Rainwater Harvesting 101:

Identifying a Well-Designed Rainwater Harvesting System

Rainwater harvesting can be an effective solution to problems of water supply and stormwater runoff. While a rainwater harvesting system does not need to complicated or expensive to be effective, some basic standards of design are required. This fact sheet identifies a few of the most important things to look for in a rainwater harvesting system. This fact sheet addresses rainwater harvesting systems which collect rainwater from a roof then direct it to a storage tank before the water is used for irrigation, toilet flushing, laundry, vehicle washing, or similar non-potable uses. Rainwater harvesting systems that are designed solely to encourage the rainwater to soak into the ground, often called passive rainwater harvesting systems, are not included.

1) Water quality is protected before storage. Many people believe that because rainwater is natural, they do not need to think about the quality of the water in a rainwater harvesting system. Others believe that using chlorine or another disinfectant after the storage tank can address any water quality problems. Unfortunately, neither is true.

Protecting the quality of harvested rainwater starts with the roof and gutters. The roof should be clear of overhanging vegetation and the gutters should be kept clean (see Fact Sheet 3). If the harvested rainwater will be used for drinking water or for watering food crops, you should also consider the roof material because some roof materials can leach metals such as lead into the captured rainwater. In particular, wood/cedar shake, copper, and any material with lead content should be avoided.

The next step in protecting the water quality is a pre-tank filter. The filter should prevent leaves and other material that washes off the roof from entering the tank. A good rainwater filter will prevent any material larger than beach sand from entering the tank. In addition, in a good rainwater harvesting filter, the harvested rainwater will not wash over or filter through the debris to enter the storage tank. The filter should also be designed so that the water from large rainfall events can move safely through the system. The storage tank should include an overflow pipe that is at least the same size as the inlet pipe. Debris should not cause water to back up into the downspouts or other piping that carries water to the storage tank or to collect near the foundation of a building.

Sample self-cleaning rainwater harvesting pre-tank filter

2) The rainwater harvesting system isappropriately sized for the collection area and water use. A well-designed rainwater harvesting system matches the amount of water available, which depends on the size of the roof and the local rainfall, the amount of water to be used, and the size of the storage tank. In general, a storage tank should be designed to store all of the water that will run off the collection area during a single large rainstorm. For most of the United States, this is between 1” and 2” of rain. As a rule of thumb, one inch of rain on 1,000 ft^2 of roof area will generate 620 gallons of runoff. To estimate the required size of the storage tank in gallons, multiply the rainfall depth you want to store (generally from 1-2”) by the roof area from which you will collect by 0.62 (this is a conversion factor from ft^2in to gallons). For example, to collect 1” of rainfall from a 2,500 ft^2 roof, the storage tank would need to be:

1” x 2,500 ft^2 x 0.62 = 1,550 gallons

If the average monthly use of the harvested rainwater is much less than the volume of water calculated from this estimate, the storage tank size can be decreased to the monthly water use.

3) The rainwater harvesting system is designed so that you can safely and easily use the water. To use the water safely, the harvested rainwater must be treated to an appropriate level. In general, harvested rainwater that will be used indoors should be disinfected with chlorine, ultraviolet light, or similar disinfectant. The rainwater harvesting system should also provide sufficient water volume and pressure for the intended use. While gravity may be sufficient for hand-watering a small garden plot, most systems will require an appropriately-sized pump. If a pump is included, be sure that the pump will not run when the storage tank does not have enough water. Running a pump without water flow can damage the pump. Overall, remember that a rainwater harvesting system is only beneficial if it is used, so be sure the system is designed to be user-friendly.

Sample post-tank water treatment system including a sediment filter, carbon filter and ultraviolet light.

4) Required maintenance on the rainwater harvesting system is easy to do and infrequent. Complicated required maintenance often leads to a lack of maintenance which leads to problems in the rainwater harvesting system. While property owners vary in their willingness to complete maintenance, you should carefully consider how much maintenance you are likely to do and how much maintenance the system requires. If the system requires more maintenance than you are likely to complete, the rainwater harvesting system is not well-designed for you. In determining the required maintenance, be sure to consider ease of access to all components that need to be maintained (see Fact Sheet 3).

5) The rainwater harvesting system should be appropriately designed for the site conditions. If the rainwater storage tank is aboveground, consider the likelihood of freezing and how the system will function in freezing temperatures. If freezing is likely, the system should either be drained for winter or all pumps and small diameter piping should be buried below the frost-line, appropriately wrapped in heat trace tape, or housed in a climate-controlled enclosure. If the storage tank is belowground, be sure the tank is appropriately designed to support any possible vehicle load on top of the tank. In addition, belowground tanks should be installed to prevent water on the ground surface from entering the tank and may need to be anchored to prevent floating. Aboveground tanks should be installed on level, compacted ground with a concrete or gravel base.

6) The storage tank is designed to keep mosquitoes out of the tank. This means that all inlets and outlets should be sealed or screened. Be sure to check for gaps around pipes.

7) The system does not include an improper cross-connection with municipal water. Many rainwater harvesting systems will include a back-up water supply, often from municipal water. An improper cross-connection allows the harvested rainwater to backflow into the municipal water system. Any connection between a rainwater harvesting system and other water supply system should include an appropriate backflow prevention device such as an air gap or a reduced pressure zone backflow prevention device.

The guidelines in this fact sheet address many of the most common problems found in rainwater harvesting systems but do not address every possible problem. For more information, purchase a copy of the ARCSA rainwater harvesting manual or a copy of the ARCSA/ASPE/ANSI system design standards at https://www.arcsa.org/store/ListProducts.aspx?catid=265505&ftr=. Anyone considering a rainwater harvesting system is also encouraged to consult an ARCSA/ASSE certified professional.