

BUILDING CODES DIVISION

OREGON SMART GUIDE

RAINWATER HARVESTING



 DEPARTMENT OF
CONSUMER
& BUSINESS
SERVICES
Building Codes Division



OUR MISSION

Working with Oregonians to ensure safe building construction while supporting a positive business climate.

FACTS ABOUT RAINWATER HARVESTING IN OREGON

A rainwater harvesting system collects water from a roof piped to a storage tank where it is then used either inside or outside a building. Designs range from a simple rain barrel at the bottom of a downspout for watering a garden to extensive cistern systems that can provide a substantial amount of the water someone uses.

Because of the efforts in Oregon to conserve water, the Building Codes Division has approved the use of rainwater harvesting systems as an alternate method to the state plumbing code. Information about the rainwater harvesting statewide alternate method is available at www.bcd.oregon.gov.

New filtration and treatment technologies make rainwater harvesting relatively easy. Rainwater harvesting systems can be installed in existing buildings or incorporated into new construction. A basic rainwater collection system includes a roof, gutters or roof drains, and a piping system to convey the water to and from a storage tank or cistern. Storage tanks can be inside or outside, above or below ground, or partially above and partially below ground (see figures 1 and 2). Basements can be good locations for storage tanks as the water will be gravity fed and protected from freezing. In some instances a separate structure is used to enclose the tank and equipment, which will increase the roof surface catchment area. Many rainwater collection systems, as well as individual components, are available commercially.

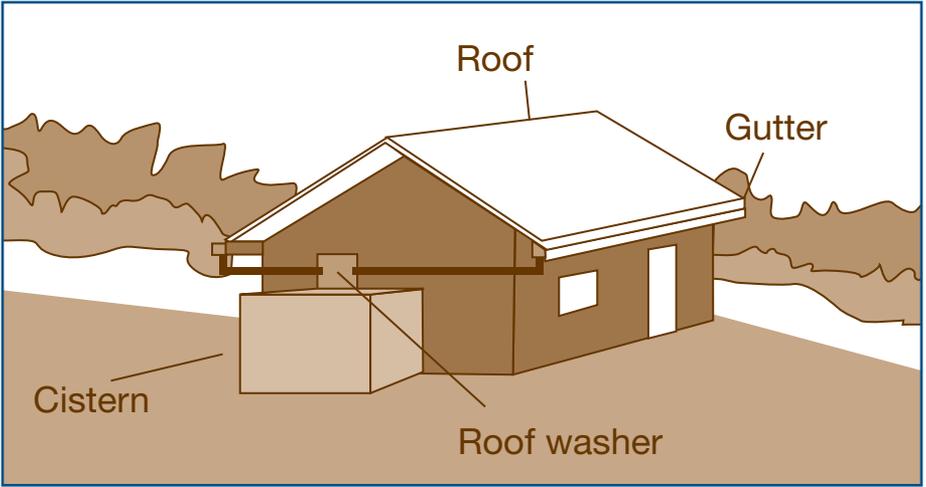


Figure 1. A simple rainwater harvesting design with an external storage tank.

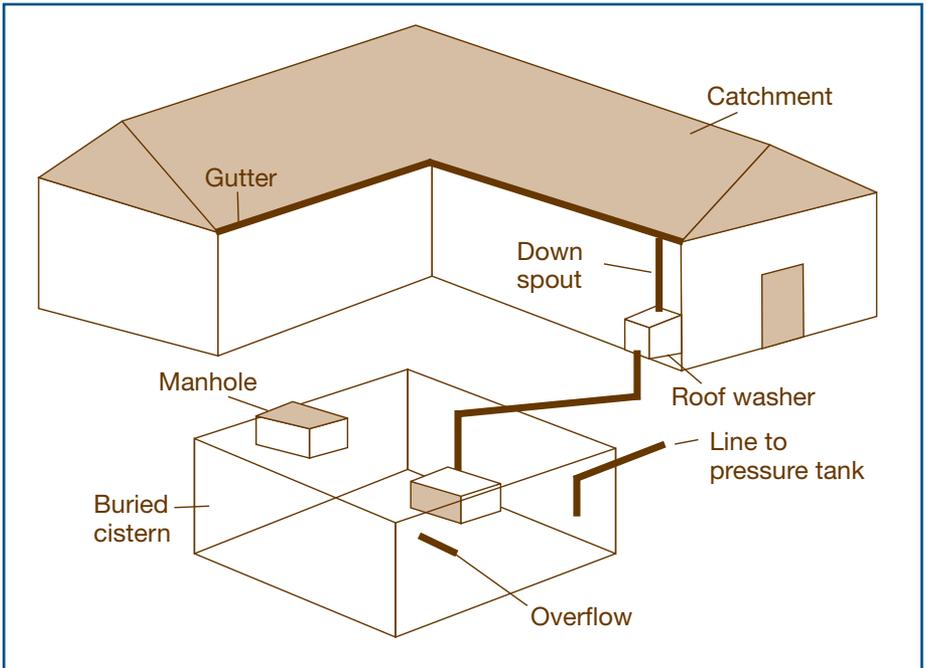


Figure 2. An underground storage tank.

THINGS TO CONSIDER

Despite its reputation as a wet and rainy place, Oregon has a very diverse climate. The potential for rainwater harvesting is dependent on location, elevation, and precipitation. While some areas in the Coast Range receive more than 200 inches of rainfall a year, approximately 60 percent of Oregon is desert, receiving less than seven inches of rain annually. In addition, higher elevations receive precipitation in the form of snow instead of rain. Western Oregon, the most densely populated area of the state, is ideal for rainwater harvesting.

Each rainwater harvesting system is unique and should be evaluated separately. Proper sizing is important when designing your system. You need to know how much rainwater you expect to collect and how much water you expect to use. Determining the right sizing will affect installation cost, operation, and on-going maintenance.

COLLECTING YOUR WATER

Detailed information about the expected rainfall in any part of the state is available online. Simply enter “Oregon precipitation data” into a search engine. Several maps and charts are available detailing daily, monthly, or annual rainfall for specific areas.

For example:

AVERAGE MONTHLY PRECIPITATION SALEM, ORE.

January	5.9 inches
February	4.5 inches
March	4.3 inches
April	2.4 inches
May	1.9 inches
June	1.3 inches
July	0.6 inches
August	0.8 inches
September	1.6 inches
October	3.0 inches
November	6.3 inches
December	6.8 inches

In Oregon, only roof surfaces may be used for harvesting rainwater. To determine how much rainwater you can expect to collect, you need to calculate your roof footprint or rainwater catchment area. The roof footprint is equal to the exterior square footage of the roof surface around the gutter line. For some roofs it may be necessary to calculate multiple rectangular areas and add them together. For a round roof, use Pi times radius squared to figure the catchment.

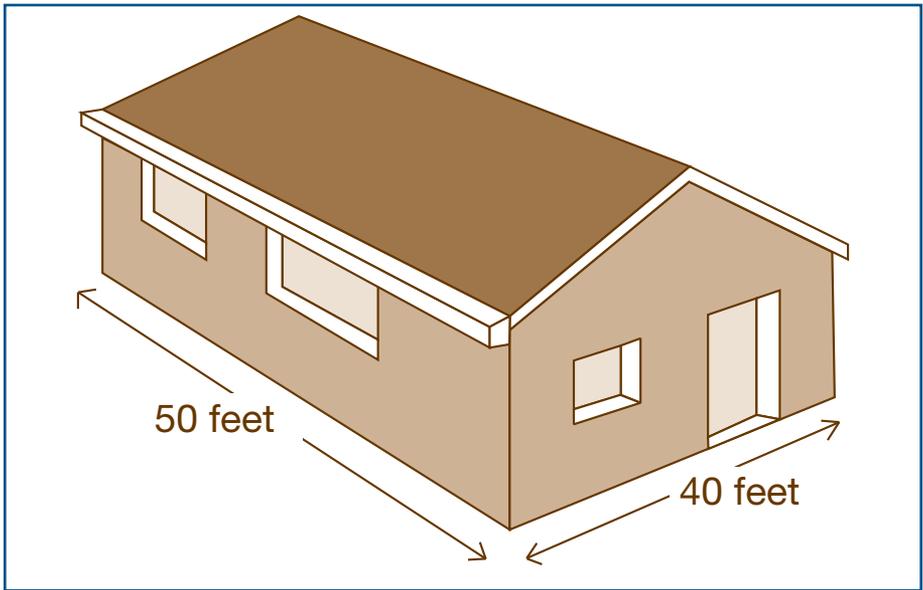


Figure 3.

Using the measurements in figure 3, the formula for calculating the catchment, or the capture potential formula, would be 40 feet times 50 feet, equaling a 2,000 square foot catchment area.

Rainwater harvesting systems can only effectively capture about 75 percent of rainwater due to evaporation, leaks, etc. This results in a capture rate of approximately 0.46 gallons of rainwater per square foot of catchment area per inch of rainfall.

To determine how much rainwater you can expect to collect, multiply the catchment area, times the average rainfall, times the percentage of water you can reliably expect to capture (catchment area times rainfall times 0.46 equals gallons expected or capture potential). This simple formula will give you a good idea of how much water you can expect to harvest from your roof's collection system.

For example, the house in Figure 3 has a roof footprint of 40 feet by 50 feet. The catchment area is $40 \times 50 = 2,000$ square feet. Assuming the house is in Salem, Ore., where the annual average rainfall is 38.8 inches per year, the expected rainwater harvest for the 2,000-square-foot roof is: $2,000 \times 38.8 \times 0.46 = 35,696$ gallons of water per year.

DETERMINING YOUR WATER USE

How much rainwater you will need depends on your intended uses. On average, a family in the United States uses approximately 50 to 70 gallons per person per day. This national average for water consumption is based on plumbing systems with both water conserving and non-water conserving fixtures. Designing a plumbing system with water-conserving plumbing fixtures reduces actual expected water demand. The more conservative your water use the smaller your demand.

Supplying all the water for an entire building requires much more rainwater storage than supplying water for a limited use, such as flushing toilets. The more water you intend to use, the more important accurate calculations are to ensure adequate supply.

The following can help you estimate your daily water needs:

- Toilet = 6 flushes per day per person, multiplied by flush volume of the fixture.
- Faucet = 5 minutes of use per person per day, multiplied by the actual flow of the faucet.
- Shower = 5 minutes per person per day, multiplied by output of the shower head.
- Bath = Actual volume of the bathtub per bath.
- Clothes washer = 25 gallons per load multiplied by number of loads a week.
- Dishwasher = 1 use per day at the rated gallons per load.
- Irrigation = Based on the system and months of year used. Summer irrigation may be as much as 70 percent of your entire water use.
- Hose bibb (outdoor faucet) = Based on its gallon-per-minute rating and expected usage.

To calculate water usage for an existing home on a municipal water system, look at your water bill records.

STORING YOUR WATER

There is no perfect one-size-fits-all tank and a backup water supply should always be available to charge the system when needed. Ideally a system should be large enough so there is little or no overflow loss during peak rainfall months and there is enough storage capacity for future demand. Determine the size of the tank needed by considering the expected water use, the capture potential (catchment area times rainfall times 0.46 equals gallons expected or capture potential), and the average monthly rainfall.

For example, a family of four will have an average demand of 200 gallons per day, using 50 gallons per person per day. They will require about 6,200 gallons a month.

In the Salem example, December has the highest average monthly rainfall at 6.8 inches. Using the earlier formula, we can anticipate collecting 6,256 gallons of water in December. Supplying all of the family's water needs for December will require a storage capacity of at least 6,200 gallons. July has the lowest rainfall with an average of 0.6 inches. Using the capture potential formula, we can expect to catch 552 gallons of water for July. Subtracting the 6,200-gallon monthly demand, the family of four will need at least 5,648 gallons of water in storage to meet the demand just for the month of July.

Based on Salem's average monthly rainfall of 3.24 inches, the example's 2,000-square-foot catchment area will collect about 3,202 gallons a month – not enough to meet the 6,200-gallons needed. Therefore, a reserve of water from peak rain months is necessary. For the example home, a storage capacity of between 8,000 to 10,000 gallons would allow water to be stored from the wetter months, with little overflow loss, forming a reserve for lower harvest months. A larger storage capacity also allows for a surplus to address long periods of drought between rain events.

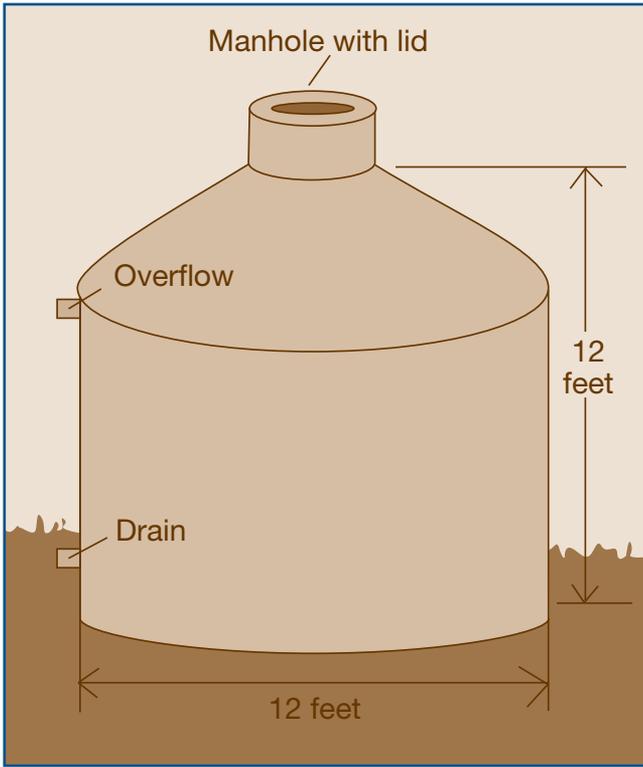


Figure 4.

A storage tank like the one in Figure 4 gives you an idea of the size of a 10,000-gallon round tank, which is approximately 12 feet wide and 12 feet high.

The larger your storage capacity, the more water available to use and the longer you can go between rain events. A smaller storage tank will be adequate if you are supplementing your water supply or for limited use. For example a 1,500- to 2,000-gallon storage tank should be adequate for flushing toilets for a family of four for a year.

MAKING YOUR SYSTEM WORK WELL

FILTERING

The cleaner the water going into your storage tank, the less often you will need to drain and clean the tank. Rain water coming off a roof will inevitably contain dust, leaves, sticks, and other debris. A screen will remove much of the big debris. Screen the gutter and downspout collection funnel and filter the water before it goes into the storage tank.

The first gallon per 100 foot of roof area should be discarded after each rain event to ensure only the cleanest water is harvested. Figure 5 shows where a roof washer or first-flush diverter is located within the filtering portion of a system.

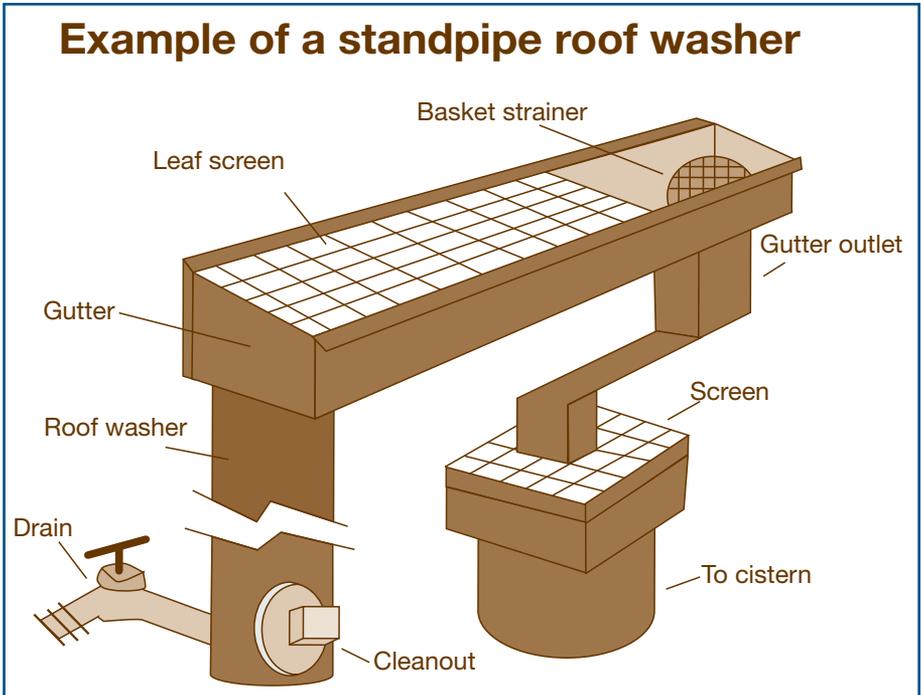


Figure 5.

The first wash of rainwater off the roof should be collected in a roof washer or first-flush diverter that will dispose of the dusty initial water from the roof's surface. You can make your own first-flush diverter or there are commercially available diverters and roof washer systems. (See Figure 6.)

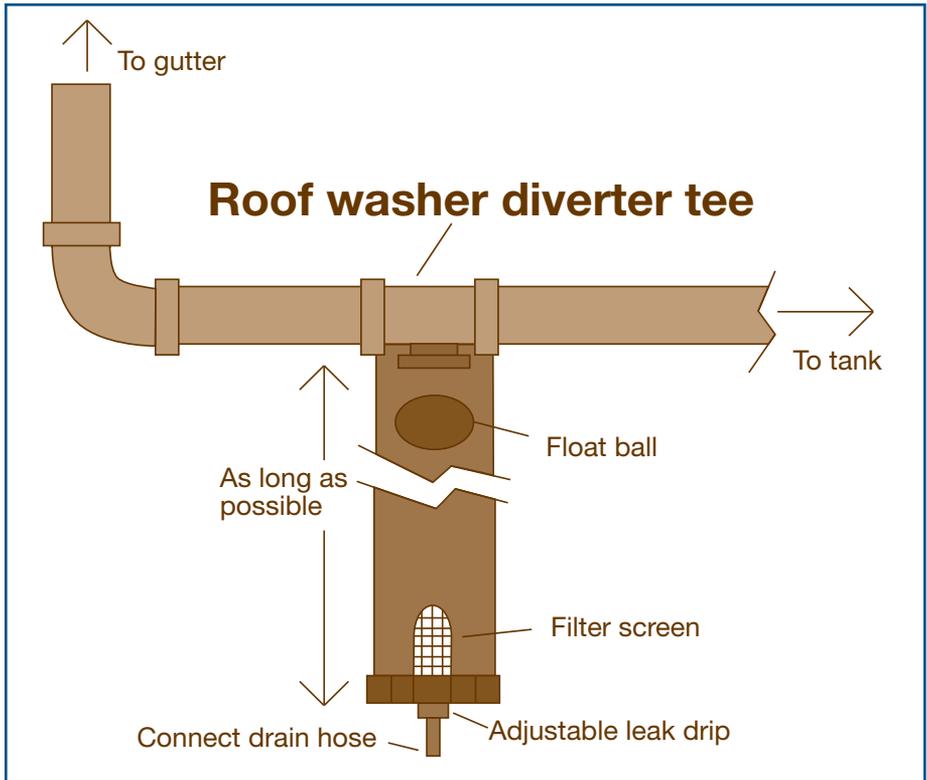


Figure 6.

A simple first-flush diverter (see Figure 6) will have a horizontal pipe that fills with the initial dusty water when it starts to rain. As the water rises in the vertical pipe, a plastic ball in the pipe rises and stops flow to the diverter. When the rain stops, the water in the diverter pipe is slowly drained out through a small drain. The bottom should include a removable plug or cap for servicing. Diverter chambers need to be cleaned between rain events to eliminate buildup of debris and dust.

SAMPLES OF FILTERING SYSTEMS

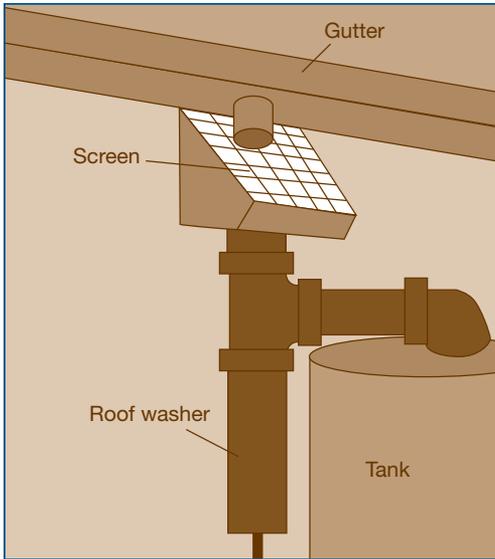


Figure 7 shows a commercially available product that includes a leaf screen at the downspout and a first flush diverter.

Filtering the water through a “filter medium” will ensure that the water in the tank is reasonably clear. Filter beds can be purchased or homemade. Homemade filter beds can be as simple as a five-gallon plastic bucket with an outlet fitting attachment, fine sand layer at the top, and layers of coarse rock on the bottom.

Figure 7.

You can make your own filter like the one in Figure 8, a homemade sediment filter. Downspout water enters the top of the filter bed and leaves from the bottom through a pipe, after filtering through the layers. You can place larger rocks over the top layer of sand to hold it in place. At the very bottom of the homemade filter you can put a porous fabric or screen that is the last layer before the water goes through the pipe, which drains to the water storage tank inlet. Many commercially manufactured rainwater filter systems are available.

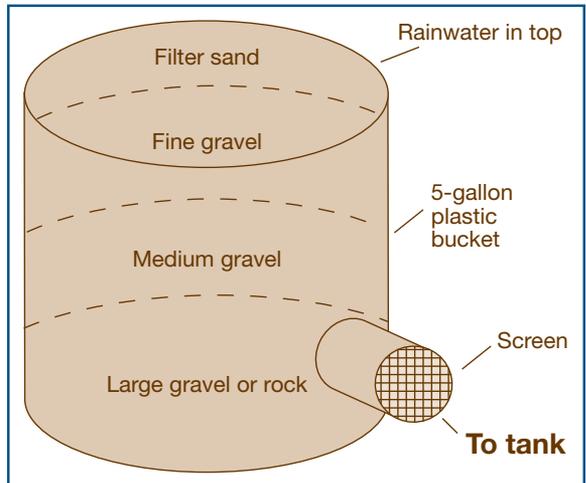


Figure 8.

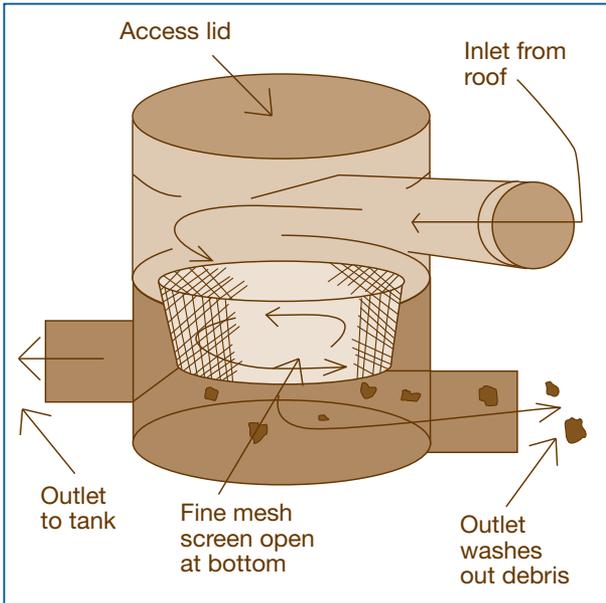
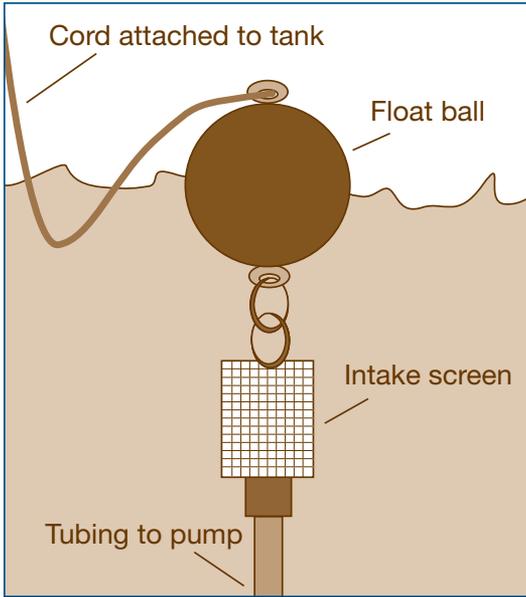


Figure 9.

Figure 9 shows a cut-away of a commercially made filter with an internal screen basket strainer that is removed from the top for cleaning.

A floating screened intake fitting, which is used inside a rainwater storage tank, can ensure clean water from the storage tank. (see Figure 10).

A hollow plastic ball attached to the screened intake fitting floats to the top of the tank. Below the ball, the inlet for the water has a fine stainless steel screen over the opening. This connects to the pressure pump inlet pipe preventing sediment and other debris, which has accumulated at the bottom of the storage tank, from being sucked up into the water supply.



A nylon rope can be tied to the top of the float for easy retrieval from the tank for cleaning and service.

Figure 10.

Note the floating inlet ball and pipe in the illustration of a cross section of a rainwater harvesting tank in Figure 11. The fill pipe has a trap device and fills from the lower part of the tank, above the bottom, to avoid stirring up sediment. The overflow at the top also needs a trap and a backwater valve if it is connected to a storm drain. Any opening to the outside should be screened to keep mosquitoes out.

If you are using your rainwater for flushing toilets, hose bibbs (outdoor faucets), irrigation and gardening, or washing clothes, no further treatment is necessary.

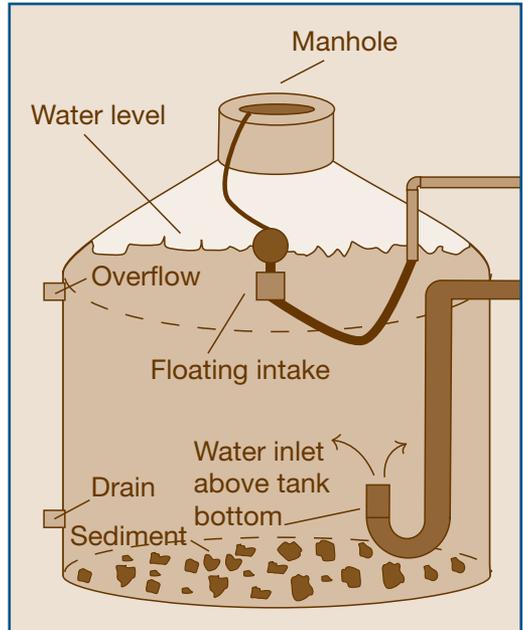


Figure 11.

PIPING, PUMPS, AND PRESSURE SYSTEMS

The water will be piped from the storage tank into the building. To do that, you will need to create the necessary water pressure to carry it to the plumbing fixtures and end uses. Without treatment, this water is not potable and should not be connected to a municipal or private drinking water system. It is important that the pipes taking water from the tank to the building be identifiable as carrying non-potable/not drinkable water and kept separate from the drinking water piping. Purple pipe is a universal identifier of non-potable water. Labels, paint, or purple-colored pipe can all be used to identify the pipes as carrying non-potable water.

There are many manufactured pump products available. Two types of pump systems are typically used for rainwater harvesting: pressure tank-type pumps (for both small and large systems) and constant pressure pump systems.

Depending on the amount of water you are using in your building, you can use a $\frac{1}{2}$ horsepower to $\frac{3}{4}$ horsepower pump. Use the manufacturer's information to determine the size and volume of pump you will need.

Pressure pumps usually work at 30 to 50 pounds per square inch (psi), meaning that when the faucet is on and water is being used, the pressure drops to 30 psi, at which point the pump starts and continues to run until the pressure reaches 50 psi and the pump shuts off. The amount of water available with this type of pressure tank pump will depend on the size of the pressure tank. The larger the pressure tank, the greater the amount of water that can be used before the pump will start.

The other common type of pump for rainwater harvesting systems, the constant or on-demand type, is small and cost effective. It operates by a pressure control valve.

DRINKING YOUR WATER

With the proper treatment, rainwater harvesting can provide drinking water. Further filtering and chemical or ultra violet (UV) treatment will be necessary if you are going to use the water for drinking or other domestic purposes.

Filtering should include a commercial five micron or less fiber cartridge filter followed by a three micron or less activated charcoal filter. The fiber filter will remove particulates and the carbon filter will remove very fine particles and improve taste. Filter elements should be replaced according to the manufacturer's instructions.

After filtering, the water must be disinfected by either chemical injection, ozone generators, or by a UV light. Most people prefer the UV light because it does not leave chemical residuals in the water. UV light systems should be listed to the ANSI/NSF 55 standard for Class A UV water treatment systems. Although the water is considered safe to drink following this treatment, it should never be connected with another drinking water supply without a reduced-pressure principle backflow preventer.

An example of a small home using rainwater for all uses including drinking water can be seen in Figure 12.

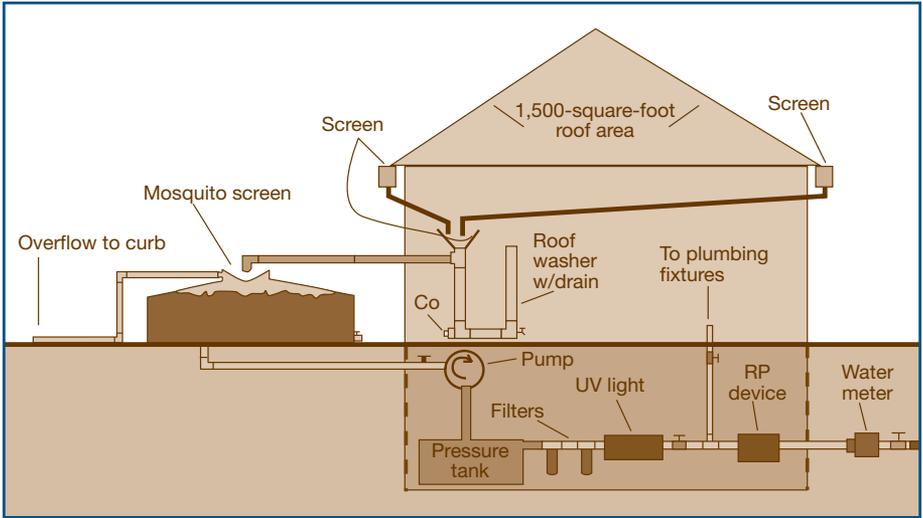


Figure 12.

Don't forget your plumbing permits. Learn more by going to www.permitsprotect.info

GLOSSARY OF TERMS

Auxiliary supply – A water supply that is arranged to provide an alternate means of filling a cistern.

Catchment – Roof area from which rainwater is collected for use in a rainwater harvesting system.

Cistern – The central storage component of the rainwater harvesting system.

Code – The 2008 Oregon Plumbing Specialty Code and Building Codes Division Alternate Method Rulings OPSC Nos. 08-03 & 08-01.

Overflow – The highest level that water in a cistern is permitted to attain.

Pump – Mechanical device necessary to distribute the harvested rainwater from the cistern to the designated plumbing fixtures.

Rainwater – Water from natural precipitation that has not been contaminated by use.

Roof washer or first-flush diverter – A device or method for removal of sediment and debris from collected roof water by diverting the initial rainfall from entry into the cistern.

Screen – A filtration device, constructed of corrosion-resistant wire or other approved mesh.

Sedimentation – Separation of solids from the water by gravity.

NOTES

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