



Desalination plant

## Brackish Groundwater

### What is brackish water?

Brackish water does not have an exact definition, but it is typically defined as distastefully salty but less saline than seawater (between 1,000 to 10,000 ppm [parts per million] in total dissolved solids [TDS]). In addition to certain surface water settings such as estuaries, brackish water can be found in aquifers. In some regions of the country with limited availability of freshwater, desalination of brackish groundwater is being used as an alternative supply.

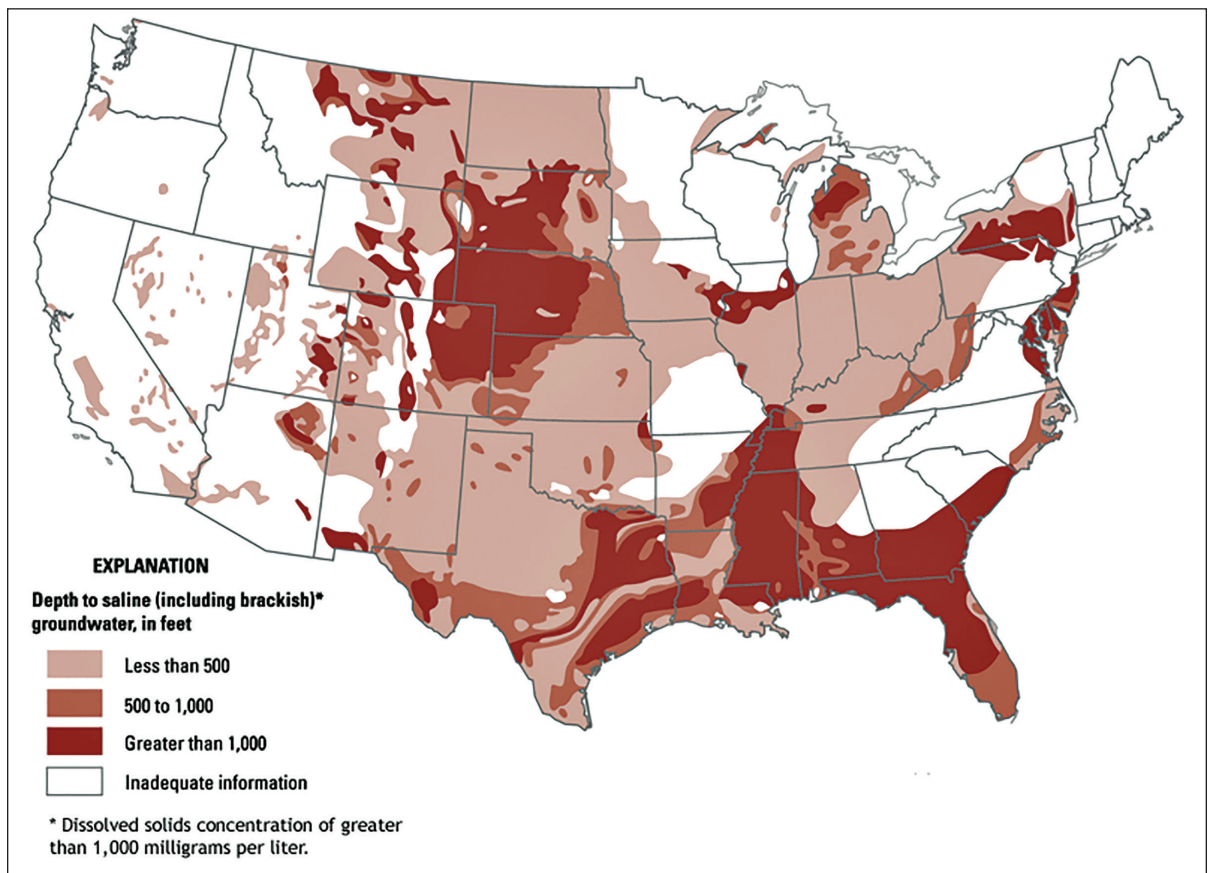
### How does brackish water differ from seawater?

Seawater usually contains a higher salt content, about 35,000 ppm as compared to 10,000 ppm or less for brackish water. Increased salt content increases the specific gravity, thus adding to the potential for suspended sediments. The table below summarizes different categories of saline water.

#### General Categories of Saline Water

Freshwater	less than 1,000 ppm
Slightly saline water	from 1,000 to 3,000 ppm
Moderately saline water	from 3,000 to 10,000 ppm
Highly saline water	from 10,000 to 35,000 ppm

\*Ocean water contains about 35,000 ppm of salt.



## Where is brackish groundwater found?

Groundwater resource evaluations have focused primarily on the extent and properties of freshwater aquifers, so comparatively little is known about saline water-bearing units.

Available evidence indicates that significant amounts of brackish groundwater exist around the country. For instance, Texas has an estimated 2.7 billion acre-feet of brackish groundwater. In New Mexico, 75 percent of groundwater is too saline for most uses without treatment.

## Is brackish groundwater currently useful as a water supply?

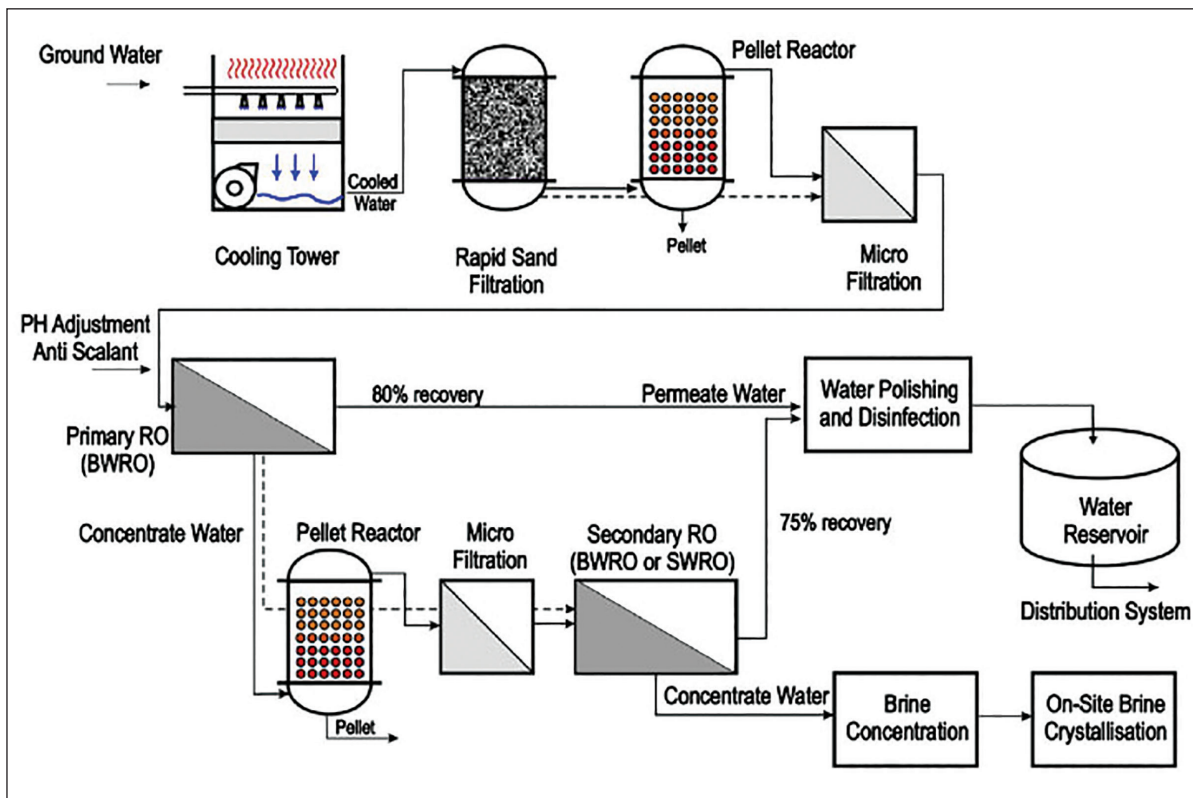
As water scarcity issues increase around the country and desalination technology becomes more affordable, more water managers are considering brackish groundwater as part of the mix of available water resources.

By the late 1990s, there were more than 12,500 desalination plants in operation around the world. Although desalination supplies less than 1 percent of the potable water in the United States, desalination grew about 40 percent between 2000 and 2005. Among the world's largest inland desalination plants, the Kay Bailey Hutchison Desalination Plant in El Paso, Texas, has the capacity to treat up to 27.5 million gallons per day of brackish groundwater.

## How is brackish groundwater treated?

There are two commonly used desalination methods—distillation and reverse osmosis (RO). Distillation, the traditional approach, is the basic process that takes place in nature whereby the sun causes water to evaporate from surface sources such as lakes, oceans, and streams. The water vapor eventually comes in contact with cooler air, where it recondenses to form dew or rain. This process can be imitated artificially, and more rapidly than in nature, using alternative sources of heating and cooling.

In the last decade, RO processes have advanced significantly, allowing new brackish groundwater desalination facilities to use RO technology much more economically than distillation. RO treatment plants use semi-



permeable membranes and pressure to separate salts from water. These systems typically use less energy than thermal distillation, leading to a reduction in overall desalination costs.

Electrodialysis reversal can also be used to remove moderate salt levels (less than 5,000 ppm). This process uses electrical current and membranes to separate salts from water.

## What challenges are associated with brackish groundwater desalination?

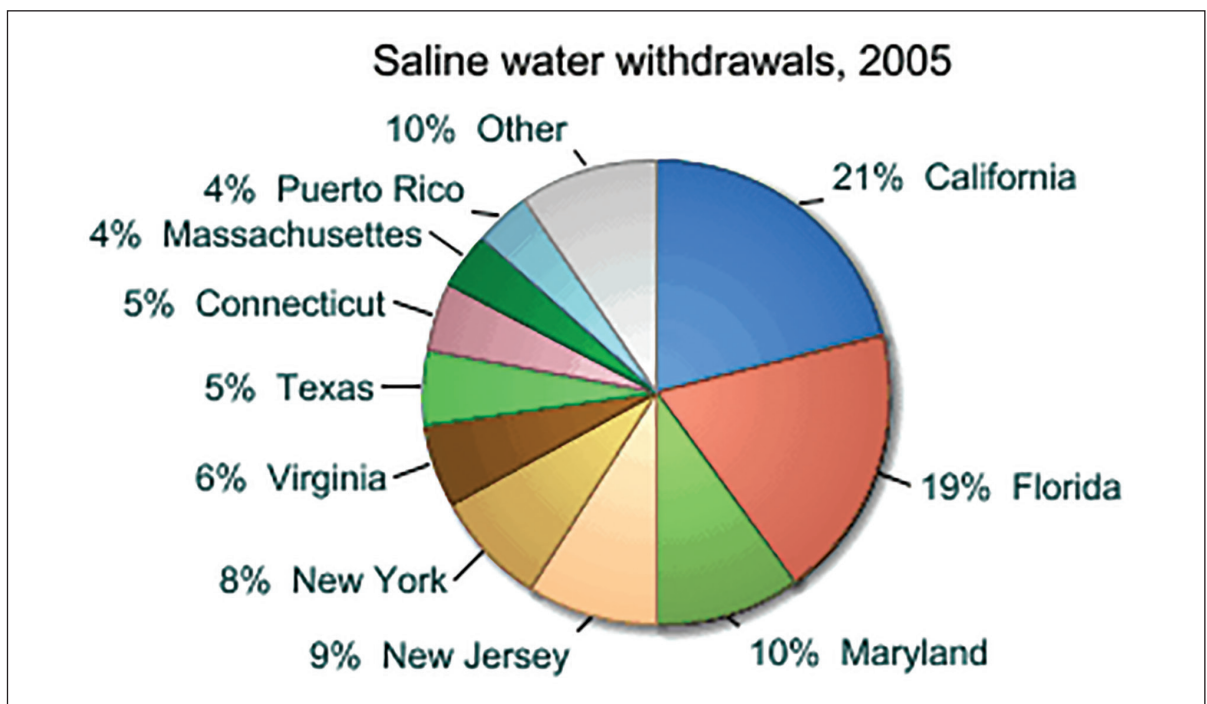
### *Disposal of waste brine:*

Desalination produces a salt concentrate. Among the disposal methods in use are surface water discharge, discharge to sewers, deep well injection, land application, evaporation ponds/salt processing, and brine concentration. Which option is used depends mostly on the plant location and desired efficiency.

For inland brackish groundwater desalination plants, surface water discharge, sewer discharge, and land application can increase the salt load in the receiving waters and soils, which may contaminate water resources and reduce soil fertility. Evaporation ponds often require large land areas and are appropriate only in arid climates and, like other brine concentration techniques, they typically require impervious disposal areas to prevent contamination of freshwater supplies and soils.

Deep well injection is not permitted in many states, but those that do, such as Texas, require permits, monitoring wells, and completion in deep confined aquifers to ensure that freshwater supplies are not contaminated. The Safe Drinking Water Act of 1974 gave U.S. EPA authority to manage disposal and reuse of concentrates and brines resulting from the desalination of brackish groundwater and oilfield-produced water through the Underground Injection Control (UIC) program. U.S. EPA developed the UIC regulations to be

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adopted by states, territories, and tribes after submitting an application for primary enforcement responsibility (primacy).

The National Research Center for Desalination of Brackish Groundwater in Alamogordo, New Mexico, is researching environmentally sound processes for disposing of concentrates and beneficial uses of concentrate as well as byproducts that can be used from concentrate.

***High energy use/costs:***

Desalination processes require significant amounts of energy. The base cost of energy along with the costs associated with brine disposal are key factors in the relatively high total cost of desalination.

The U.S. average cost for treating 1,000 gallons of water is \$2. Even though desalinated brackish groundwater is becoming increasingly cost competitive, particularly in areas of the country such as the southwestern United States where water scarcity is a problem, desalination remains a more expensive process for producing potable water.

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***Desalination efficiency:***

Generally speaking, desalination systems have recovery efficiencies of 60 to 85 percent for brackish groundwater, which means 15 to 40 percent of the available water is not used but is instead disposed of as a concentrate stream. Improving recovery efficiencies to 90 or 95 percent would significantly reduce concentrate disposal volumes, extend the supply of brackish resources, and potentially reduce overall desali-

nation costs. As part of its mission, the Research Center for Desalination of Brackish Groundwater is focusing on developing innovative methods for reducing the volume of concentrate removed from desalinated water to increase the amount of usable water produced.

### **Depth of drilling:**

Brackish groundwater often is located at considerable depths of 4,000 feet or greater, though not always (i.e., as in some aquifers in coastal areas). Implications include (1) the need to refine deeper drilling technology, and (2) an increase in operational costs required to pump from greater depths.

## **How does desalination of seawater vs. inland brackish groundwater differ?**

The major differences relate to cost of operation. All other things being equal, seawater is more expensive to treat than brackish groundwater due to the increased amount of TDS that has to be removed. However, seawater desalination plants sometimes have lower operating costs than inland desalination plants, largely because they can discharge concentrate streams directly to coastal water bodies. In addition, seawater desalination plants are frequently co-located with power plants to take advantage of common water intake and outfall structures and less expensive power.

Conversely, brackish water desalination facilities in inland areas may cost more to operate due to higher costs to dispose of concentration streams and higher energy costs.

## **Glossary**

*Aquifer*—A geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield economical quantities of water to wells and springs.

*Confined aquifer*—A formation in which the groundwater is isolated from the atmosphere at the point of discharge by impermeable geologic formations; confined groundwater is generally subject to pressure greater than atmospheric.

*Total dissolved solids (TDS)*—The quantity of minerals (salts) in solution in water, usually expressed in milligrams per liter (mg/L) or parts per million (ppm).

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