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Alternative Water Supply Tool Help Guide

> ***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.

The Alternative Water Supply Tool is sponsored by the Federal Energy Management Program (FEMP). This tool's objective is to help federal agencies evaluate the potential for alternative water at their sites. The Alternative Water Supply Tool currently evaluates potential for harvesting rainwater and capturing condensate.

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 state-level rainwater harvesting regulations and technical resources, and a range of available rainwater for harvesting across the United States, both for general applications and specifically for 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.

The tool also includes condensate capture potential, which is when water condenses on air-handling units (AHUs) and cooling coils from humid air contacting these cool surfaces. A large amount of condensate can form on cooling equipment in areas with hot, humid summers such as the southeastern United States. Water that collects on the AHUs and cooling coils must be drained to prevent damage to the equipment or the building from water pooling. Typically, the condensate is collected in a central location and discharged to a sewer drain. In a condensate capture system, the condensate is directed to a central storage tank or basin and then distributed for reuse.

Harvested rainwater and captured condensate can be used in a variety of applications. Most commonly, alternative water is used for non-potable applications such as the following:

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

Tool Data Layers

The tool's four main data layers are rainwater harvesting regulations and technical resources, rainwater harvesting potential for year-round use, rainwater harvesting potential for landscape irrigation, and condensate capture potential. The following sections provide information on each feature and limitations of the tool.

Regulations and Technical Programs for Harvesting Rainwater in Each State

Information on state regulations and technical programs related to harvesting rainwater were collected from individual state resources and compiled to provide a central location for this information. The map layers provide an at-a-glance view of the level of regulation for each state using the following categories:

- Very Limited: The state has limited exemptions available for legal implementation of rainwater harvesting.
- Not Illegal/No Regulations: No regulations are in place prohibiting rainwater harvesting. The state generally has no information regarding rainwater harvesting.
- No Regulations/Encouraged: No regulations are in place prohibiting rainwater harvesting. State-specific rainwater harvesting technical resources are available to encourage use such as handbooks and guidelines on rainwater harvesting systems.
- State Regulations: Regulations are in place allowing rainwater harvesting; however, no specific technical resources or incentives are provided.
- State Regulations/Encouraged: Regulations are in place allowing rainwater harvesting, and state-specific technical resources are available to encourage the collection and use of rainwater.
- State Regulations/Incentives: Regulations are in place allowing rainwater harvesting, state incentive programs are in place, and state-specific technical resources are available.

Links to state resources are included in the popup window that is accessed by selecting a state while this data layer is turned on (i.e., visible in the tool).

Rainwater Harvesting Potential

The rainwater harvesting potential layer was developed using ZIP-code-level monthly precipitation data across the United States.[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 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 provides RWHP in categories from highest to lowest. The following six groupings are used in the map help identify the relative rainwater available during frost-free months. This information can help prioritize locations that may be optimal for harvesting projects:

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[1] Precipitation data were provided to Pacific Northwest National Laboratory (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.

[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.

- 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.

Rainwater Harvesting Potential for Landscape Irrigation

The Alternative Water Supply Tool also includes a layer that provides RWHP for landscape irrigation using ZIP-code-level monthly precipitation and evapotranspiration (ET) data across the United States.[3] ET is the amount of water a plant requires to stay healthy over a given 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 United States. 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 United States 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.
- 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.

[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.

- 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.

Condensate Capture Potential

The potential for condensate capture from air-conditioning systems across the United States was studied by faculty and staff at the University of Georgia and later published by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE).[4] The researchers developed a method to estimate how much condensate can be collected annually, based on the location's annual average dew point, cooling degree days, and rainfall. This method was applied to 47 cities in the United States, and the results were mapped to ascertain patterns in the amount of condensate that can be captured in specific U.S. regions. To evaluate this potential in greater detail, FEMP applied the same estimating method to 64 additional sites across the United States. The estimated condensate potential values for all 111 locales were then placed on the U.S. map, allowing for the creation of the areas that characterize condensate capture potential across the country. This is shown in color-coded regions, ranging from highest to lowest potential.

This layer intends to provide an initial assessment of the feasibility of implementing condensate capture from air-conditioning systems at a given site. To determine whether condensate capture should be considered for your site, locate your site on the map and determine the potential based on the color of your region. The potential to capture condensate is categorized as follows:

- Highest: Areas in the southeastern United Sates have high cooling loads during most of the year and high humidity and, therefore, have the highest potential for condensate capture projects; areas along the Gulf Coast, southern Florida, and Hawaii have particularly excellent potential.
- High: Areas from the Ohio River Valley to West Virginia and Mid-Atlantic regions, remaining areas of the South, and central Texas have high cooling loads and high summer humidity, giving them very good potential for capturing condensate.
- Medium-High: Areas in the northern Mid-Atlantic across to the central Midwest and coastal Southern California have relatively hot and humid summers, giving them good potential for condensate capture projects.
- Medium: Areas along southern New England across the southern Great Lakes and into portions of the Midwest down to Texas have humid summers, giving them marginal potential for capturing condensate.
- Low and Lowest: Areas in the western United States, with low humidity or relatively low cooling demand, have poor potential for condensate capture.

Tool Limitations

The data used to develop the maps has limitations. Parts of the regulation layer may become outdated as new state legislation is passed. For determining how much rainfall is available for harvesting, daily precipitation is best. The potential maps are based on historical, monthly average rainfall. This does not

[4] Lawrence, T., J. Perry, and T. Alsen. 2012. "AHU Condensate Collection Economics: A Study of 47 U.S. Cities." *ASHRAE Journal* 54 (5): 18–25.

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.

The condensate capture potential presented is based on local climate conditions of the selected cities. Within the regions, the condensate capture potential may vary due to local annual weather patterns. Other factors affecting the potential for condensate capture should also be considered when assessing the potential at a specific site; these include the following:

- Size of cooling system: Larger systems can potentially produce more condensate (depending on cooling system operation).
- Cooling system operation: Hours of operation and temperature set points will influence condensate production.

Applying the Results of the Rainwater Harvesting Potential Layers

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 square feet) × *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 Alternative Water Supply 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,[5] depending on how efficient 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.

The tool provides an estimate of how much monthly and yearly rainfall can be collected from a 15,000 square foot roof (catchment area), with a rainwater harvesting system collection efficiency of 80 percent. To change the variables, 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 United States.

The Alternative Water Supply Tool can be used to help strategically identify where to install rainwater 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

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

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 Alternative Water Projects

Use the following tips to help in the selection of alternative water projects and other important considerations for long-term success.

Selecting Locations for Alternative Water Projects

Use these tips for selecting locations for alternative water projects.

Select sites with high water use: Prioritize locations with large water-using applications (e.g., irrigation, cooling tower makeup) 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 an alternative water system.

Select sites where alternative water can be used in multiple applications: Alternative water sources 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 makeup water) along with supplying potable water.

Select sites with high risk: Prioritize areas with high water risk. Alternative water 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 operations and maintenance is critical to making sure alternative water systems continue to work as designed. If there are no dedicated and trained personnel to perform system maintenance, or there is not a maintenance contract, then a system should not be installed.

Other Considerations

Alternative water may be appropriate for many areas across the United States, and there are important considerations when planning for these projects:

- **Water rates**: Areas with more expensive water rates should also be considered when prioritizing locations for alternative water projects.
- **Permits**: 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 alternative water a viable option in many areas of the United States.

For More Information on Alternative Water

- Alternative Water Projects: Implementation Steps: Step-by-step guide walking users through the process of assessing and implementing alternative water projects.
- Rainwater Harvesting Systems Technology Review: Technical information on rainwater harvesting, describing technical components, operations and maintenance requirements, and system sizing considerations.

- FEMP Case Study: Potable Rainwater Harvesting System at U.S. Army Garrison For Buchanan
- Best Management Practice #14: Alternative Water Sources: Overview of several alternative water source types with important considerations.
- U.S. Environmental Protection Agency's WaterSense at Work: Chapter 8, "Onsite Alternative Water Sources," provides technical information on rainwater harvesting and several other source types.