Rainwater Harvesting Tool Help Guide

The Rainwater Harvesting Tool is sponsored by the Federal Energy Management Program. This tool's objective is to help federal agencies strategically prioritize commercial rainwater harvesting projects. Rainwater harvesting is the collection of rainwater from rooftops or other covered surfaces to divert and store for later use. Rainwater harvesting can provide a key source of alternative water to federal facilities. The tool provides a range of available rainwater for harvesting across the U.S. both for general applications and specifically for landscape irrigation.

> ***Alternative water*** is derived from sustainable sources, not supplied from fresh surface or groundwater. Alternative water offsets freshwater demand and diversifies water sources. Example alternative water sources include harvested rainwater, reclaimed wastewater, and captured condensate.

Harvested rainwater can be used in a variety of applications. Most commonly, harvested rainwater is used for non-potable applications such as:

- Toilet and urinal flushing
- Vehicle wash
- Dust suppression
- Cooling tower makeup
- Ornamental pond and fountain filling
- Landscape irrigation

In addition to providing alternative water, harvesting rainwater can also potentially prevent stormwater from entering waterways, helping agencies meet federal requirements for stormwater management. Reducing stormwater eases flooding and erosion by slowing runoff and allowing it to soak into the ground, turning stormwater problems into water supply assets. Less runoff also means less contamination of surface water from sediment, fertilizers, pesticides, and other pollutants that runoff might transport.

Tool Data Layers

The tool's two main data layers are rainwater harvesting potential for general applications and specifically for landscape irrigation. The following sections provide information on each feature and how to interpret the results.

Harvesting Rainwater for General Applications

The Rainwater Harvesting Tool for general applications was developed using ZIP-code-level monthly precipitation data across the U.S.[1] The map is based on the total available rainfall during frost-free months and the total number of months with one inch or more of total rainfall to indicate areas that

[1] Precipitation data were provided to Pacific Northwest National Laboratory by the Environmental Protection Agency. Data originated from the International Water Management Institute Climate Atlas, which uses 30 years of historical climate data at the U.S. ZIP code level.

may be more conducive to storing rainwater for later use. The tool outputs the monthly amount of rainwater available for harvesting, called the rainwater harvesting potential (RWHP), in inches of rain per month[2]. The data is available to the user by ZIP code and for frost-free months. Months with frost are blank. The tool provides total annual RWHP along with a graph of the monthly data.

This map's legend also provides a ranking from highest to lowest to show the RWHP. The map is categorized into the following six groupings to help identify the relative rainwater available during frost-free months that can help prioritize locations that may be optimal for harvesting projects:

- Highest: Areas with abundant rainfall and year-round storage potential that receive a total of 28 inches of precipitation or more during frost-free months and have 9 months or more with at least 1 inch of rain
- High: Areas that receive 23–27 inches of total precipitation during frost-free months
- Medium-High: Areas that receive 19–22 inches of total precipitation during frost-free months
- Medium: Areas that receive 13–18 inches of total precipitation during frost-free months
- Low: Areas that receive 8–13 inches of total precipitation during frost-free months
- Lowest: Areas that receive less than 8 inches of total precipitation during frost-free months.

Harvesting Rainwater for Landscape Irrigation

The Rainwater Harvesting Tool for landscape irrigation was developed using ZIP-code-level monthly precipitation and evapotranspiration (ET) data across the U.S.[3] ET is the amount of water a plant requires to stay healthy over a given time period. A metric was developed from the data that compares the total precipitation to ET of a traditional landscape, such as turfgrass, which typically requires supplemental irrigation in most regions of the U.S. This metric provides the total amount of supplemental irrigation for a traditional turf landscape needed in a given area. This comparison reveals areas in the U.S. that likely have more rainwater available to supply supplemental irrigation.

The tool outputs monthly RWHP for irrigation provided in inches where months with frost are blank. This map also provides a ranking from highest to lowest to show the RWHP. Negative numbers represent rainfall not meeting the plants' water requirements. Positive numbers represent rainfall exceeding the plants' water requirements. Total annual RWHP is also provided along with a graph of the monthly data.

The map features rankings of the amount of rainfall that is typically available for irrigating a traditional turf landscape during the irrigation season. The intent of the rankings is to help prioritize locations that may be optimal for rainwater harvesting projects. The map provides the following designations:

- Rainfall Exceeds Irrigation: Areas where abundant rainfall exceeds the ET of a traditional turf landscape most of the year, and rainwater harvesting for irrigation may not be necessary
- Highest: Areas where the ET of a traditional turf landscape closely matches rainfall and that have 4–9 months where rainfall exceeds ET during the irrigation season

[2] Inches of rainwater is a unit of measure describing an area that is one inch deep. There is 0.62 gallons of water in an area that is one inch deep, covering one square foot.

[3] Precipitation data were provided to PNNL by the Environmental Protection Agency. Data originated from the International Water Management Institute Climate Atlas, which uses 30 years of historical climate data at the U.S. zip code level.

- High: Areas where the ET of a traditional turf landscape closely matches rainfall and that have 1–4 months where rainfall exceeds ET
- Medium-High: Areas where the ET of a traditional turf landscape typically exceeds rainfall and that have 3–6 months where rainfall exceeds ET
- Medium: Areas where the ET of a traditional turf landscape typically exceeds rainfall and that have 0–2 months where rainfall exceeds ET
- Low: Areas where there is high ET for a traditional turf landscape and low precipitation, and that have 5 or fewer months where rainfall exceeds ET
- Lowest: Areas where there is very high ET for a traditional turf landscape and minimal precipitation, and that have 4 or fewer months where rainfall exceeds ET
- Not Recommended: Areas where there is very high ET for a traditional turf landscape and insignificant precipitation, and that have 1 or fewer months where rainfall exceeds ET.

Tool Limitations

The data used to develop the map have limitations. Daily precipitation is best for determining how much rainfall is available for harvesting. The map is based on historical, monthly average rainfall. This does not account for monthly variation such as large rain events, or rainy periods versus dry periods. For example, if there are large rain events at the beginning of the month, there may be minimal rainwater at the end of the month.

Applying the Results of the Tool

The RWHP can be used to estimate the volume of rainfall that can be collected from roofs or hard surfaces. Use the following calculation to estimate the gallons of rainwater available for harvesting:

Monthly Rainfall Collected (gal) = *Catchment Area* (size in sq. ft) × Monthly Rainwater Harvesting Potential (inches) × *Collection Efficiency* × *0.62*

where:

- *Catchment Area* is the size of the roof or hard surface where rainfall will be collected.
- *Monthly Rainwater Harvesting Potential* is the number of inches of rainfall for the month (obtained from the Rainwater Harvesting Tool).
- *Collection Efficiency* is a factor applied to the total monthly harvesting potential to account for losses in the system. Typical system efficiency is between 0.75 and 0.9[4], depending on how efficiently the rainwater harvesting system is at collecting rainfall, primarily driven by water lost from type of roof material (e.g., rough surface equals more water lost), first flush, evaporation, spillage from gutters, and leaks in the system.
- *0.62* is a conversion factor to convert inches of rainfall per square foot of area to gallons.

Use FEMP's Rainwater Harvesting Calculator, which is a tool that automates this calculation to help estimate the amount of rainfall that can be harvested at locations across the U.S.

The Rainwater Harvesting Tool can be used to help strategically identify where to install rainwater

[4] Texas Water Development Board. 2005. *The Texas Manual on Rainwater Harvesting.* Third Edition. Austin, TX. https://www.twdb.texas.gov/publications/brochures/conservation/doc/RainwaterHarvestingManual_3rdedition.pdf?d=1631051959117

harvesting systems. The tool results can help to prioritize locations that may be optimal for harvesting projects. For example, an agency can determine potential applications for rainwater harvesting projects, estimate the amount of water expected to be needed, and then map its building inventory over the appropriate rainwater harvesting potential map. A list of suitable sites can be developed to prioritize the sites with the best potential for implementing rainwater harvesting projects.

Tips for Rainwater Harvesting Projects

Use the following tips to help in the selection of rainwater harvesting projects and other important considerations for long term success.

Selecting Locations for Rainwater Harvesting

Use these tips for selecting locations for rainwater harvesting projects:

Select sites with adequate rainfall and high water use: Prioritize locations with high rainfall, large water-using applications (e.g., irrigation, cooling tower make-up), and high water risk. It is important to estimate the water use of a potential site and to select sites that use enough water to justify a rainwater harvesting system.

Select sites where alternative water can be used in multiple applications: Rainwater harvesting systems are appropriate to supply non-potable water for landscape irrigation. However, more critical water loads should be considered when implementing these systems (e.g., toilet flushing and cooling tower make-up water) along with supplying potable water.

Select sites with high risk: Prioritize areas with high water risk. Rainwater may serve as a viable source of water in areas with constrained freshwater supplies or high likelihood of natural disasters that may disrupt utility water.

Select sites with the ability to perform proper operation and maintenance: Having trained on-site personnel or having a maintenance contract in place to perform ongoing O&M is critical to making sure these systems continue to work as designed. Maintenance of the system, especially cleaning the gutters and roof and fixing leaks, will ensure the system is capturing as much rainfall as possible to offset any potable water use. If there are not dedicated and trained personnel to perform system maintenance, or there is not a maintenance contract, then a system should not be installed.

Select the facility to maximize rainfall collected: When selecting locations for system installation, many aspects of the building need to be assessed to ensure that the building is well suited for rainwater harvesting, including roof layout, gutter system, adequate space for system components, and vegetation.

Other Considerations

Rainwater harvesting may be appropriate for many areas across the U.S. even in areas of low rainfall availability. Important considerations when planning for harvesting projects should include the following:

- Size of catchment area (roof size): Larger roof area can capture significant precipitation even in areas of low rainfall availability.

- Rainwater storage capacity: Areas with lower available precipitation may require larger tanks to provide more storage capacity, and increased tank size will increase equipment cost.
- Water rates: Areas with more expensive water rates should also be considered when prioritizing locations for rainwater harvesting projects.
- Permits: Rainwater harvesting permits may be required; check with local or state government.
- Turf replacement (irrigation): Consider replacing traditional turf with native landscaping that requires significantly less water and can make rainwater harvesting a viable option in many areas of the U.S.

For more information on rainwater harvesting:

- Water-Efficient Technology Opportunities: Rainwater Harvesting Systems: Key information to deploy rainwater harvesting systems
- Best Management Practices #14: Alternative water sources
- Rainwater harvesting regulations: Map that shows state-by state listing of rainwater harvesting regulations
- U.S. Environmental Protection Agency's WaterSense at Work: Best Practices