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# Choosing Large-scale Rain Harvesting for Potable Supply

## Guide for Rural Homeowners in Arizona

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Figure 1. A circular cistern and pump-filtration shed store and process rain captured from a multi-use out building. St. David, Arizona. Photo courtesy of Derek 'Handeeman' Howlett.

## Rain harvesting in the desert

As groundwater becomes harder to access in many areas of Arizona, risks and costs associated with groundwater wells have become an important economic consideration for property owners. Groundwater is considered a non-renewable water supply when aquifers do not recover enough from pumping to reliably produce water from the same level through time. Water may refill the aquifer very slowly, so slowly that the groundwater being pumped today may be thousands of years old. Once more water is pumped than is recharged, an aquifer is in overdraft, with multiple potential negative effects, including the water level drops that have affected the water supplies of individual small-acreage landowners.

Some property owners have turned to large-scale rainwater harvesting to supplement or replace well water supplies. Rainwater is renewable and can be a realistic source of water for homeowners living in remote areas. There are many reasons to turn to harvesting rain for potable water supply. Some homesteaders who purchase land without a well decide that it is less risky to install a rain harvesting system than to drill for groundwater that may be inaccessible at a reasonable depth and cost. Others have a low-yield or seasonally dry well and choose not to deepen their well because they worry that the water level may fall below the new well depth before they can afford to drill again. Water harvesting is an alternative to having water trucked in. Other people find that the quality of their well water is unacceptable for potable use, and a growing number of people prefer the taste, softness and purity of rainwater over groundwater. Finally, rainwater is collected to suppress fires and stored rainwater is made available to fire departments. Rainwater is generally free of the problems that occur in groundwater, like minerals, common in Arizona groundwater, and contaminants that find their way to groundwater from various sources of pollution.

## Is there enough rain?

Many people think that it doesn't rain enough in the desert to collect a worthwhile amount of water. But consider this: In a one-inch rainstorm, you can collect 600 gallons of rainwater off a 1,000 square foot roof. For example, Cochise County receives an average of 12 to 19 inches of rain a year, in different areas of the county. That amounts to about 7,200 to 11,400 gallons of free water for your rain harvest! With large storage tanks and treatment fixtures you can provide for the potable needs of an entire household.

## Is large-scale rain harvesting for potable use right for you?

### *4 factors to consider*

Four primary factors are the keys to deciding if harvesting rainwater to meet the water needs of your entire household is the right choice for you. They are (1) how much water you can harvest, (2) how much water you can store, (3) how much water you need for your lifestyle, and (4) your willingness to take responsibility for treating your water so that it remains safe to drink. You can calculate the amount of rain you can harvest using the size of your roof or other harvesting surface and your local average annual rainfall. From that you can estimate the size of the cistern or cisterns you will need to store that much water. Then you can compare your potential rainwater supply with your household's water demand.

Figure 2. A rain roof doubles as an open-air workshop on this Sulphur Springs Valley, AZ homestead. Photo courtesy of Jim Bonilla, Green Team You Tube channel.

> "Rainwater quality almost always exceeds that of ground or surface water."
>
> *Texas Water Development Board.*

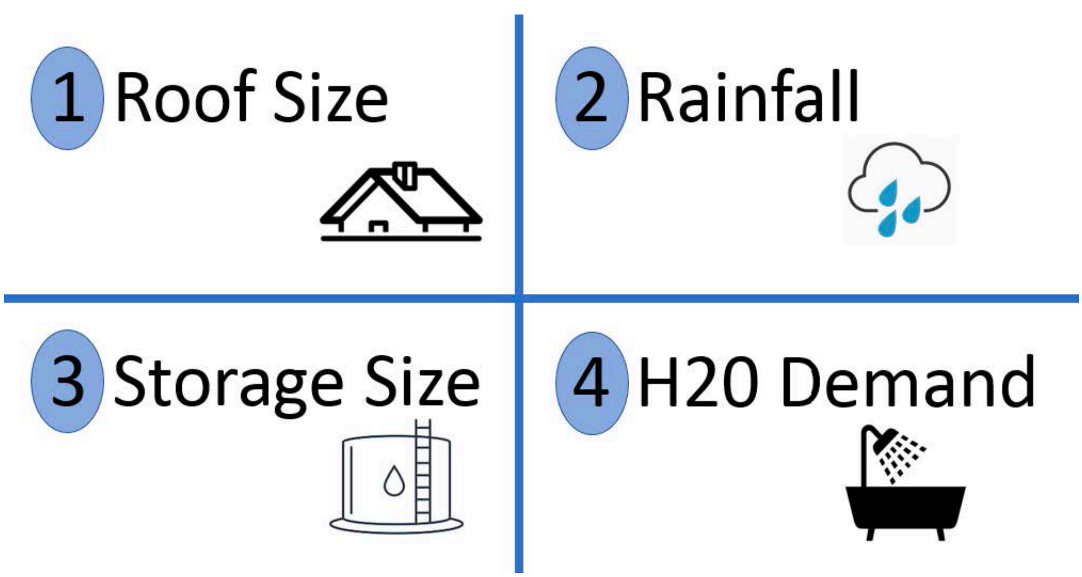


Figure 3. Four considerations determine your rain collection potential. Of these, roof size, storage size and your water demand can be adjusted. Rainfall amounts cannot. Averages from past years are used to calculate potential yield.

# 1 How much can be harvested?

## Calculating your capacity for collection

### *Roof*

A roof or several roofs are probably your best rainwater collection areas, be it your house, shed, barn, workshop, porch or shade structure roof. The size of the collection area will determine how much water you can harvest. When measuring the roof area, measure the footprint on the ground and do not worry about the slope of the roof. For example, the roof on a 50-foot-long by 20-foot-wide house is 1,000 square feet. Complex roofs can make guttering and harvesting more difficult than simple roofs. Recommended roof surfaces are standing-seam metal, EPDM (Ethylene propylene diene monomer), slate, tile or composition tile. Roof surfaces not recommended for rain harvesting are asphalt, unprotected metal, tar and gravel, or wood shingles.

### *Rainfall*

Most of Arizona has a bimodal rainfall pattern. This means that most of the rain we receive occurs in two periods, either in the winter months (December-February) or during the monsoon season (July-September). Because months without rain can occur between these two wetter periods, when it rains, you need to catch what you can!

The US Climate Data website (usclimatedata.com) or the National Weather Service (http://www.wrh.noaa.gov/twc/climate/seaz_rainfall_normals.php) are good places to find average annual rainfall in your location. Both sites show the yearly and monthly averages. Of course, rainfall amounts vary from year to year as well as from month to month. Rainlog.org also displays rainfall information. On the interactive map, click on a square near your location to find citizen reports of rainfall on a day-by-day basis, as well as yearly charts. This is recorded, actual rainfall information, not averages.

**Climate Tombstone - Arizona** °C | °F

| | Jan | Feb | Mar | Apr | May | Jun |
|---|---|---|---|---|---|---|
| Average high in °F: | 60 | 63 | 69 | 77 | 85 | 94 |
| Average low in °F: | 36 | 38 | 41 | 47 | 55 | 63 |
| Av. precipitation in inch: | 1.02 | 0.79 | 0.75 | 0.31 | 0.28 | 0.59 |
| Days with precipitation: | - | - | - | - | - | - |
| Hours of sunshine: | - | - | - | - | - | - |

| | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|
| Average high in °F: | 92 | 89 | 87 | 78 | 68 | 60 |
| Average low in °F: | 66 | 65 | 61 | 52 | 43 | 36 |
| Av. precipitation in inch: | 2.99 | 3.19 | 1.61 | 0.98 | 0.63 | 1.06 |
| Days with precipitation: | - | - | - | - | - | - |
| Hours of sunshine: | - | - | - | - | - | - |

Figure 4. Precipitation information for Tombstone, AZ. US Climate Data.

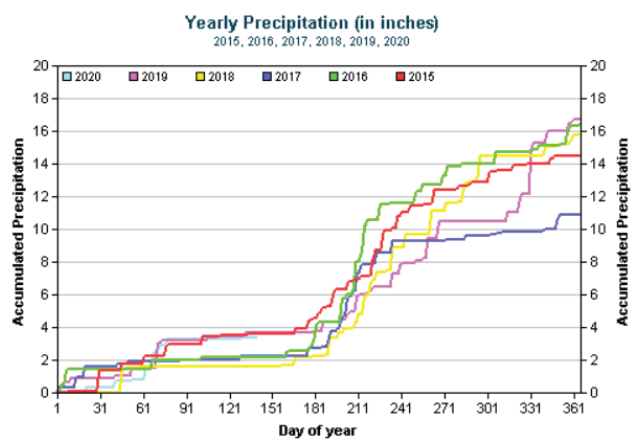


Figure 5. Multiple Year Chart showing actual rainfall amounts for a location near Douglas, AZ. Rainlog.org.

| usclimatedata.com | Jan. | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ajo | 0.83 | 0.73 | 0.7 | 0.25 | 0.04 | 0.03 | 0.71 | 1.51 | 0.51 | 0.4 | 0.34 | 0.79 | 6.84 |
| Buckeye | 0.79 | 0.79 | 0.98 | 0.28 | 0.16 | 0.08 | 0.67 | 1.22 | 0.75 | 0.63 | 0.63 | 0.91 | 7.89 |
| Carefree | 1.9 | 1.72 | 1.89 | 0.62 | 0.14 | 0.09 | 1.04 | 1.38 | 0.92 | 1.11 | 0.82 | 1.44 | 13.07 |
| Casa Gramde | 0.79 | 0.83 | 0.98 | 0.28 | 0.2 | 0.12 | 0.79 | 1.97 | 0.83 | 0.79 | 0.75 | 0.94 | 9.27 |
| Clifton | 1.1 | 1.02 | 0.87 | 0.31 | 0.43 | 0.35 | 2.01 | 2.28 | 1.5 | 1.26 | 0.87 | 1.3 | 13.3 |
| Flagstaff | 2.12 | 2.33 | 2.26 | 1.27 | 0.62 | 0.42 | 2.38 | 3.47 | 2.56 | 1.89 | 1.81 | 2.03 | 23.16 |
| Florence | 1.06 | 1.06 | 1.14 | 0.39 | 0.28 | 0.16 | 0.94 | 1.22 | 0.91 | 0.91 | 0.75 | 1.22 | 10.04 |
| Holbrook | 0.71 | 0.67 | 0.71 | 0.35 | 0.39 | 0.2 | 1.18 | 1.5 | 1.18 | 1.06 | 0.67 | 0.55 | 9.17 |
| Kingman | 1.22 | 1.1 | 1.3 | 0.47 | 0.31 | 0.2 | 0.98 | 1.42 | 0.67 | 0.83 | 0.71 | 0.83 | 10.04 |
| Nogales | 1.25 | 0.97 | 0.87 | 0.55 | 0.27 | 0.58 | 4.14 | 4.43 | 1.6 | 1.36 | 0.6 | 1.43 | 18.05 |
| Oracle | 2.48 | 2.6 | 2.52 | 0.91 | 0.63 | 0.39 | 3.27 | 4.09 | 1.97 | 2.01 | 1.81 | 2.24 | 24.92 |
| Parker | 1.01 | 0.68 | 0.56 | 0.15 | 0.08 | 0.01 | 0.26 | 0.64 | 0.48 | 0.28 | 0.37 | 0.57 | 5.09 |
| Payson | 2.3 | 2.34 | 2.31 | 1.02 | 0.57 | 0.31 | 2.43 | 3 | 1.89 | 1.45 | 1.67 | 2.04 | 21.33 |
| Prescott | 1.59 | 1.79 | 1.69 | 0.78 | 0.49 | 0.3 | 2.71 | 3.09 | 1.95 | 1.02 | 1.08 | 1.46 | 17.95 |
| Safford | 0.76 | 0.75 | 0.62 | 0.29 | 0.25 | 0.29 | 1.5 | 1.91 | 1.02 | 0.87 | 0.54 | 0.87 | 9.67 |
| Tombstone | 1.01 | 0.77 | 0.73 | 0.32 | 0.28 | 0.61 | 2.98 | 3.17 | 1.6 | 0.98 | 0.64 | 1.05 | 14.14 |
| Window Rock | 0.75 | 0.63 | 0.94 | 0.59 | 0.47 | 0.43 | 1.69 | 1.54 | 1.18 | 1.3 | 1.02 | 0.79 | 11.33 |
| Yuma | 0.39 | 0.28 | 0.28 | 0.08 | 0.04 | 0.04 | 0.24 | 0.59 | 0.28 | 0.28 | 0.16 | 0.43 | 3.09 |

Figure 6. Monthly normal rainfall (1981-2010) across Arizona. usclimatedata.com

### Rainwater collection potential
### How much can I harvest?

A simple formula can be used to calculate the total rainwater collection potential of any rainwater harvesting system. Once you have measured your rainfall collection area-- roof (or other catchment) and looked up your annual average rainfall, multiply your collection area by your annual rainfall, then multiply the total by 0.6 (to convert to gallons).

So, for example:

**1,000** square foot roof × **16** (inches of annual rainfall, Wilcox, AZ) × **0.6** (conversion factor)

= 9,600 gallons a year rainwater collection potential

Well-designed rain harvesting systems capture 75-85% of the rain that falls on the collection area. For this reason, some rain harvesting experts use an efficiency factor to account for rain that does not actually make it into a container. This can be rain lost because of wind, tree cover, your roof material, or water spilled by gutters that are too small to hold rain during large rain events. Accounting for some losses won't leave you disappointed in your harvest.

**1,000** square foot roof × **16** (inches of annual rainfall) × **0.6** (conversion factor) × **85%** (efficiency factor)

= 7,200 gallons a year rainwater collection potential

When you know the rainwater collection potential, it is then possible to decide how much storage you need and to choose the size of your cistern(s).

## 2 Storage

Storage is by far the most expensive component of a rain harvesting system, although it is usually cheaper than drilling a well. Cost can be a major factor in choosing the right tank size. For example, a 12,000-gallon poly-lined, steel tank typically required for a two-person household that depends solely on rainwater could cost over $10,000. An equivalent amount of storage in smaller polyethylene plastic tanks, plumbed in a series, could be less expensive. Adding tanks as you can afford them can help reduce upfront costs. You can work towards having enough storage as you purchase additional new tanks, or find them used or on sale, and rely on stored well water or trucked-in water to supplement your rainwater if necessary. If you can afford it, however, it is generally easier to store all your water in one tank. Ferrocement tanks can be constructed on site, with inexpensive materials but are labor intensive. Underground tanks, steel-reinforced concrete tanks constructed like swimming pools, can hold large volumes of water, as can underground, modular water storage systems.

Figure 7.Cisterns on a small-acreage property in Hereford, Arizona. Photo courtesy of Rick Weisberg, Oasis Water Harvesting

Think as big as you can afford! On the other hand, there is no reason to install a tank that exceeds the capacity of your rainwater collection potential, unless there is a possibility you will add more collection area in the future.

It is necessary to have a back-up amount of water in the cistern that exceeds your water demand to prepare for a possible long dry period or overuse. Many rain harvest planners recommend being able to store enough back up water for four months of water demand, which is about the average number of consecutive months without rain likely to occur in much of Arizona. Local environmental patterns and conditions may warrant a different storage capacity.

Next determine if you can harvest enough water for all your household's needs by estimating your annual water demand.

## 3 H2O Demand

### How much water do I need for my lifestyle?

The national average amount of water used per-person-per-day in the United States is 93 gallons. In the water industry that average is referred to as gpcd (gallons-per-capita-per-day). For comparison, Canadians use an average of 71 gpcd, the French 33 and Israelis 29. People in the state of Arizona average 146 gpcd; 30%-80% of this is likely used outdoors. Rural communities tend to have lower gpcd rates. For example, water companies in Sierra Vista, AZ reported in 2019, the average gpcd to be 86. (Most gpcd calculations combine residential and business demand and divide by the population.)

When homeowners become rainwater harvesters, they frequently become water conservers at the same time. Rainwater-dependent users consider 35–50 gallons per-person-per-day a reasonable amount and some use as low

Billy [Kniffen, of the Texas Water Development Board] practices what he preaches. He and his wife Mary live entirely on harvested rainwater in their Menard, Texas home. They use about 70 gallons of water per day, indoors and outdoors, and Billy observed that they had enough water in their tanks to easily get through the 2011-2012 drought.
Texas Water Development Board

as 25–30 gallons per-person-per-day. As rain harvesters become more aware of where their water comes from and their rainfall patterns, they recognize the need to reduce their consumption.

| Estimated Indoor Daily Demand | | | | Per Person |
|---|---|---|---|---|
| Low-flow toilet | 1.28 gallons/ flush | 4 flushes per person per day | | 5<br>Try a composting toilet.<br>5 gallons saved per day |
| Showers | 2.2 gallons/ minute | 10 minutes/ per person per day | | 22<br>Shorter 5-minute shower?<br>11 gallons saved per day |
| Faucets (personal hygiene, cooking, cleaning) | 2.2 gallons/ faucet per min. | 5 minutes/ per person per day | | Turn off water while you shave.<br>14 gallons saved per day<br>22 |
| Shared Use | | | # of people in household | |
| Check for leaks | | | | Leaks fixed<br>6.75 gallons saved per day |
| Clothes washing | 25 gallons/ load | 2.6 loads per week | 2 | 32<br>Energy star certified washers use only 10 gallons per load.<br>13 gallons saved per day |
| Dishwasher | 8 gallons/ cycle | 0.7 cycles/ day | 2 | 5.6 |
| **Total** | | | | |
| Gallons per person (capita) per day (gpcd) | | | | **84**<br>Conservation lowered gpcd to:<br>34 |

## What can you use less of?

Once you know your annual water demand, you know how much storage you would need for a 12-month water supply. If you have a two-person household and water demand of 45 gallons per person per day, a 12-month supply would be around 33,000 gallons (2 people x 45 gallons per day x 365 days = 32,850). Because rainfall in Arizona tends to be bimodal, you may be able to fill your cisterns twice a year and make do with half that storage capacity. For a 2-person household with 45 gpcd demand, it is best to wait until your tank(s) have 1,000 gallons stored before relying totally on rainwater.

## Right-Sizing Your Capacity

### *Adjust one of the 4 factors*

You can't do anything about the amount of rainfall in your area, but if one of the remaining 3 factors is limiting your ability to harvest enough rain to live on, you can alter your set-up by (1) increasing your collection area (2) adding more storage, or (3) using less water.

### *Add more collection area*

Not having a large enough roof area to collect enough water can be solved by connecting additional roof areas, such as an existing garage, shed, or porch roof to your system. Some harvesters build rain roofs which are roofs that are constructed specifically to harvest rain and may also serve a second function, such as a livestock or vehicle cover. Rain roofs, which some folks call 'rain barns', are simple freestanding structures with metal roofs--the ideal surface for harvesting rain.

Figure 8. Two rain roofs in southeastern Arizona made with recycled materials. Photo (top) courtesy of Joe Mooney, Homesteadonomics You Tube channel. Photo (bottom) courtesy of Derek Howlett, Handeeman You Tube channel.

Figure 9. Two 2825-gallon cisterns installed in the foothills of the Huachuca Mountains, AZ. Photo courtesy of Mary Ann Capehart.

### *Add more storage*

Cost is usually the first consideration for adding additional cisterns. Also, if there is not enough roof surface, a larger cistern will not solve the problem. If the roof area and the rainfall yield enough water, you can increase your capacity by using a larger cistern or adding more cisterns.

### *Use less water*

Conserving water can be achieved by installing low-water-use fixtures, such as ultra, low-flow toilets, WaterSense labeled appliances, or on-demand hot water systems. Good water conservation practices, such as taking shorter showers, filling clothes and dish washers full for every load, and turning off water while brushing teeth or sudsing dishes, can also help lower your demand. Soak pots and pans instead of letting water run. Scrape dishes into the garbage or compost rather than using a disposal. Installing aerators on all faucets can reduce flow per minute. Check for and fix leaks, which waste an average of 6.75 gallons-per-person-per-day. For outdoor water needs, graywater reuse and passive rain harvesting can decrease the amount of potable water you use outdoors. Households depending on rain learn to conserve in drought periods in order to maintain their backup water supply at safe levels.

“Imagine you lose half your average rainfall and use twice as much water as you think you do.” Mike McEveen longtime rainwater user, Rain Harvesting for the Mechanically Challenged, authors Suzy Banks with Richard Heinichen

### A Cascabel Arizona Scenario

On this Cascabel property, house and garage roofs make a combined collection area of 3,000 square feet. In 2010, 14.33 inches of rain fell on these roofs, yielding a capture potential of 22,655 gallons of water. Four 2,500-gallons tanks, plumbed in a series, provided 10,000 gallons worth of storage. The water demand of this 2-person household was 1,825 gallons a month (22,000 gallons a year) a gpcd of 30 gallons. These homesteaders waited until they had collected 6,000 gallons before beginning to depend upon their rain harvest. After the first year of using rain, January to December, they ended up with a 1,913 gallon surplus. Since a three-month dry period is common in their area, 3-months’ worth of security water is advisable. So, they might increase their storage, making more back-up water available, or truck in water in the event of a prolonged dry spell.

## How It’s Done

A large-scale water harvesting system consists of five main components: 1) Collection Area, usually a roof surface 2) Conveyance System including gutters or flat roof drainage holes (scuppers), downspouts and piping. 3) Water Storage, including a cistern or series of cisterns 4) Pre-filtration Device to keep debris out of the system, such as a first-flush diverter pipe (Figure 9, Item 2.), and/or a basket strainer placed in the top of a cistern see 3 in the diagram below). A sediment filter can be installed in-line to protect the pump and treatment system in situations where the collection area has a noticeable amount of sediment. 5) Distribution System to provide water pressure, often a suction pump and pressure tank like those used with wells or an on-demand pressure pump. For more information about basic rain harvesting components, see Rainwater Collection -- Basic Components of a Rainwater Storage System Fact Sheet in the Resources section below. When the system is used to provide potable water inside the home, you must have a treatment system as well.

<table>
<tr><th colspan="3">DROUGHT OPTIONS: Coping with dry periods</th></tr>
<tr><th>Primary Source</th><th>Backup Source</th><th>Considerations</th></tr>
<tr><td>Harvested rainwater</td><td>Trucked-in water</td><td rowspan="2">Trucked-in water can be added to existing rain harvest containers ahead of treatment.<br>If adding rainwater to trucked-in water tank, combined water must be treated before use. Rainwater stored separately can be for non-potable uses untreated.</td></tr>
<tr><td>Trucked-in water</td><td>Harvested rainwater</td></tr>
<tr><td>Low-yield well water</td><td>Harvested rainwater</td><td rowspan="2">Water from a low-yield well can be combined with harvested rainwater. Where possible, combine them before treatment and consider contaminants in both waters in treatment.</td></tr>
<tr><td>Harvested rainwater</td><td>Low-yield well water</td></tr>
</table>

# 4 Treatment

## One last very important factor

Rainwater is naturally soft, slightly acidic water, making it excellent for cooking, washing and watering plants. Because it is low in minerals, however, it can leach metals from cisterns and pipes. It also can pick up contaminants from collection surfaces, such as bird droppings or dust and organic material deposited from the air. Water treatment for potable use is necessary and should include filtration and disinfection in addition to any screens or filters used in the harvesting system.

### *Filtration and disinfection*

A three-prong filtration system can create potable water from most rain harvesting systems. This typical filtration and disinfection system consists of a 5-micron fiber filter, a 3- micron activated charcoal filter, and an ultraviolet lamp. A pump shed, or any room near the cistern, can hold the components that go into water treatment. The pressurizing pump can also be housed here to deliver clean water to fixtures in the home, and if needed, to outdoor spigots. For more detailed information on treating rainwater to drinking water standards, see link for Preparing Rainwater for Potable Use in the Additional Resources section of this document.

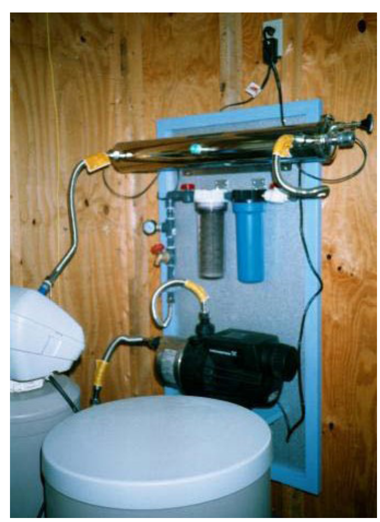

Figure 11. Typical treatment installation of an on-demand pump, 5-micron fiber filter, 3-micron activated charcoal filter, and an ultraviolet lamp (top). Photo courtesy of Texas AgriLife Extension Service.

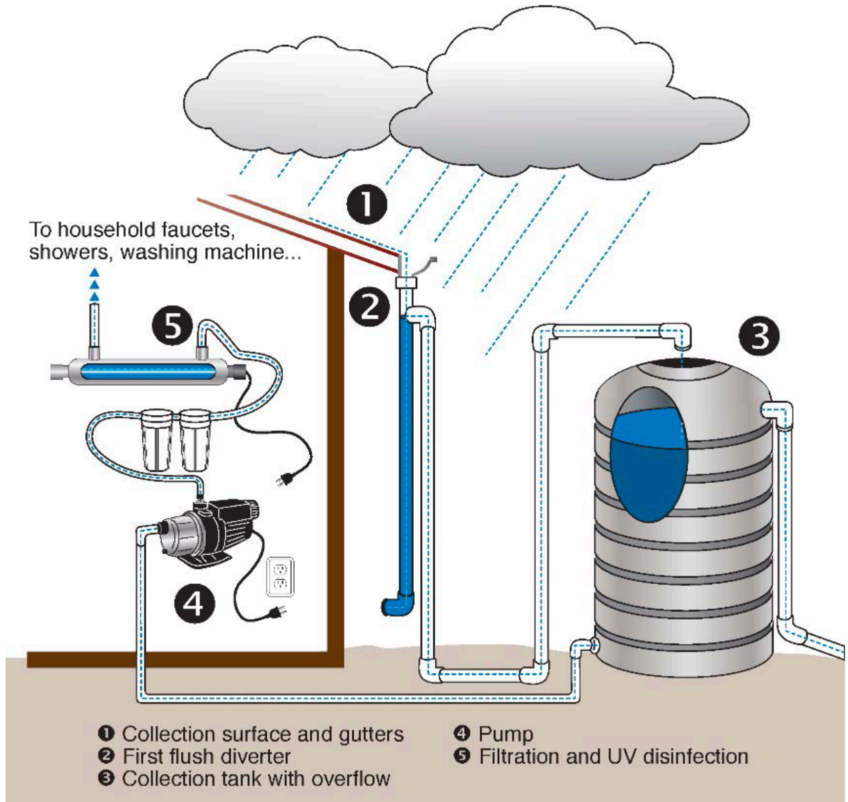


Figure 10. The primary components of a potable rain harvesting system include: 1. the collection area, a roof and a gutter, 2. pre-filtration such as a first flush diverter pipe depicted here, 3. a storage container, 4. a way to pressurize water such as an on-demand pump depicted here, and 5. filtration and disinfection including units such as a sediment filter, active charcoal filter, and a UV lamp depicted here. Diagram by John Polle.

## Maintaining Your Home Water Treatment Plant

### Questions to help you decide if you can harvest and treat your own water:

- Are you physically capable of maintaining the system, including emptying a first flush system, cleaning gutters, and cisterns if necessary? Or can you afford to pay someone to take on maintenance tasks and emergency repairs?
- Are you home enough to complete monthly inspections, including checking for leaky pipes or valves?
- Can you afford replacement parts, such as UV bulbs?
- Who will freeze-proof the system in very cold weather?
- Can you take responsibility for safe electrical components?
- Can you take responsibility for troubleshooting water pressure issues?
- Can you be sure no one can fall into a cistern?

### Some Examples

Rain harvesters move from groundwater dependence to rainwater dependence in different ways. Below are four sample rain harvesting set-ups used by harvesters around the state of Arizona. In each of these examples, compare the roof area, the collection potential, storage volume, and the water demand, shown here as gallons-per-person-per-day, gpcd.

### Cost comparison: rain harvesting versus wells

As aquifers are pumped lower and lower, access to water becomes an economic question. When aquifers drop below the level of a well, homeowners usually must deepen their wells or truck in water. The decision to deepen a well can be difficult because of uncertainty about future water levels and consideration of the water quality from greater depths.

Now that large-scale, steel poly-lined water tanks ranging in capacity from 5,000 to 200,000 gallons are more widely available and more affordable, rainwater harvesting on a large scale is a viable alternative to deepening a well or drilling a new well. Keep in mind, however, that maintaining a rain harvesting and treatment system may take more attention than a well.

| HOME NEAR BISBEE, AZ | | |
|---|---|---|
| SUPPLY<br>roof area (home, porch and shed) | 2,660 square feet |  |
| rainfall collection potential (at 18" average annual rainfall) | 25,354 gallons/yr. | |
| storage volume | 6,220 gallons | |
| containers: (1) 2,500-gallon (2) 1,500-gallon (1) 30-gallon (1) 420-gallon polyethylene plastic tanks | | |
| DEMAND<br>percentage of annual demand that can be stored | 24% | Photo courtesy of Mary Ann Capehart. |
| amount made available by capturing all rain: 2 inhabitants | 36 gpcd | |

| HOME IN THE SULPHER SPRINGS VALLEY, AZ | | |
|---|---|---|
| SUPPLY<br>roof area (rain roof and large porch roof) | 2,360 square feet |  |
| rainfall collection potential (at 13" average annual rainfall) | 16,247 gallons/yr. | |
| storage volume | 14,000 gallons | |
| containers: (1) 14,000-gallon ferrocement tank | | |
| DEMAND<br>percentage of annual demand that can be stored | 1.16% | Photo courtesy of Jim Bonilla. |
| amount made available by capturing all rain: 2 inhabitants | 22 gpcd | |

| HOME IN THE TUCSON MOUNTAINS, AZ | | |
|---|---|---|
| SUPPLY<br>roof area (house roof) | 5,250 square feet |  |
| rainfall collection potential (at 10" average annual rainfall) | 27,801 gallons/yr. | |
| storage volume | 26,000 gallons | |
| containers: (1) 26,000-gallon underground cement cistern | | |
| DEMAND<br>percentage of annual demand that can be stored | 93% | Photo courtesy of Jay Cole. |
| amount made available by capturing all rain: 2 inhabitants*<br>* includes water for a 12,000-gallon swimming pool | 38 gpcd | |

| HOME NEAR ST. DAVID, AZ | |
|---|---|
| SUPPLY<br>roof area (large multipurpose workshop building) | 4,500 square feet |
| rainfall collection potential (at 10" average annual rainfall) | 23,830 gallons/yr. |
| storage volume | 28,000 gallons |
| containers: (1) 28,000-gallon above-ground poly-lined steel cistern | |
| DEMAND<br>percentage of annual demand that can be stored | 1.16% |
| amount made available by capturing all rain: 2 inhabitants | 33 gpcd |

Photo courtesy of Derek Howlett.

| HOME NEAR WILLIAMS, AZ | |
|---|---|
| SUPPLY<br>roof area (home and garage roofs) | 3,069 square feet |
| rainfall collection potential (at 10" average annual rainfall) | 19,502 gallons/yr. |
| storage volume | 15,00 gallons |
| containers: (3) 5,000-gallon partially buried polyethylene cisterns | |
| DEMAND<br>percentage of annual demand that can be stored | 77% |
| amount made available by capturing all rain: 2 inhabitants | 33 gpcd |

Photo courtesy of Thad Johnson.

Figure 12. Bolting together a 28,000-gallon steel tank requires around 1,000 large nuts and bolts. A flexible monofilament, polyethylene liner fits inside the assembled tank. Photo courtesy of Oasis Water Harvesting.

For the purpose of discussion, two hypothetical systems in Cochise County conditions were compared. The cost of drilling a 350-foot well, including casing and well cap, pump tank, piping to the home, wiring with a control panel was compared with the cost of installing a 28,000-gallon, steel poly-lined rain tank, 200 feet of seamless gutter, a pressure booster pump, and a filtration system. At 2020 prices, the costs were comparable. Of course, costs for both systems would vary according to any unique characteristics of the property and other costs that may be incurred for both systems. Regarding maintenance issues, pumps are the most likely component to need replacement. Slime and algae issues can arise with wells. Service for this would likely exceed the cleaning of a cistern. Rural property owners can know that it is worth considering rain harvesting on a large scale when making choices about their water supply.

It is also important to think about maintenance and repair costs. Rain harvesters will have to treat their water, if

| Wells | Large Rain Tanks |
|---|---|
| *Maintenance* | |
| Cleaning of well water tanks and rainwater storage tanks: costs are equivalent | |
| Inspection by licensed water well contractor every 7 - 10 years: $200 - 300 | Home owners can conduct inspections or pay for a general contractor or handyman to inspect. |
| Annual Water Quality Testing: $200 | Initial water testing if contaminant is suspected. Further testing not needed unless conditions change |
| Water treatment chosen depends on well water quality testing/ or no treatment | Water treatment required: supplies: $140 a year |
| *Parts Replacement* | |
| Submersible well pump: $700 to $1,200 + labor of licensed water well contractor | Typical on-demand pump for a rain harvesting system: $80 - $700 (owner installed or general contractor) |
| Pressure tank replacement at equivalent costs for well water and rainwater systems | |

for nothing else but pathogens left by bird droppings, etc., on roofs at around $140 a month. Some well owners need or prefer to filter their well water. When components of the system fail, in particular pumps, the costs for well owners will far exceed rain harvesters. Pumps in wells must be replaced by a licensed water well contractor and they cost much more than a typical pump for a rain harvest system.

## Building code standards and building permits

Arizona does not have regulations governing private water harvesting systems, however local governments may have requirements for building permits and construction associated with such systems. For all rainwater storage systems, check with your local government's planning or building department for any codes that may apply. A safe potable system consists of all food grade materials. Water should be tested regularly to ensure that it meets potable water quality standards.

## Rain Harvesting Rebates

The City of Tucson offers a up to $2,000 rebate for passive (water-harvesting earthworks or rain gardens) and/or active (gutters and cistern/tank) rainwater-harvesting systems.

cms3.tucsonaz.gov/water/rwh-rebate.

The City of Prescott offers a rebate for rainwater harvesting cisterns at $0.50/gallon of storage.

The City of Flagstaff offers rebates for rain harvesting cisterns of 1000 gallons capacity or larger.

| | Contact Information |
|---|---|
| University of Arizona Cooperative Extension, Cochise County, Water Wise Program | https://waterwise.arizona.edu/ (520) 458-8278 |
| UA Water Resources Research Center | https:// wrrc.arizona.edu/ (520) 621-9591 |
| Watershed Management Group | https://watershedmg.org (520) 396-3266 |

## Additional Resources

### *University of Arizona*

Rainwater Collection -- Basic Components of a Rainwater Storage System Fact Sheet

https://extension.arizona.edu/pubs/rainwater-collection-basic-components-rainwater-storage-system

Layperson's Guide to Arizona Water

https://wrrc.arizona.edu/publications/laypersons-guide-arizona-water/laypersons-guide-arizona-water

Water Wise, Cochise County Cooperative Extension

https://waterwise.arizona.edu/harvest-rain

Water Storage Tank Disinfection, Testing, and Maintenance https://extension.arizona.edu/pubs/water-storage-tank-disinfection-testing-maintenance

Rainlog.org a cooperative rainfall monitoring network for Arizona maintained by citizen scientist data contributors.

http://Rainlog.org

Preparing Rainwater for Potable Use Publication , authors Capehart, Artiola, Eden.
http://extension.arizona.edu/pubs/az1863-2021.pdf

### *Other organizations*

Texas Water Development Board
https://www.twdb.texas.gov/innovativewater/rainwater/raincatcher/2012/kniffen.asp

US Climate Data. for rainfall information
https://www.usclimatedata.com/climate/arizona/united-states/3172

American Rainwater Catchment Systems Association
http://www.arcsa.org/

Arizona Department of Water Quality
https://www.azdeq.gov/

Brad Lancaster | Rainwater harvesting author and expert
http://www.harvestingrainwater.com/

Desert Water Harvesting Initiative
https://wrrc.arizona.edu/DWHI

EPA Water Sense
www.epa.gov/watersense

Greywateraction.org
https://greywateraction.org/rainwater-harvesting/

Oasis Design
https://oasisdesign.net/about/artludwig/

The Online Rainwater Harvesting Community
http://www.harvesth2o.com/index.shtml

R.A.I.N
http://www.rainfoundation.org/

Roof Gutter and Downspout-Sizing Guide. Search "Downspout & Gutter Sizing" at:
HarvestingRainwater.com

Tucson Water, Resource List for Southern Arizona
https://www.tucsonaz.gov/files/water/docs/RWH_Resource_List_Nov_2019.pdf

Watershed Management Group, non-profit rain harvesting training and services
https://watershedmg.org/

### *Books on Rain Harvesting*

Rainwater Harvesting for Drylands and Beyond, Volume 1: Guiding Principles to Welcome Rain into Your Life and Landscape, 2nd Edition Revised, 2013 by Brad Lancaster (Author)

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

Rainwater Collection for the Mechanically Challenged, Tank Town Publications, Dripping Springs, Texas, 2004 by Suzy Banks with Richard Heinichen (Authors)

### *Videos on Rain Harvesting*

Handeeman You Tube Channel Derek Howlett
https://www.youtube.com/Handeeman/videos

Homesteadonomics You Tube Channel
https://www.youtube.com/user/homesteadonomics

Aquamate
https://www.youtube.com/channel/UCCUzOIh16CXvLNlJa8s1efQ

Oasis Water Harvesting
http://oasisrainwaterharvesting.com/videos/

### *Rain Harvesting Supplies*

Acer Water Tanks, San Marcos, Texas
Acerwatertanks.com
877-223-7785

Aquamate Water Tanks North America
https://www.aquamatetanks.com/
844.320.8265

Coconino County Sustainable Building Service Provider Directory
https://www.coconino.az.gov/DocumentCenter/View/18429/Resource-Directory-New-Format--?bidId=

Loomis Tanks Centers, Dewey, AZ
https://loomistank.com/
866-636-0046

Oasis Water Harvesting, Sierra Vista, AZ
http://oasisrainwaterharvesting.com/
520-234-7681

Southern Arizona Rain Gutters, Tucson, AZ
http://www.southernarizonaraingutters.com/#rain-harvest-solution

The University of Arizona Cooperative Extension
520-299-7246

SunPumps, Solar Solutions, Safford, AZ
http://sunpumps.org/

Tanks N Barrel, Apache Junction, AZ
https://www.tanknbarrel.com/
480-233-6463

## Need additional help?

Contact the Water Wise Program
(520) 458-8278 x2139
https://waterwise.arizona.edu/

THE UNIVERSITY OF ARIZONA
Cooperative Extension

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**This information has been reviewed by University faculty.**
extension.arizona.edu/pubs/az1864-2021.pdf

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extension.arizona.edu/pubs