Rainwater Harvesting and Purification System

In January 1996 we installed a rainwater catchment system to capture Oregon's abundant rainfall. Portland receives between 3 and 4 feet of rainfall annually. During a gentle rain a typical Oregon downspout sheds several gallons per minute. Our twelve hundred square foot roof captures on average 3600 cubic feet (27,000 gallons) of water per year.

In 1998 we received approval from the city of Portland to use this water for all household use. This system, which cost less than $1,500, consists of the following components:

- A 1500 gallon plastic cistern, approximate cost: $500. Our tank was made by Snyder Industries. Contact local agriculture or farm stores for best prices. Or check yellow page listings for tanks. Here is a link to an Oregon dealer.
- A 1/2 horsepower shallow-well pump to pressurize the water to between 20 and 30 psi (pressure is adjustable), approximate cost: $250. I utilized a Jacuzzi brand pump.
- Plastic (outdoor PVC and indoor CPVC) piping to connect to the household cold water system.
- Two particulate filters in series, rated at 20 and 5 micron particle size, approximate cost: $20 each; replaceable filter cartridges cost $3-5 each.
- An ultraviolet light sterilizer capable of sterilizing water at 10 gallons per minute. This appliance was recently approved for use in Oregon. I used the PURA (1-800-292-PURA, Valencia, California) model UV20-1, cost approximately $350. Uses about 40 watts. Fluorescent ultraviolet light rated at 9600 hours, about one year of continuous use. Replacement cost of fluorescent tube: about $80.
- Screen covering the cistern to prevent entry of mosquitoes and to catch any large particles that make it past the gutter screening.
- A roof-washer which wastes the first 7.5 gallons of captured water which has "washed" the roof. Once the roof washer has filled, the rest of the water flows to the cistern. See below for details.
- A 20 gallon water butyl rubber diaphragm pressure storage tank, approximate cost: $150.
- A reduced pressure backflow prevention device. This was required by the city to prevent flow of rainwater into the public system. Cost: $120. This would not be necessary if we used rainwater exclusively. However, Oregon has very dry summers and our cistern is exhausted by July. We currently depend on city water during the summer. The city requires annual inspection of these devices, costing about $30. (See photo below.)
- A (optional) water meter to measure rainwater output, approximate cost: $45.

Maintenance consists of keeping gutters and cistern screen clean. Filters and ultra-violet lamp will need periodic replacement. The tank is thoroughly cleaned annually

in the summer when it empties. Backflow prevention device requires annual inspection. Public health authorities recommend periodic testing of water for fecal coliform bacteria, as for any private water system. Several recent tests showed none. The inside components of our system, pictured here, take up about 6 square feet of floor space.

At the current time we continue to use the public water supply only for summertime water and occasional drinking and cooking. In fact, during the rainy season, which lasts from about September to June, our only connection to the public utility is one faucet at the kitchen sink which uses less than one gallon per day, which got us into hot water with the city water bureau.

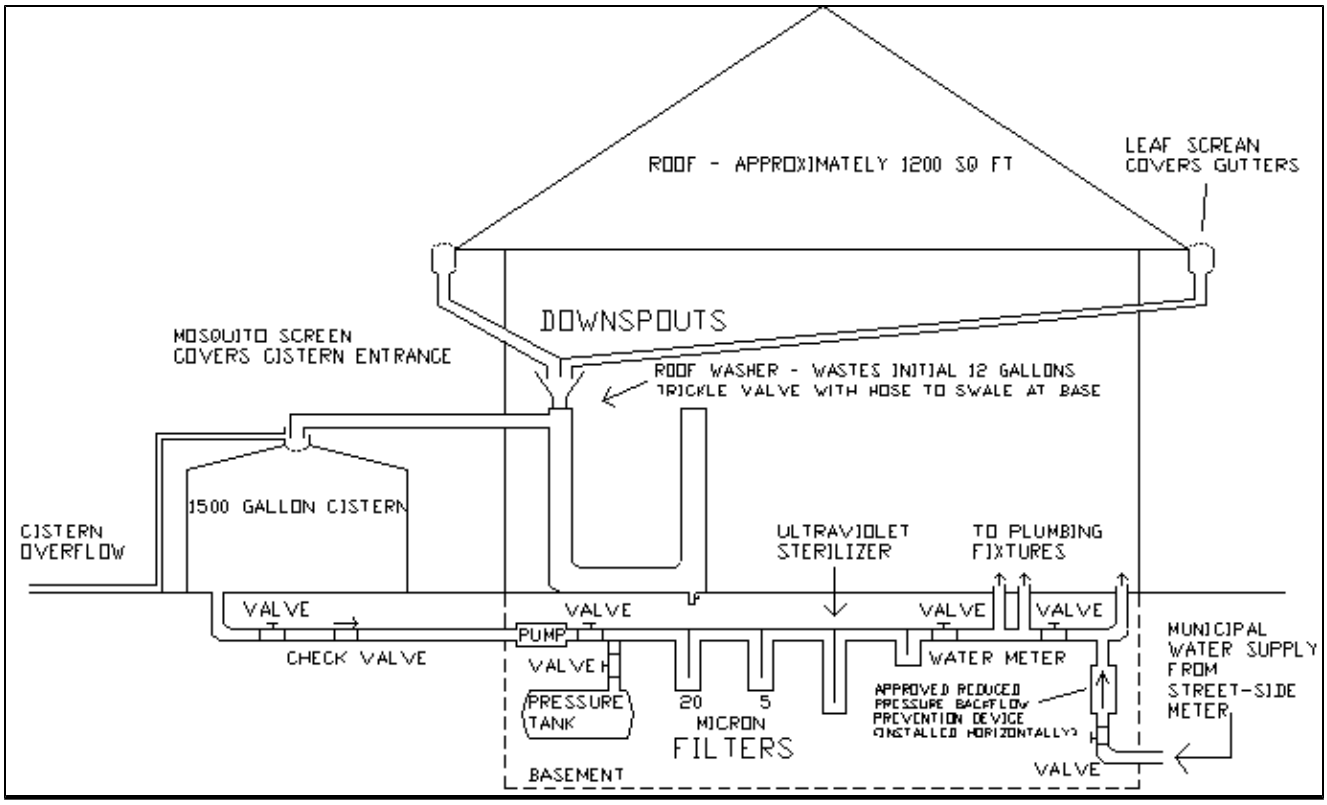
In my research on rainwater catchment systems the best single reference I have come across for detailed design guidelines is the Texas Water Development Board's *Texas Guide to Rainwater Harvesting*.

Roofwashers. A simple prototype is shown in the TG. It consists of a length of pipe for storage of the initial flush of water with a trickle valve (hose bib just slightly opened) and clean out valve at the bottom. Only when the this pipe fills is water then allowed to continue into the cistern. It's very simple, no moving parts. The only thing I would change is to have a narrow section or trap configuration at the top to reduce mixing of the flush water with the still arriving (clean) water. Yet another method to aid this is to add a lightweight (like styrofoam) ball that would seal the intake when the roof washer fills. This simple design is very inexpensive, easy to drain or clean manually, and works very well. The TG suggests one gallon of washer capacity for each 100 square feet of roof. So make your roof washer pipe length long enough. For our model we used 20 feet of 3" ABS. We made it in the shape of a giant U to get this length. Remember, volume equals length times area. Area equals pi times radius squared (in our case 3 inches internal diameter, or .25 foot) and one cubic foot equals 7.5 gallons. To avoid long lengths of roofwasher pipe, it makes sense to use larger diameters. Portland's chief residential plumbing inspector commented that our use of ABS didn't conform to code as plastic may eventually decay in sunlight. Therefore, you should use copper, iron, or other sunlight-resistant materials to be completely correct. Or simply paint any plastic parts to protect them from the effects of sun light.

Rainbarrels. A rainwater harvesting system can be as simple as a barrel connected to a downspout. Check the Rainbarrel Tutorial for tips on how to put together a system for as little as $15-20. Another great link is the Rain Barrel Guide. One of our neighbors has connected his rain barrel to his basement washing machine and gets virtually all his laundry water from this super-soft source for a miniscule investment.

One notable advantage of rainwater is its softness. Rainfall in the Portland area contains about 5 mg/liter of dissolved minerals. Compare this with some hard groundwater which exceeds 500 mg/liter. Portland city water, which has an exceptionally pure source, is rated at 12 mg/liter.

According to two officials in Alaska and Hawaii with whom I have communicated, there is a long established tradition of rainwater collection in some parts of their states. According to Sourcebook Harvested Rainwater, in some areas of the Caribbean, new houses are required to have rainwater capture systems. Hawaii apparently is currently developing (or has already developed) guidelines. In Oregon, there is no regulation of water quality for individual residences -- this is left up to the homeowner. The only regulations I have come across relating to rainwater harvesting are from Ohio, whose Department of Health Administrative Code regulates private water systems. Note, in particular, Rules 3701-28-09 Continuous disinfection and 3701-28-13 Construction and surface design of cisterns, hauled water storage tanks, and roof washers.

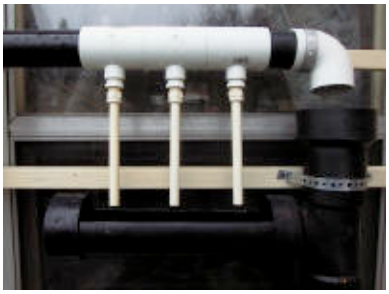


A great resource for rainwater harvesting information is Warwick (Coventry, United Kingdom) University's Development Technology Unit Roofwater Harvesting Programme.

Update Summer 2002 -- A different style of roof washer. This summer we installed a commercially available roof washer that uses a programmable valve to divert a rain's first flow away from the cistern. A purported advantage is the absence of standing water that can stagnate and potentially contaminate the cistern water. (This could happen, for example, if the trickle valve on the conventional device were to clog or it were left closed.) Below are two photos of the system with this new device. The first photo shows the roof washer mounted on a window frame near the cistern. Rainwater, which enters from the two downspouts above, can be observed from inside the dwelling. The first flush is diverted downwards into a holding barrel. An overflow hose from the top of the cistern also empties into this barrel. Post-flush water enters the cistern via the roof washer's side port through a screened cistern entry hole. The barrel overflow is directed to a swale in the middle of our back yard.

Update January 2004 -- An American-made roof washer and rainwater sculpture. I never was able to get the SafeRain roof washer to function properly in Oregon's often drizzly weather. Either the roof washer diversion valve would not properly close, thus diverting all the rainwater into the overflow, or it would not open after the rainfall event ended, retaining dirty water in the device. I attempted numerous times to adjust it, all to no avail. Unfortunately, for this reason, I can not recommend this device. The last straw came during recent freezing weather when the device froze with water in it, rendering it non-functional. Therefore, recently, I installed a newer style of first-flush device. This device is considerably less expensive (approximately $66 versus $140 at currency exchange rates 22 Jan 2004, including shipping) for North Americans, since it is locally made and uses standard pipe fittings. The first-flush valve kit consists of a hollow ball (see middle two photos below) which, when filled by the initial flow of water, seats itself onto a rubber gasket. This closes the overflow pipe and subsequent rainwater is then diverted to the cistern. After the rain stops the ball empties and the diversion valve returns to the open position. I will post a review of how well this device performs at the end of this rainy season. At this time it already seems to be functioning properly.



At the same time I installed this roof washer I also installed a more elaborate piping configuration (see photo, above, left) leading from the downspouts to the cistern that is intended to act as a water sculpture. Viewable from our dining room window, it will display ten areas of flowing water, depending on the time in a rainwater event and the rainwater flow. During a typical Oregon drizzle, only the left most vertical pipe (see photo, above right) carries water. During a downpour all three pipes will be filled to capacity and additional flow will emerge from the 2" elbow.

Update January 2005 -- final roof washer review. Unfortunately, this second roof washer employs the same mechanism as the earlier, Australian, model to reset itself after a storm event. Both devices use a small, hollow, plastic ball that fills with water when rain begins. While the ball fills, the initial dirty rainwater is wasted. When the ball is full, it lowers over a drain hole, causing the remaining clean rainwater to be diverted into the cistern. The problem with both these devices is that their ball depends on a tiny pin-hole to empty their water when the rain stops. However, it is all too easy for this hole to become obstructed with small particles of sand or other debris common in a gutter. The ball then does not drain properly and the device does not reset itself. Thus, both devices required close monitoring and frequent manual cleaning in our system. I regret to say that I cannot recommend either one. My recommendation at this time is to employ a homemade Texas style standpipe roof washer. Its simplicity allows it to be constructed and maintained inexpensively.

We have now sold this house and moved to a different residence. We will work with the new owners who will continue using this system.

Rainwater Harvesting and Purification System / *Feedback welcome* / revised May 16, 2005