough method to estimate cistern size is described below, but commercial cisterns should be sized using a calculator that considers water demand (outdoor such as irrigation or any indoor use), roof surface area, rainfall patterns, and available storage. Calculators are available from the [American Rainwater Catchment Systems Association](#) (ARCSA), [Minnehaha Creek Watershed District](#), [Virginia Water Resources Research Center](#), and [Texas A&M Extension](#).

Cistern volume can be estimated for a given rainfall using the following equation (*Virginia Rainwater Harvesting Manual*):

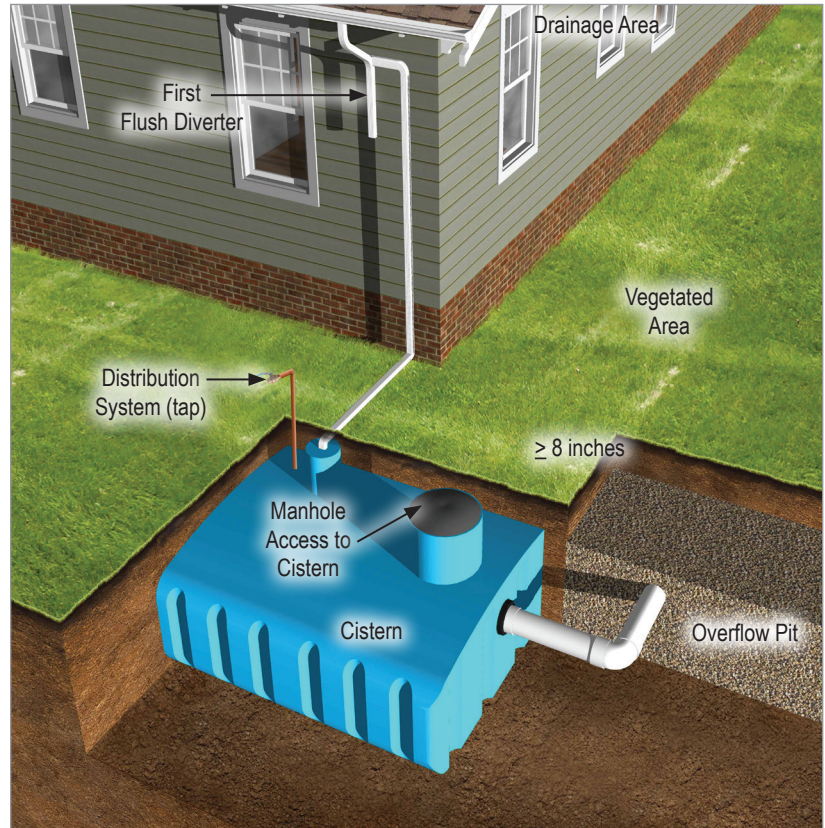
$$\text{Cistern volume (gallons)} = \text{roof surface area (ft}^2\text{)} \times \text{collection efficiency} \times \text{rainfall depth (in)} \times 0.62$$

For example, for a collection efficiency of 0.95, a 1,000 ft² roof and 1-inch rain event will require a cistern of almost 600 gallons. A collection efficiency of 0.95 is used because some rainwater is lost to first flush, splash-out, or overshoot from the gutters.

What are the typical components of a cistern?

The main components of a cistern system include:

- **Drainage area.** The portion of a roof that drains to the cistern.
- **Collection and conveyance system.** The gutters and downspouts that collect runoff from the drainage area and directly convey it to the cistern.
- **Pre-screening.** To remove debris that collects on the drainage area, a pre-screen such as a leaf guard or similar mesh screen is used.
- **First flush diverter.** To remove smaller contaminants that pre-screening does not capture, such as dust, pollen, or bird feces, a first-flush diverter should be installed to divert the first 1 to 2 percent of flow from the drainage area away from the cistern before the cistern begins to fill.
- **Cistern (storage tank).** An opaque tank used to temporarily store rainwater before use. Typically the most expensive component of a cistern system.
- **Distribution system.** Often includes a pump and pressure tank along with irrigation or other distribution lines.
- **Overflow, filter path or secondary stormwater retention practice.** An overflow pipe should be included to handle storms that exceed the capacity of the tank. The overflow pipe should be directed to a pervious or grass filter path or retention practice.
- **Overflow Pipe.** An overflow pipe should be included to handle storms that exceed the tank capacity. The overflow pipe should be directed to an overflow pit, a pervious area, or retention practice.



Cistern Diagram (Source: Pg. 5-11, City of Dublin Stormwater Management Design Manual)



*Cedar Street School cistern distribution system, Lansing, MI
Photo credit: DC Engineering, PC*

The American Rainwater Catchment Systems Association has developed a resource guide website with a list of designers, equipment suppliers, and installers for cisterns. See www.arcsaresource.com.

How do I maintain the cistern?

Maintenance will vary depending on the type of cistern and components installed; however, cisterns should be inspected at least twice a year to ensure that:

- downspouts are properly positioned, intact, and free of debris;
- filters and screens are intact and free of debris and sediment;
- tanks and covers are intact and not leaking;
- pumps (if installed) are working properly;
- overflow outlets are clear and are directed away from building foundations; and
- spigots and hoses are functioning properly.

Cisterns should be drained between significant rainstorms to ensure adequate storage.

Winter Use. Above ground cisterns, unless protected against freezing, should be taken off-line by being drained during the winter months. If used during winter months, above-ground outdoor pipes should be insulated or heat-wrapped to prevent freezing. Underground or indoor cisterns can still be used, but downspouts and overflow components should be checked for ice blockages during snowmelt events.



Detroit Farm and Garden's cistern



Walmart cistern, Fayetteville, AR

Permits and Forms

- A permit is generally not required to install a cistern, however, a permit may be required if the cistern requires electrical operations (e.g., a pump) or if significant earth-moving disturbances are required.
- If an overflow pipe goes to the DWSD sewer, a plumbing permit from the Building, Safety, Engineering and Environmental Department (BSEED) and a DWSD sewer tap is required.
 - Sewer Tap (DWSD): Contact DWSD at 313.964.9236
 - Plumbing Permit (BSEED): Any time project work on private property connects to City sewer
Contact: BSEED's Plumbing Inspector at 313.224.3158
 - Construction and any other required City, State, or Federal permit.
- Complete engineered drawings stamped by a registered Professional Engineer or Landscape Architect must accompany the Drainage Charge Credit Application. Additional required documentation is found on the application and can be downloaded from www.detroitmi.gov/drainage.

DWSD has developed a water balance calculator for systems that reuse stored stormwater for irrigation and non-irrigation purposes.

Additional Resources

For Drainage Charge Credit Information and other resources, visit the drainage webpage: www.detroitmi.gov/drainage

Specific documents to review:

- ◆ Guide to Drainage Credits
- ◆ Guide to Credits for Commonly Used Stormwater Management Practices
- ◆ Credit Calculator
- ◆ Credit Application

American Rainwater Catchment Systems Association (ARCSA). Undated. ARCSA Resource Guide <http://www.arcsaresource.com/>

Minnesota Pollution Control Agency. Undated. Minnesota Stormwater Manual. Design criteria for stormwater and rainwater harvest and use/reuse https://stormwater.pca.state.mn.us/index.php?title=Design_criteria_for_stormwater_and_rainwater_harvest_and_use/reuse

Prince George's County, Maryland. Undated. Cisterns Fact Sheet <http://www.princegeorgescountymd.gov/DocumentCenter/View/169>

Texas Water Development Board. 2005. The Texas Manual on Rainwater Harvesting. Third Edition http://www.twdb.texas.gov/publications/brochures/conservation/doc/RainwaterHarvestingManual_3rdedition.pdf

Virginia DEQ. 2011. Stormwater Design Specification No. 6: Rainwater Harvesting. Version 1.9.5. http://www.vwrrc.vt.edu/swc/documents/2013/DEQ%20BMP%20Spec%20No%206_RAINWATER%20HARVESTING_Final%20Draft_v1-9-5_03012011.pdf

Examples of cisterns installed at various sites



*Wood wrapped cistern
Pine Knoll Shores, NC*



*Cistern with lattice for
decorative greening
Photo credit: Abby Hall, EPA*

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