A USER'S GUIDE TO SECTION P2914 OF THE 2018 INTERNATIONAL RESIDENTIAL CODE: POTABLE RAINWATER COLLECTION AND DISTRIBUTION SYSTEMS COCONINO COUNTY, ARIZONA

USING THIS GUIDE:

What is this guide for?

This guide will help you understand the section of the ordinance for potable rainwater collection and the components of designing and installing a rainwater harvesting system for potable uses, such as drinking, bathing, and cooking.

How is the guide organized?

Part 1 explains the basics of what is required for a potable water harvesting system in Coconino County.

Part 2 discusses how to design a rainwater harvest system for potable use. This includes how to properly size a system to meet your needs, estimating the expected yield in harvested rainwater, more in-depth information on the system components and maintenance, specific information on tanks or cisterns (types of tanks, where to install, maintenance), and the approximate cost of a typical system.

Part 3 outlines guidelines for testing your rainwater system and the quality of your harvested water.

Part 4 has appendices, such as a full copy of the approved ordinance for Potable Rainwater Distribution Systems [P2914] and Potable Water Storage Tanks [P2915], estimation worksheets, and recommended resources.

Throughout the guide, there are links that will connect you to the relevant section of the ordinance or guide that is being referenced. Where appropriate, the ordinance is also cited directly to assist anyone using the print version of this guide.

PART 1: UNDERSTANDING THE BASICS OF THIS ORDINANCE:

When does this ordinance apply?

The provisions of this section shall govern the construction, installation, alteration, and repair of rainwater collection and conveyance systems for the collection, storage, treatment and distribution of rainwater for potable applications, as permitted by Coconino County. [P2914.1 General]

What is Potable Water?

The International Code Council defines potable water as: Water free from impurities present in amounts sufficient to cause disease or harmful physiological effects and conforming in bacteriological and chemical quality to the requirements of the public health authority having jurisdiction. (International Code Council, 2017). This means the water is safe for human consumption through activities like cooking, drinking, bathing, and food preparation. Water that has not been properly filtered, treated, and stored should never be used for potable applications because it can carry bacteria, viruses, or other disease that can make a person ill.

Can I Collect Rainwater for Potable Use?

Rainwater can be collected for potable or non-potable use. It is a great way to conserve water and lower your utility costs. Rainwater collected for potable use requires a system that complies with the regulations explained in this guide. Buildings and homes in “dry” neighborhoods where water is supplied by wells, or by hauling water, may be especially well-suited to consider harvesting rainwater for potable use.

There is no ordinance for rainwater harvesting for irrigation purposes or other outdoor uses. Thus, no permit is required for these systems. However, if you are bringing your harvested water back into your home for toilet flushing or laundry, these systems are governed by section [P2912] Nonpotable Rainwater Collection and Distribution Systems. Rainwater harvesting used for potable uses such as cooking, drinking, bathing, and food preparation are governed by Chapter 29 Water Supply and Distribution of the Ordinance, Section [P2914] Potable Rainwater Collection and Distribution Systems.

Where Can I Collect Rainwater for Potable Use?

Rainwater shall be collected only from above-ground impervious roofing surfaces constructed from *approved* materials. [P2914.2 Collection surface]

Surfaces such as tile, metal, slate, concrete, fiberglass, galvanized metal, and asphalt shingle, as well as others, may be approved. The material on the surface that you collect rainwater from may also determine if additional testing or filtration are needed. Some surface materials may also require a larger amount of water to be diverted by the roof washer. Continue reading for more information about testing and roof washers.

Collection of water from vehicular parking or pedestrian walkway surfaces shall be prohibited, except where the water is used *exclusively* for landscape irrigation. Landscape irrigation is typically considered non-potable water and will not be covered extensively in this guide.

Overflow and bleed-off pipes from roof-mounted *appliances* including, but not limited to, evaporative coolers, water heaters and solar water heaters shall not discharge onto rainwater collection surfaces.

Do I need special gutters, tanks, and other equipment?

The entire rainwater collection, conveyance, storage, treatment, and distribution system must meet the standards required for potable water use. Rainwater collection systems that harvest water for potable

applications must deliver water that is safe for human consumption. All the components of the system must be safe to carry, store, and deliver water that is usable in potable applications; this includes the gutters, storage tanks, collection and drainage pipes, distribution pipes, and joints. Any rainwater harvesting system in which the stored water will be utilized for potable use must be approved by Coconino County and is subject to all required inspections, testing, and regular maintenance as outlined in the approved ordinance [P2914] and [P2915].

Storage tanks must be manufactured of material approved for the intended application and compatible with any disinfection and treatment systems used. Tanks must be made of durable, nonabsorbent, and corrosion-resistant material. Tanks may be above the ground or buried below grade; buried tanks may require installed ballasts to secure the tank in place. Areas that are prone to sustained freezing temperatures during operations must also make provisions to ensure their tanks and associated pipes do not freeze. More information about storage tanks can be found in Section P2915 of the ordinance and Part 2 of this guide.

The surface of a roof can collect a lot of unwanted debris and animal waste. Potable rainwater harvest systems must have a component that diverts the water at the beginning of a rain event to allow the roof to be rinsed of these contaminants before any water is allowed into the collection system. [P2914.4 Roofwasher] These roof washers are also called “First-Flush Divertors.” Debris excluders and pest control screening prevent waste from entering the collection/distribution piping and storage systems. [P2914.3 Debris excluders] and [P2915.2 Insect and vermin control] The collected water must also be filtered and possibly disinfected to ensure it delivers quality potable water to the end user. [P2914.7 Filtration] and [P2914.8 Disinfection] Some users choose to include additional filtration systems to cleanse their water, such as: box or small tank roof washers, UV lights, and reverse osmosis systems, but these features are not required.

Valves in a rainwater system prevent the water from mixing, or backflowing, into any alternate sources of potable water that may be connected to the plumbing. [P2914.10.1 Backwater valve] This prevents possible contaminants in the rainwater system from contaminating other water sources. Valves may also be needed to regulate the water pressure in the pipes, especially if pumps are being used to carry the water throughout the system. [P2914.12 Water pressure-reducing valve or regulator]

Cleanouts, shutoff valves, or diversion systems are required near any component that requires regular maintenance, cleaning, or inspection. [P2914.5.2 Cleanouts], [P2914.7 Filtration], [P2914.10 Influent diversion], [P2915.6.5 Access] Parts of the system that control water flow must be easily accessed and removed from the system for maintenance and repair. [P2914.11 Pumping and control systems]

A full list and diagram of the components of an approved rainwater system is included later in this guide.

Do I need to test my rainwater collection and storage system?

You will need to have the various components of your rainwater system inspected or tested before you begin using the water. An inspection will ensure that the system is safe for use. Inspections and tests should include the roof washer, gutters, collection pipes and vents, tanks, water supply, backflow prevention, and pest control systems. Regular maintenance and testing of the components in your system, as well as regularly testing the water quality coming out of the system, will ensure the water you are consuming is not contaminated or dangerous.

More information about testing and inspecting your rainwater system can be found in Part 3 of this guide.

Do I need to test my water quality?

Where asphalt shingles, or galvanized metal roofing, are used as part of the collection surface, the water shall be tested for potability by a laboratory licensed by the Arizona Department of Health Services. Laboratory results shall be provided to the Coconino County Building Division before the water can be used for potable purposes.

Approved roofing material such as tile, metal, slate, concrete, fiberglass, or other approved material shall not be subject to testing. [P2914.14.7 Water quality test]

More information about water quality testing can be found in Part 3 of this guide.

Do I need to do anything special with my plumbing?

The pipes that carry the harvested rainwater and all the components of your system must be approved for carrying, storing, and delivering potable water. If you have an alternate source of potable water, such as a well or hauled water, you will need to install a backflow prevention device to keep water from your rainwater system from accidentally mixing into the alternate source. This prevents any cross-contamination between the two systems. Otherwise, you do not have to do anything special with your plumbing to use rainwater for potable use.

Fresh, potable water is an extremely valuable resource. It is recommended that buildings using harvested rainwater for potable use should try to conserve as much water as possible through low-flow fixtures, and water-conserving appliances. It is also important to observe how your normal routines and practices can be adjusted to conserve and reuse water throughout the day.

Part 2: Designing a Rainwater Harvest System for Potable Use

What Should I Consider When Designing My System?

There are several steps to deciding if a rainwater harvest system is a good fit for your potable water needs. This guide will walk you through all of them.

Step 1: Determine how much water you need
First, you must balance your calculated water need with your available supply of rainwater and your desired storage capacity. Consider how much potable water you use (in gallons) each month and potential ways you could reduce your use. Implement water conservation practices and fixtures to minimize the amount of water that you are wasting. Use old utility bills, water hauling records, or water-use calculation worksheets (provided in the Appendix) to get a rough estimate of your monthly water needs. Be sure to think about how you may use more or less water during certain seasons and estimate your need for each month. This will help to ensure that you are planning to save enough water.

Step 2: Calculate how much water you can collect from your collection surface and whether that will meet your demand
Next, you must calculate how much water you can collect each month from the collection surface you are hoping to use and average rainfall amounts. Once you know how much water you need in an average month, and how much water you can expect to harvest each month, you must decide how much water you want to store. You can use your rainwater system as your primary source of potable water, or you can use it to supplement an existing water supply, such as a well or water-hauling system. Systems that are designed to meet most of your potable water needs throughout the year will be larger than systems that are used to supplement an alternate source of water. These stand-alone systems must be large enough to sustain the water supply through dry periods, and to capture as much water during the wet season as possible. Keep in mind that you can only use as much water as you have available, so if you are going to need more water than you can harvest and store, you will need to consider an alternate water supply during extended dry periods.

Step 3: Design your rainwater harvest system including gutters, pipes and pumps
After you have determined the storage capacity (in gallons) of your tank, you need to choose a location for the tank and consider how you will configure your gutters, pipes, pumps, and other components to convey the water throughout your system. Then you must design the necessary cleanouts, shutoff valves, diverters, and other components that isolate the various sections of the system that may need to be inspected, cleaned, maintained, or replaced regularly. Be sure to design for easy access to any parts that may need to be maintained; design access to components like pumps and filtration devices from a variety of angles. To design your system to be as user-friendly and accessible as possible, consider what it would be like to need access to each component in the middle of the night during a heavy rain or blizzard. If you had to maintain or repair the system in those conditions, would you be able to? If you needed another person's assistance, is there enough access that they would be able to help you? If you live in an area with sustained freezing temperatures, you will also need to consider how you protect your pipes, tank, and the rest of the system from freezing.

Step 4: Find a qualified contractor to help you decide on the appropriate components of your system, and to help with installation, maintenance and determining the cost. You need to consider the cost of building and maintaining your rainwater harvesting system. Time, specialized knowledge, and labor required to maintain the system should also be considered.

How Much Water Can I Collect?

You can use a basic formula to get a rough estimate of how much water you can expect to collect based on your area's average monthly rainfall. You should perform the calculations for each month and use the data to fill out the worksheet attached in the Appendix.

Before you can calculate how much rain to expect, you need some information to help you understand the formula.

- You need to know the square footage of your catchment surface. This is calculated by multiplying the length and width of the roof from eave to eave in the front and rear. The pitch of the roof and roof style do not affect the footprint of the surface. However, if only part of the roof is guttered, the calculation

should only include the footprint of the area drained by gutters because that is the only surface contributing to the rainwater collection system.

- You can collect approximately .62 gallons of water per square foot of catchment surface for every inch of rain that falls. This is known as the Rainfall Constant and it is used in the calculation to convert the average monthly rainfall in inches into gallons of water that will be stored.

- Because of the roof washing system, leaks, water diversions, and spillover, your system will never collect 100% of the water that falls during a rain event or a snowmelt. The material of your roof can also affect how efficiently your surface collects water. On average, a rainwater collection system can be expected to harvest about 75-90% of the water that falls during a storm. This is referred to as the Catchment Efficiency ratio, and most formulas set this amount at about 85%.

The formula to calculate your monthly rainwater supply is:

Monthly Water Supply = Catchment Area (sq. ft) x Average Rainfall (in.) x Rainfall Constant (.62) x Catchment Efficiency (.85)

For example, if you have a home with a roof footprint = 2,500 sq. ft. and average rainfall for May = 0.8 inches

$$2{,}500\ ft^2 \times 0.8 \text{ inches rainfall} \times .62 \ \frac{gal/ft^2}{in} \times 0.85 \text{ efficiency} = 1054 \text{ gallons of expected supply}$$

Simplified, the formula looks like this:

2,500 ft² x .8 in x .62 x 0.85 = 1054 gal.

You can compare the expected rainfall over several months:

Average Monthly Rainfall in Area	Rainwater Calculation for Month	Expected Rainwater Harvest for Each Month
May = 0.8 inches	2,500 ft² x 0.8 in x .62 x 0.85 = 1054 gal	About 1054 Gallons
June = 0.43 inches	2,500 ft² x 0.43 in x .62 x 0.85 = 566.5 gal	About 566 ½ Gallons
July = 2.4 inches	2,500 ft² x 2.4 in x .62 x 0.85 = 3162 gal	About 3162 Gallons
August = 2.89 inches	2,500 ft² x 2.89 in x .62 x 0.85 = 2807.5 gal	About 2807 ½ Gallons

How Much Water Should I Store?

How much water you need to store is based on a percentage of what you use and how much you are able to collect each month. The design of your rainwater system (water catchment area, weather patterns, distribution, demand, storage capacity) will dictate whether you will need a backup supply such as hauled water, or well water. If you find you need to supplement with hauled water or well water, the supplemental water may be added directly to your rainwater storage tank. (please see Figure 1: Flow Chart for Designing Your Rainwater Harvesting System)

What are the Components and How Do I Design My System for Rainwater Collection and Storage?

Components and Maintenance of your System:

The most important aspect of using rainwater for potable use is to be careful about the components of your harvesting system to ensure that your collection and storage components are not contaminating your water. The less your collection system contaminates your water, the less work your filter needs to purify it for potable use. The ordinance does not have any specifics on maintaining your system other than specifics on testing. Nonetheless, proper maintenance of your system is crucial to keeping your water safe for potable use.

Each collection system will be slightly different, but all systems are required to have at least:

- **A suitable and approved collection surface:** Many roofing surfaces are acceptable for rainwater harvesting, but metal, concrete, or slate roofing are generally considered the best. Asphalt shingle roofing contains many chemicals and can deposit debris into your system as the water runs off the roof. Wood shingles can harbor bacteria and other contaminants. The ordinance specifies the requirement for water quality testing depending on your roof type. [P2914.2 Collection surface] [P2914.14.8 Water quality test]

- **Gutters, downspouts, debris excluder, and a roof washer (a.k.a. first-flush diverter):** All gutters, joints, sealants, and downspouts should be comprised of a safe, non-toxic material. As should the collection and drainage pipes, distribution pipes, and joints that carry, store, and deliver water that will be used in a potable system. Make sure you have debris excluders or leaf screens attached to gutters so that water flowing into your gutters is free from large detritus. The initial water flowing from the collection surface is always the dirtiest. For this reason, you will also have a roof washer or "first flush diverter" that diverts the initial water flowing from the collection surface away from the storage tank. [P2914.14 Roof gutter inspection and test] [P2914.14.1 Roofwasher test] [P2914.14.2 Collection pipe and vent test]

- **A suitable and approved water storage tank with proper overflow outlets and vermin control**: Storage tanks must be made of safe, non-toxic materials that will not leech into the water. [P2915.6 Materials] Tanks should be sanitized regularly and inspected for cracks, wear, and potential sources of contamination. Tanks need to have an appropriately sized vent and must be protected from insects and vermin. [P2914.14.3 Storage tank test] [P2914.14.6 Inspection of vermin and insect protection]

- **Backwater valves and influent diversion systems**: In the event of a significant rain event, you will have an overflow pipe with a backwater valve. Occasionally, you will need to repair or clean your tank and will need a way to divert incoming water with an influent diverter. [P2914.14.5 Inspection and testing of backflow prevention assemblies]

- **Distribution pumps and piping to carry the water from the tank to the point of use:** Piping systems and pumps should be inspected and maintained regularly. All joints must be sealed and free of leaks.

- **A filtration and purification system to cleanse the water and make it suitable for potable use:** Filtration and purification as it is conveyed from the tank, pump and piping into your home.

How Do I Design My System?

The design of your system depends on the intended application for your potable water. Will you just be using it for laundry and flushing toilets? Or, will you also be using it for drinking, cooking and bathing? Regardless, you need to work with your building official to determine the specific aspects of your system to be considered, such as the holding capacity of your storage tank, and sizing of your collection piping.

Some aspects of your system are specified in other parts of the building ordinance. This includes the installation and size of your collection piping; the materials and standards for your distribution piping; the type and size of your joints, overflow, and cleanouts; flow rate and pressure for your pumping and control system; pressure regulators and backwater valves.

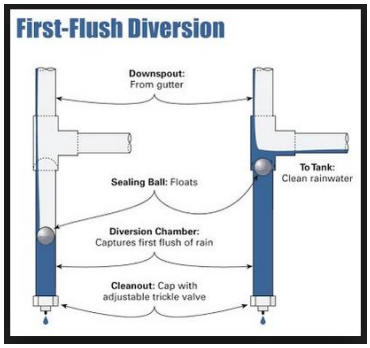
The ordinance offers specific requirements for the design of your gutters, leaders and rainwater collection piping. Gutters and downspouts should have a slope of at least 1/8 inch per foot (10.4 mm/m) along their entire length. Installation of gutters and downspouts must be installed so that water does not pool at any point. [P2914.5.1 Slope]

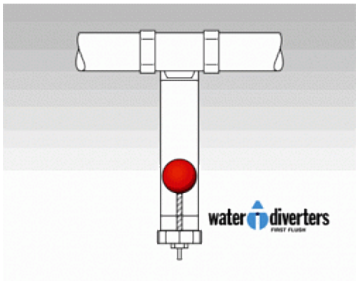
As mentioned in Part 1, water coming into your gutters often caries a lot of unwanted debris that you will want to filter out. Thus, you will need a debris excluder, usually a screen that filters out the detritus such as leaves, twigs, bugs, etc. In deciding the level of screening and the type of debris excluder to use, you will want to make note of how many trees are nearby and other kind of detritus that may accumulate on your roof or collection. When a rain event occurs, the first rain that collects on your roof will often be dirty and may even have bird droppings and other harmful material that will not be filtered out with the debris excluder. For this reason, you will also need a roof washer, also known as a "first flush diverter" to divert that initial water away from your storage tank. The ordinance does not specify how much initial rainwater should be diverted but does specify that "*The amount of rainfall to be diverted shall be field adjustable as necessary to minimize storage tank water contamination*." [P2914.3 Debris excluders] [P2914.4 Roofwasher]

The type storage tank you use, how many tanks you select, and the location are also important factors to think about when designing your system. Additionally, you will need to consider how easy it will be to access your tanks for maintenance, repair and cleaning. Other system components to consider are the piping and plumbing components. All are outlined in the Flow Chart and the Diagram on the following page.

Leaf Screen

Debris Excluder





Flow Chart for Designing Your Rainwater Harvesting System:

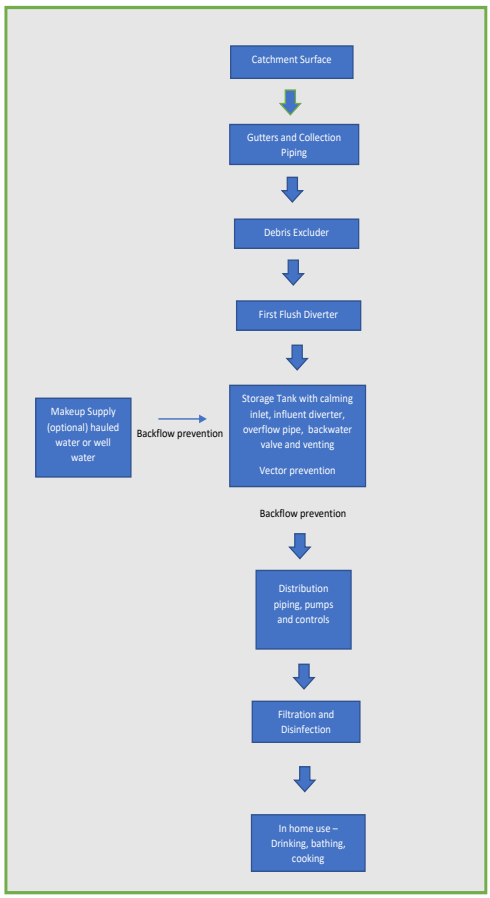


Fig. 1. Flow Chart for Designing Your Rainwater Harvesting System

Diagram of Above Ground Cistern:

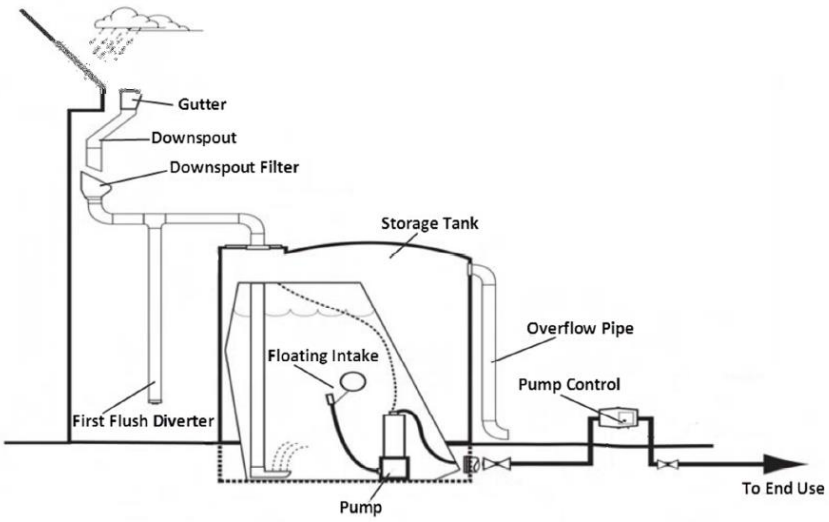


Fig. 2. Basic Above Ground System and Components from: "Diagram of above ground cistern," 2009 https://www.dca.ga.gov/sites/default/files/2009_ipc_appendixi_rainwater.pdf. Accessed 15 May, 2020

What Type of Storage Tank Should I Use?

Water storage tanks or cisterns are a vital component of your rainwater harvesting system, so you need to be aware of your options before deciding on what tank(s) you select. When deciding on a tank, keep in mind that storage tanks must be tested and pass certain criteria. For more information on how tanks will be tested, please refer to [P2915.7 Storage tank tests]. Water storage tanks come in a variety of shapes, sizes and materials to fit the needs of your space and location. Please see figures below for size in gallons for round cisterns (the most common shape for storage tanks) and material types.

Round Cistern Capacity (Gallons)

Height (feet)	6-foot Diameter	12-foot Diameter	18-foot Diameter
6	1,269	5,076	11,421
8	1,692	6,768	15,227
10	2,115	8,460	19,034
12	2,538	10,152	22,841
14	2,961	11,844	26,648
16	3,384	13,535	30,455
18	3,807	15,227	34,262
20	4,230	16,919	38,069

Fig. 3. Table of Different Round Cisterns and their capacity in gallons from “Round Cistern Capacity (Gallons),” 2005 http://www.twdb.texas.gov/publications/brochures/conservation/doc/RainwaterHarvestingManual_3rdedition.pdf Accessed 15 May 2020

Cistern Types

Material	Features	Caution
Plastics		
Trash Can (20-50 gallon)	Commercially available; inexpensive	Use only new cans
Fiberglass	Commercially available; alterable and moveable	Must be sited on smooth, solid level footing
Polyethylene/Polypropylene	Commercially available; alterable and moveable	UV-degradable, must be painted or tinted
Metals		
Steel drums (55 gallon)	Commercially available; inexpensive	Verify prior to use for toxics; prone to corrosion and rust
Galvanized steel tanks	Commercially available; Alterable and moveable	Possible corrosion and rust; Must be lined for potable use
Concrete and Masonry		
Ferrocement	Durable and immoveable	Potential to crack and fail
Stone, concrete block	Durable and immoveable	Difficult to maintain
Monolithic/Poured-in-place	Durable and immoveable	Potential to crack
Wood		
Redwood, fir, cypress	Attractive, durable, can be disassembled and moved	Expensive

Fig. 4. Table comparison of different storage tank materials from "Cistern Types," 2005 http://www.twdb.texas.gov/publications/brochures/conservation/doc/RainwaterHarvestingManual_3rdedition.pdf

Accessed 15 May 2020

How Many Tanks Do I Need?

Some homeowners choose to have just one large tank for their storage while others may decide on a series of daisy-chained tanks. Having one tank will be cheaper. However, the advantage of having multiple, is if something goes wrong with one of your tanks, you can continue collecting water and using your system while the damaged tank is repaired. If this is your sole source of water, it is recommended that you have more than one tank.

How Do I Maintain, Clean and Repair My Tank?

Hopefully, you can avoid having to repair or do much maintenance on your storage tank(s). Other than specification on testing, the ordinance does not offer any specific guidance on maintaining your tank or how to maintain other components of your system. It is recommended that you regularly clean your tank in accordance with the manufacturer's instructions. In the event that your tank needs to be repaired or cleaned, you will need to have a way to divert incoming water, or an "influent diverter."

Your tank must have at least one access opening for maintenance and cleaning the interior of the tank. Below-grade tanks must have a manhole. For specifications of proper sizing of manholes, please refer to section [P2915.6.5 Access]. Below-grade storage tanks less than 800 gallons are exempt from having a manhole but must have a service port no less than 8 inches in diameter.

You will need to think about how to divert access water during significant rain events when your tank becomes full. Proper piping and drainage to direct the water elsewhere are required. Overflow drains should not have shutoff valves. For every overflow pipe, you must have a backwater valve and at least one cleanout. [P2915.6.4 Overflow] As mentioned previously, backwater valves are covered in a different section of the ordinance Section P3008.

What Other Features of My Tank(s) Should I Be Aware Of?

Any tank that holds liquid must have proper ventilation. A vent may seem like a minor component, yet without a a vent, your tank could potentially implode from the pressure differential caused by the pump drawing suction. All storage tanks must have a properly sized vent and the vent must be protected from contamination with an approved cap or U-bend installed with the opening directed downward. [P2915.6.6 Venting]

Fast moving water entering your tank can create turbulence. This in turn may stir up any sediment from the bottom of your tank or the thin layer of film that sometimes develops at the top, which may contain bacteria. For this reason, the inlet into your storage tank needs to be designed and located for minimum turbulence to avoid agitating the water in your tank. Additionally, the outlet should be no less than 2 inches above the bottom of the storage tank and should not skim any water from the surface. The better the water you can deliver to your pumps and filters, means less maintenance and longevity. Some may choose to have a "floating pick-up" attached at the end the outlet, which allows water to be drawn from the middle of the tank. [P2914.9.2 Inlets] [P2914.9.3 Outlets]

Your drain should be located at the lowest point of the storage tank and should discharge as required for overflow pipes. At least one cleanout for each drainpipe is required. [P2915.6.7 Drain]

Where Should I Install My Tank?

Where your property is located, the temperature, the soil type, etc. are all factors that may influence the type of tank(s) you choose and where you decide to install. It is important to note that soil types will vary. Certain soil types may not be able to handle the weight capacity or size of your tank and may require preparation of the area prior to installation. Consult your building official or work with your contractor to determine the best location for your water tank on your property and whether you may need a compaction test for your soil. Below are some basic guidelines to follow when deciding where to install your water tank(s).

Storage tanks or cisterns must be located a minimum distance from certain elements of your property such as septic tanks and seepage pits. Please refer to the Table in [P2914.9.1] in the Appendix on the exact minimum distance. In order to reduce the distance your water needs to be pumped, it is advisable that storage tanks be located as close as possible to where you will be harvesting and using your water. Cisterns may be installed at

or below grade; there are advantages and disadvantages to both. Above grade cisterns will likely be easier to inspect and maintain. Having them below grade will help to avoid freezing, which is especially important in certain areas of the County. Depending on your location and likelihood of freezing temperatures, your tank may need to be insulated. Above grade cisterns must be protected from direct sunlight with opaque, UV resistant material or specially constructed sun barriers to avoid algae growth. Avoid placing tanks under any soil piping, waste piping or any other source of contamination. [P2915.5 Location]

When considering your foundation be aware that water weighs just over 8 pounds per gallon, so even a small 1500-gallon tank can weigh upwards of 12,000 pounds. Thus, tanks must be supported on a firm base, often a concrete pad, that can withstand the weight of the tank when completely filled. If your tank is below grade, make sure the installation can withstand earth and structural loads. [P2915.6.1 Foundation and supports] [P2915.6.3 Structural support]

For tanks located underground, if there is a chance of flooding, you will need to secure the tank by ballasting it. Otherwise, if there is a flood event, your tank could potentially float out of the ground if not secured. [P2915.6.2 Ballast]

What Other System Parts Will I Need?

In order to move the water from your tank into your home, a pumping and control system are necessary, along with distribution piping. The Rainwater Harvesting System of the ordinance simply specifies that the "mechanical equipment including pumps, valves and filters be easily accessible and removable in order to perform repair, maintenance and cleaning." For specifications on minimum flow rate and pressure, please refer to Section P2903 of the ordinance. You will need to install a water pressure-reducing valve or regulator only if the pumping systems exceeds 80 psi (552 kPa) static. For more information on pressure-reducing valves, please refer to Section P2903.3.

All components of your rainwater harvesting system including piping, plumbing components, and materials used for collection and conveyance, must be approved for rainwater harvesting and must be compatible with any disinfection and treatment systems used. Likewise, you will need to consider how to control vermin and pests form entering your tank(s).

To prevent vermin and other pests from entering your storage tank and piping systems, you need compatible screen materials with contacting system components. [P2915.2 Insect and vermin control]

Finally, once the water has reached your home, you will need a filtration and disinfection system before you can use it. As mentioned in Part 1, the collected water must be filtered and possibly disinfected to ensure it delivers quality potable water to the end user. Your filtration and disinfection system will likely be located inside your home, often in a utility room. Filters must be accessible for inspection and maintenance. Filters must also have shutoff valves installed immediately upstream and downstream to allow for isolation during maintenance. Your water should be disinfected to ensure required water quality at the point of use. Please see table below of Treatment Techniques. [P2914.7 Filtration] [P2914.8 Disinfection]

Typical filtration system will include the following:

Sediment filter – two sediment filters, a 5-micron fiber cartridge followed by a 3- micron charcoal cartridge, should be installed after the pressure tank or pump. These filters remove sediment, dust, microscopic particles, and organic molecules. The filters must be changed on a regular basis.

UV light – after filtration, the water should be treated with a UV light to kill any remaining bacteria or other contaminants. Typically, a lamp rated at 12 gallons per minute is sufficient; however, research your system size to make sure you have installed an adequate UV light.

Treatment Techniques

Method	Location	Result
Treatment		
Screening		
Leaf screens and strainers	gutters and downspouts	Prevent leaves and other debris from entering tank
Settling		
Sedimentation	within tank	settles out particulate matter
Activated charcoal	before tap	removes chlorine *
Filtering		
Roof washer	before tank	eliminates suspended material
In-line/multi cartridge	after pump	sieves sediment
Activated charcoal	after sediment filter	removes chlorine, improves taste
Slow sand	separate tank	traps particulate matter
Microbiological treatment/Disinfection		
Boiling/distilling	before use	kills microorganisms
Chemical treatments (chlorine or iodine)	within tank or at pump (liquid, tablet, or granular) before activated charcoal filter	kills microorganisms
Ultraviolet light	after activated charcoal filter, before tap	kills microorganisms
Ozonation	after activated charcoal filter, before tap	
Nanofiltration	before use; polymer membrane (pores 10^{-3} to 10^{-6} inch)	removes molecules
Reverse Osmosis	before use: polymer membrane (pores 10^{-10} inch)	removes ions (contaminants and microorganisms)
***Should be used if chlorine has been used as a disinfectant.		

Fig. 5. Table of different rainwater harvesting treatment techniques “Treatment Techniques” 2005

http://www.twdb.texas.gov/publications/brochures/conservation/doc/RainwaterHarvestingManual_3rdedition.pdf

Accessed 15 May 2020

Approximately How Much Will My Rainwater Harvest System Cost?

Various elements of your rainwater harvesting system will factor into the cost. For example, will your system be above or below ground? How many storage tanks do you plan to have and what size and material will they be? How far will your storage system be from your home? How may gutters and how much distribution piping will be necessary? What type of filtration system do you plan to use? The approximate cost can range anywhere between **$8,000 and $25,000**, and this does not include the collection surface material, which will ideally be either metal, concrete or slate.

What Contractors are Available to Do the Work?

Please refer to Coconino County's Sustainable Building Service Provider Directory, (which is continually updated and vetted), for contact information of contractors providing installation services, components, and maintenance of rainwater harvesting systems. Please refer to the Service Provider Directory for water quality testing as well.

Part 3: Testing your Rainwater System and Water Quality

What should I be testing my water for?

Areas throughout Coconino County have varied contaminants that could be in your harvested rainwater, and the components of your system can also affect what you should be testing for. Each system is unique and bringing the water in your system up to potable standards will not be the same for everyone. Work with your local building officials to identify the contaminants and other potential hazards that your system will need to filter and test for. As mentioned above, the Sustainable Building Service Provider Directory has listed two different testing laboratories where you can have your water tested.

Water testing should be done at the point of use. This means that you should be testing water that is coming from your home faucets, after the water has already been purified through your filtration and other purification systems. The ordinance specifies that water collected from galvanized metal or asphalt roofing must be tested prior to use. [P2914.14.7 Water quality test]

How often do I have to have my water tested?

Your water quality must be tested and approved prior to using it for potable applications. After the system is initially approved, the ordinance does not specify how often it should be retested.

Regular retesting is the best way to ensure the water in your system continues to be safe for potable applications. Speak to your local building official for recommendations on how often to retest, and plan to retest whenever you change a major component of your system, such as replacing a storage tank or gutter, or switching to a new filtration system. Retesting is not necessary when replacing the filters in your existing system, but if you change your filtration system, it is recommended that you retest after the new components are installed.

Part 4: Appendices

CHAPTER 29 WATER SUPPLY AND DISTRIBUTION

SECTION P2914 POTABLE RAINWATER COLLECTION AND DISTRIBUTION SYSTEMS

P2914.1 General.

The provisions of this section shall govern the construction, installation, *alteration*, and repair of rainwater collection and conveyance systems for the collection, storage, treatment and distribution of rainwater for potable applications, as permitted by Coconino County.

P2914.2 Collection surface.

Rainwater shall be collected only from above-ground impervious roofing surfaces constructed from *approved* materials. Collection of water from vehicular parking or pedestrian walkway surfaces shall be prohibited except where the water is used exclusively for landscape irrigation. Overflow and bleed-off pipes from roof-mounted *appliances* including, but not limited to, evaporative coolers, water heaters and solar water heaters shall not discharge onto rainwater collection surfaces. Where asphalt shingles or galvanized metal roofing are used as part of the collection surface, the water shall be tested for potability by a laboratory licensed by the Arizona Department of Health Services. Laboratory results shall be provided to the Coconino County Building Division before the water can be used for potable purposes.

P2914.3 Debris excluders.

Downspouts and leaders shall be connected to a roof washer and shall be equipped with a debris excluder or equivalent device to prevent the contamination of collected rainwater with leaves, sticks, pine needles and similar material. Debris excluders and equivalent devices shall be self-cleaning. Exhibit 1. Example of a Debris Excluder.

P2914.4 Roofwasher.

An amount of rainwater shall be diverted at the beginning of each rain event, and not allowed to enter the storage tank, to wash accumulated debris from the collection surface. The amount of rainfall to be diverted shall be field adjustable as necessary to minimize storage tank water contamination. The roofwasher shall not rely on manually operated valves or devices and shall operate automatically. Diverted rainwater shall not be drained to the roof surface and shall be discharged in a manner consistent with the storm water runoff requirements of the *County*. Roofwashers shall be accessible for maintenance, service and drainage. Exhibit 2. Example of a Roofwasher

P2914.5 Roof gutters and downspouts.

Gutters and downspouts shall be constructed of materials that are compatible with the collection surface and the rainwater quality for the desired end use. Joints shall be watertight.

P2914.5.1 Slope.

Roof gutters, leaders and rainwater collection piping shall slope continuously toward collection inlets and shall be free of leaks. Gutters and downspouts shall have a slope of not less than $^1/_8$ inch per foot (10.4 mm/m) along their entire length. Gutters and downspouts shall be installed so that water does not pool at any point.

P2914.5.2 Cleanouts.

Cleanouts shall be provided in the water conveyance system to allow access to filters, flushes, pipes and downspouts.

P2914.6 Collection pipe.

Rainwater collection and conveyance systems shall utilize drainage piping *approved* for use within plumbing drainage systems to collect and convey captured rainwater. Vent piping *approved* for use within plumbing venting systems shall be utilized for vents within the rainwater system. Collection and vent piping materials shall comply with Section P3002.

P2914.6.1 Installation.

Collection piping conveying captured rainwater shall be installed in accordance with Section P3005.3.

P2914.6.2 Joints.

Collection piping conveying captured rainwater shall utilize joints *approved* for use with the distribution piping and appropriate for the intended applications as specified in Section P3003.

P2914.6.3 Size.

Collection piping conveying captured rainwater shall be sized in accordance with drainage-sizing requirements specified in Section P3005.4.

P2914.7 Filtration.

Collected rainwater shall be filtered as required for the intended end use. Filters shall be accessible for inspection and maintenance. Filters shall utilize a pressure gauge or other *approved* method to provide indication when a filter requires servicing or replacement. Filters shall be installed with shutoff valves installed immediately upstream and downstream to allow for isolation during maintenance. Exhibit 3. Example of a Filtration and Disinfection system.

P2914.8 Disinfection.

Where the intended application for rainwater requires disinfection or other treatment or both, it shall be disinfected as needed to ensure that the required water quality is delivered at the point of use. Exhibit 3. Shows a representative Filtration and Disinfection system.

P2914.9 Storage tanks.

Storage tanks utilized in potable rainwater collection and conveyance systems shall comply with Section P2915

P2914.9.1 Location.

Storage tanks shall be located with a minimum horizontal distance between various elements as indicated in Table P2914.9.1.

TABLE P2914.9.1
LOCATION OF RAINWATER STORAGE TANKS

ELEMENT	MINIMUM HORIZONTAL DISTANCE FROM STORAGE TANK (feet)
Critical root zone (CRZ) of protected trees	2
Lot line adjoining private lots	5
Seepage pits	5
Septic tanks	5

For SI: 1 foot = 304.8 mm

P2914.9.2 Inlets.

Storage tank inlets shall be designed to introduce collected rainwater into the tank with minimum turbulence and shall be located and designed to avoid agitating the contents of the storage tank.

P2914.9.3 Outlets.

Outlets shall be located not less than 2 inches (102 mm) above the bottom of the storage tank and shall not skim water from the surface.

P2914.10 Influent diversion.

A means shall be provided to divert storage tank influent to allow for maintenance and repair of the storage tank system.

P2914.10.1 Backwater valve.

Backwater valves shall be installed on each overflow and tank drainpipe. Backwater valves shall be in accordance with Section P3008.

P2914.11 Pumping and control system.

Mechanical equipment including pumps, valves and filters shall be easily accessible and removable in order to perform repair, maintenance and cleaning. The minimum flow rate and flow pressure delivered by the pumping system shall be appropriate for the application and in accordance with Section P2903.

P2914.12 Water pressure-reducing valve or regulator.

Where the water pressure supplied by the pumping system exceeds 80 psi (552 kPa) static, a pressure-reducing valve shall be installed to reduce the pressure in the rainwater distribution system piping to 80 psi (552 kPa) static or less. Pressure-reducing valves shall be specified and installed in accordance with Section P2903.3.1.

P2914.13. Materials, joints and connections.

Distribution piping shall conform to the standards and requirements specified in Section P2906 for potable water.

P2914.13.1 Design.

Distribution piping systems shall be designed and sized in accordance with the Section P2903 for the intended application.

P2914.14 Roof gutter inspection and test.

Roof gutters shall be inspected to verify that the installation and slope is in accordance with Section P2914.5.1. Gutters shall be tested by pouring not less than 1 gallon of water (3.8 L) into the end of the gutter opposite the collection point. The gutter being tested shall not leak and shall not retain standing water.

P2914.14.1 Roofwasher test.

Roofwashers shall be tested by introducing water into the gutters. Proper diversion of the first quantity of water in accordance with the requirements of Section P2914.4 shall be verified.

P2914.14.2 Collection pipe and vent test.

Drain, waste and vent piping used for rainwater collection and conveyance systems shall be tested in accordance with Section P2503.

P2914.14.3 Storage tank test.

Storage tanks shall be tested in accordance with the Section P2915

P2914.14.4 Water supply system test.

The testing of makeup water supply piping and distribution piping shall be conducted in accordance with Section P2503.7.

P2914.14.5 Inspection and testing of backflow prevention assemblies.

The testing of backflow preventers and backwater valves shall be conducted in accordance with Section P2503.8.

P2914.14.6 Inspection of vermin and insect protection.

Inlets and vents to the system shall be inspected to verify that each is protected to prevent the entrance of insects and vermin into the storage tank and piping systems in accordance with Section P2915.2

P2914.14.7 Water quality test.

The quality of the water for the intended application shall be verified at the point of use in accordance with the requirements of the *jurisdiction*. If testing is required, the water shall be tested for potability by a laboratory licensed by the Arizona Department of Health Services. Approved roofing material such as tile, metal, slate, concrete, fiberglass, or other approved material shall not be subject to testing. Water shall be tested if collected off asphalt shingles or galvanized metal roofing.

SECTION P2915 POTABLE WATER STORAGE TANKS

P2915.1 Approved components and materials.

Piping, plumbing components and materials used in collection and conveyance systems shall be manufactured of material *approved* for the intended application and compatible with any disinfection and treatment systems used.

P2915.2 Insect and vermin control.

The system shall be protected to prevent the entrance of insects and vermin into storage tanks and piping systems. Screen materials shall be compatible with contacting system components and shall not accelerate the corrosion of system components.

P2915.3 Freeze protection.

Where sustained freezing temperatures occur, provisions shall be made to keep storage tanks and the related piping from freezing.

P2915.4 Sizing.

The holding capacity of the storage tank shall be sized in accordance with the anticipated demand.

P2915.5 Location.

Storage tanks shall be installed above or below grade. Above-grade storage tanks shall be protected from direct sunlight and shall be constructed using opaque, UV-resistant materials such as, but not limited to, heavily tinted plastic, lined metal, concrete and wood; or painted to prevent algae growth; or shall have specially constructed sun barriers including, but not limited to, installation in garages, crawl spaces or sheds. Storage tanks and their manholes shall not be located directly under any soil piping, waste piping or any source of contamination.

P2915.6 Materials.

Where collected on site, water shall be collected in an *approved* tank constructed of durable, nonabsorbent and corrosion-resistant materials. The storage tank shall be constructed of materials compatible with any disinfection systems used to treat water upstream of the tank and with any systems used to maintain water quality within the tank. Wooden storage tanks that are not equipped with a makeup water source shall be provided with a flexible liner.

P2915.6.1 Foundation and supports.

Storage tanks shall be supported on a firm base capable of withstanding the weight of the storage tank when filled to capacity. Storage tanks shall be supported in accordance with this ordinance.

P2915.6.2 Ballast.

Where the soil can become saturated, an underground storage tank shall be ballasted or otherwise secured to prevent the tank from floating out of the ground when empty. The combined weight of the tank and hold-down ballast shall meet or exceed the buoyancy force of the tank. Where the installation requires a foundation, the foundation shall be flat and shall be designed to support the storage tank weight when full, consistent with the bearing capability of adjacent soil.

P2915.6.3 Structural support.

Where installed below grade, storage tank installations shall be designed to withstand earth and surface structural loads without damage and with minimal deformation when empty or filled with water.

P2915.6.4 Overflow.

The storage tank shall be equipped with an overflow pipe having a diameter not less than the inlet pipe. The overflow outlet shall discharge at a point not less than 6 inches (152 mm) above the roof or roof drain; floor or floor drain; or over an open water-supplied fixture. The overflow outlet shall be covered with a corrosion-resistant screen of not less than 16 by 20 mesh per inch (630 by 787 mesh per m) and by $^1/_4$-inch (6.4 mm) hardware cloth or shall terminate in a horizontal angle seat check valve. Drainage from overflow pipes shall be directed to prevent freezing on roof walks. The overflow drain shall not be equipped with a shutoff valve. Not less than one cleanout shall be provided on each overflow pipe in accordance with Section P3005.2.

P2915.6.5 Access.

Not less than one access opening shall be provided to allow inspection and cleaning of the tank interior. Access openings shall have an *approved* locking device or other *approved* method of securing access. Below-grade storage tanks, located outside of the building, shall be provided with a manhole either not less than 24 inches (610 mm) square or with an inside diameter not less than 24 inches (610 mm). Manholes shall extend not less than 4 inches (102 mm) above ground or shall be designed to prevent water infiltration. Finished grade shall be sloped away from the manhole to divert surface water. Manhole covers shall be secured to prevent unauthorized access. Service ports in manhole covers shall be not less than 8 inches (203 mm) in diameter and shall be not less than 4 inches (102 mm) above the finished grade level. The service port shall be secured to prevent unauthorized access.

Exception: Storage tanks under 800 gallons (3028 L) in volume installed below grade shall not be required to be equipped with a manhole but shall have a service port not less than 8 inches (203 mm) in diameter.

P2915.6.6 Venting.

Storage tanks shall be provided with a vent sized in accordance with Chapter 31 and based on the aggregate diameter of all tank influent pipes. The reservoir vent shall not be connected to sanitary drainage system vents. Vents shall be protected from contamination by means of an *approved* cap or a U-bend installed with the opening directed downward. Vent outlets shall extend not less than 4 inches (102 mm) above grade, or as necessary to prevent surface water from entering the storage tank. Vent openings shall be protected against the entrance of vermin and insects in accordance with the requirements of Section P2915.2.

P2915.6.7 Drain.

A drain shall be located at the lowest point of the storage tank. The tank drainpipe shall discharge as required for overflow pipes and shall not be smaller in size than specified in Table P2915.6.4. Not less than one cleanout shall be provided on each drainpipe in accordance with Section P3005.2.

P2915.7 Storage tank tests.

Storage tanks shall be tested in accordance with the following:

1. Storage tanks shall be filled with water to the overflow line prior to and during inspection. Seams and joints shall be left exposed and the tank shall remain watertight without leakage for a period of 24 hours.
2. After 24 hours, supplemental water shall be introduced for a period of 15 minutes to verify proper drainage of the overflow system and leaks do not exist.
3. Following a successful test of the overflow, the water level in the tank shall be reduced to a level that is 2 inches (51 mm) below the makeup water trigger point by using the tank drain. The tank drain shall be observed for proper operation. The makeup water system shall be observed for proper operation, and successful automatic shutoff of the system at the refill threshold shall be verified. Water shall not be drained from the overflow at any time during the refill test.