THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE AND LIFE SCIENCES
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BASIC COMPONENTS OF A RAINWATER STORAGE SYSTEM

RAINWATER COLLECTION

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Basic components described are for a non-potable storage system. *A potable system would need to consist of all food grade materials, and water would need to be properly treated to meet drinking water quality standards. For all rainwater storage systems, check with your local governing agency for any codes that may apply.*

Storing and using rainwater for landscape plants is a great alternative to using treated drinking water for irrigation. Collecting rooftop rainwater for later use is described as "active" rainwater collection.

Before you set up a water catchment system, think about these questions:

- What will the water be used for?
- Will I want the option to expand the system?
- How much rain can be collected?
- Where will the tank overflow go?
- Where can the containers be located? Above or below ground?
- Can the containers serve several purposes where they are located such as shading a garden, providing a windbreak or as the edge of a structure?
- Do I need to hide the containers for aesthetic purposes or neighborhood restrictions?
- How will the water get from the roof to the container and to the end use area? Will the system be gravity fed, or will it need a pump?

The Basics

A storage system is comprised of four key components:

1. Collection Area – roof surfaces provide an opportunity for rainwater capture.
2. Conveyance System – used to transfer water and is comprised of gutters or flat roof drainage holes, and downspouts and piping.
3. Water Storage – may be above or below ground and can be comprised of a single container or multiple containers.
4. Filtration – to keep debris out of the system.

Key Components

Collection area

- The smoother and more impermeable the collection surface, the less debris will accumulate, keeping the stored water cleaner.

Conveyance systems

- Dry – Do not have water in them until it rains.
- Wet – Water sits in the low sections until replaced by new water entering the system. This type of system allows for more flexibility in storage tank location. Proper pipe sizing is important to prevent flow backup, and pipes are susceptible to freezing. Connections between downspouts and piping must be watertight to prevent leaking. The water inlet must be higher than the outlet.

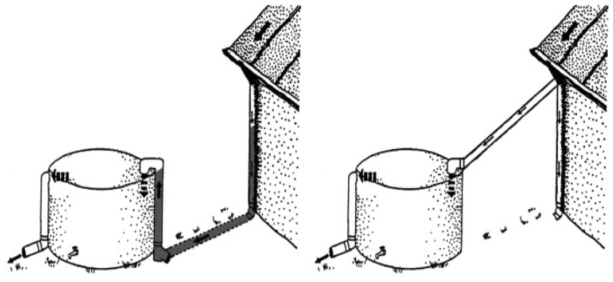


Figure 1 Examples of wet (left) and dry (right) conveyance systems

Storage tank features

- Inlet for rainwater to enter.
- Outlet to access water such as a hose bib.
- Overflow pipe. The overflow pipe should be as large as the inlet pipe.
- Air vent for air to escape while the tank is filling. If open to the air, the overflow pipe can serve as the vent.

Multiple tanks can be connected together to increase storage capacity. They can be linked at the top or the bottom.

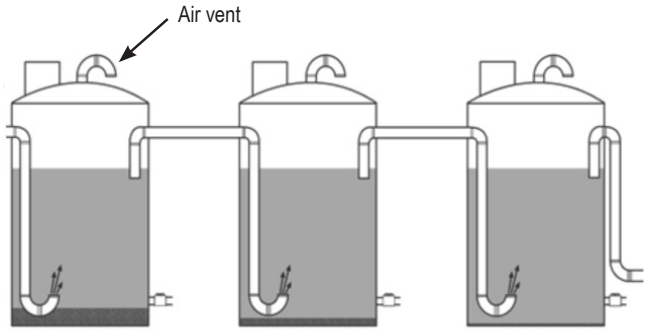


Figure 2 Multiple tanks connected in series at the top

Filtration

To keep water clean, prevent clogging and sediment build-up, basic filtration is needed. The type and number of filtering components on a system depend on the amount of roof debris. If possible, use a floating inlet to draw water from the middle of the tank (see Figure 8).

Filtration may include:

- Gutter and downspout screens:

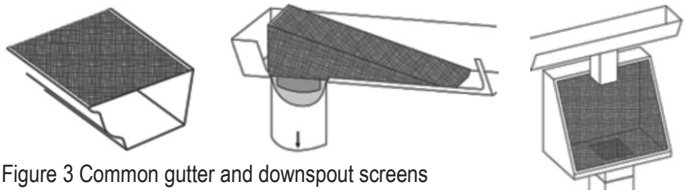


Figure 3 Common gutter and downspout screens

- First flush diverters keep the first flush of poor quality roof runoff from entering the tank. Diverters must have a drainage outlet for emptying standing water, and be emptied as needed. Diverters are usually not needed unless water quality is especially poor (i.e. significant bird droppings on collection surface).

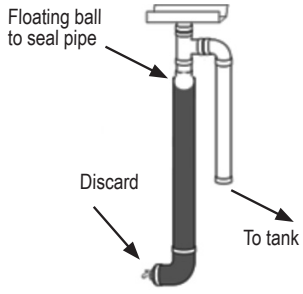


Figure 4 Example of a first flush diverter

How Much Rain Can I Collect?

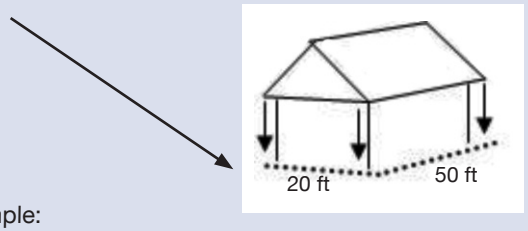
(To find rainfall for your area, see References)

To calculate collection potential, multiply:

square foot of collection area x rainfall (in inches) x 0.623 x efficiency factor for collection type = gallons

(The efficiency factor is approximately 90% for most roof types because most of the water is collected.)

Measure the footprint of the collection area:



Example:

Roof area = 1,000 sq ft

Annual Rainfall = 15 inches

Apply formula:

1,000 sq ft x 15 inches x 0.623 x 0.90 = 8,140 gallons/year

TIPS

- 1,000 square feet of roof = 623 gallons/1" rain
- One foot of elevation = 0.43 psi
- 2.31 feet in elevation = 1 psi, no matter the size of the storage tank
- Water weighs 8.34 pounds per gallon
- There are 7.48 gallons of water in one cubic foot
- First flush diverters: Depending on your water quality needs, divert 1 -10 gallons of runoff water per 1,000 square foot of roof area

- A strainer basket or screen at the tank water inlet serves as further protection from debris and animals. Do not allow the basket to sit below the water line and clean frequently.

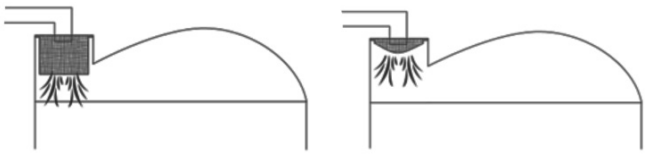


Figure 5 Examples of a strainer basket (left) and screen (right)

Optional Components

Pumps: If rainwater is used in a drip irrigation system, moved long distances or uphill, a pump may be needed to pressurize the system. Without a pump the water will be pressured by gravity. There are many different types of pumps, either external or submersible.

For drip irrigation systems, choose a pump system that prevents pump cycling on and off from pressure feedback. Drip emitters and soaker hoses emit gallons per **hour** at 15-25 psi while pumps produce gallons per **minute** at over 40 psi. The low pressure and low output of drip irrigation systems puts back- pressure on a pump.

Select pumps based on the water harvesting system design. It is best to consult a pump technician and provide him/her with the system requirements for correct pump sizing.

Irrigation: An irrigation controller can be used to automate landscape watering on a pressurized or gravity-fed system.

If a pressurized system does not use an on-demand pump, the controller should directly control the pump with a "pump start relay".

The irrigation filter and pressure regulator should be installed after the pump.

If a gravity-fed system uses a controller to operate irrigation valves, low-flow/low-pressure or mechanical valve (s) should be used because standard irrigation valves need water pressure behind them to close. Use a low-pressure or mechanical irrigation controller if attached to a gravity-fed hose bib.

Basin flooding, bubblers, special soaker hoses or "T-Tape" (a drip line that functions on 2-10 psi) can be used for gravity fed systems. For more information on soaker hoses or "T-Tape", search the web.

Automatic Fill Valve: A fill valve is connected to an alternative water supply that automatically refills the tank to a specified level if rain amounts are insufficient. This system is used when the raintank is the sole source of the non-potable water. This is especially important if the system uses a pump.

When connecting a potable water supply to any rainwater system component that conveys water, a backflow prevention device or an air gap between the potable water and the rainwater component MUST be used to prevent cross-contamination of waters.

Things to Know

Conveyance System

- Size and slope gutters correctly. The rule of thumb is ¼ inch of slope per 10 ft of seamless gutter.
- Connections such as elbows will slow the water flow. Size correctly to not restrict flow.

Storage Tanks

Tank considerations include cost, size, aesthetics, and/or the water use. To determine an appropriate tank size, consider using a water *supply* and *demand* water budget calculator. (See Resources).

- Identify water supply outlets as "RAINWATER—DO NOT DRINK".
- Cover tank openings to prevent evaporation and exclude light. Light promotes algae growth.
- Dark colored tanks are preferable to light color tanks as they do a better job of keeping out light.
- Above ground tanks should be UV resistant to prevent sun damage. Tanks can be painted with rubberized paint (no tank prep or primer needed for poly tanks) to provide sun protection, help prevent light from entering, make them blend with surroundings or be fun and interesting.
- Water reaches its own level, so interconnected multiple tank systems will only fill to the highest point on the lowest tank.
- Be sure tanks are level.
- For tanks in windy areas, tie them down or store a reserve of water as ballast.
- Place tanks at least as far away from foundations as the foundation is deep—usually 10-18 inches, and on a surface such as a cement pad, contained pea gravel, or compacted earth.
- Tanks can be raised to increase water pressure and to easily access the water outlet.
- On multiple tank systems, install shutoff valves between tanks for easy maintenance.
- Mosquito and animal-proof tank access points. A microbial insecticide specific to mosquito larvae containing Bacillus thuringiensis israelensis (Bti) can be used and is easy to find in gardening catalogues and in garden departments, often called "Mosquito Dunks".
- Direct the overflow to a useful area, away from tank foundation, buildings, and toward plants or to another tank.

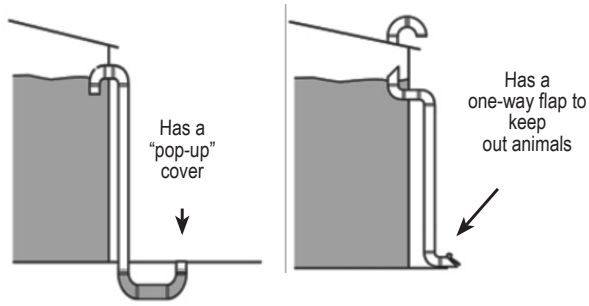


Figure 6 Examples of tank overflow outlets

- Weatherize water pipes and outlets to protect from freezing and UV degradation.
- Containers can be plastic, metal, fiberglass, ferrocement, new septic-tanks, corrugated metal pipe (culverts), etc. Find containers at feed stores, car washes, soft-drink companies, web sites, septic system suppliers, building suppliers, tank supply companies, and rainwater suppliers.
- Any tanks used for underground storage must be rated for this use.
- A tank "calming" inlet helps calm the entering water and prevent stirring the bottom sediment layer.

Figure 7 Examples of calming inlets

Figures 1-7 courtesy of Texas AgriLife Extension Service

Maintenance

- Adequate filtration will slow sediment buildup and reduce cleaning chores. Clean filters periodically. This includes:
  - cleaning downspout and gutter screens
  - draining the first flush diverter of debris
  - clearing the strainer basket
  - rinsing or replacing pump filters
  - rinsing or replacing irrigation system filters
- Tanks do not need to be cleaned unless storing poor quality water.
- Check the system regularly to identify potential problems.
- Install shut off valves and unions to disconnect pumps in freezing weather.
- An access hatch or inspection port on a tank eases maintenance. Secure the access hatch to prevent unauthorized access.

Residential Cistern Detail

Forgotten Rain – Rediscovering Rainwater Harvesting, Heather Kinkade Illustration used by permission

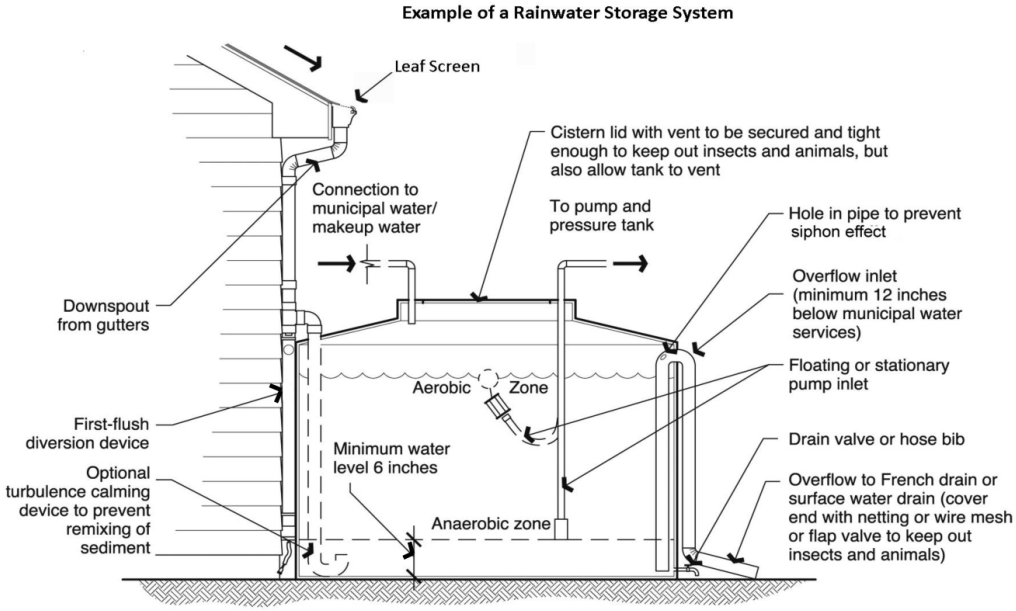


Figure 8.

Resources

Rainfall data: www.noaa.gov: "Regional Climate Centers"

UA Publications (**http://cals.arizona.edu/pubs**):

RainScapes, AZ1539 Harvesting Rainwater for Landscape Use, AZ1344

Water Wise (**waterwise.arizona.edu**):

Rainwater Collection – Passive Water Harvesting AZ1564

Water Supply and Demand Budgeting

References

American Rainwater Catchment Systems Association

Forgotten Rain - Rediscovering Rainwater Harvesting, Heather Kinkade

Texas AgriLife Extension Service

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This information has been reviewed by University faculty.
cals.arizona.edu/pubs/water/az1565.pdf

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