Congressional Research Service
Informing the legislative debate since 1914

INSIGHT

Desalination: Converting Saline Water into a Municipal Water Source

June 14, 2024

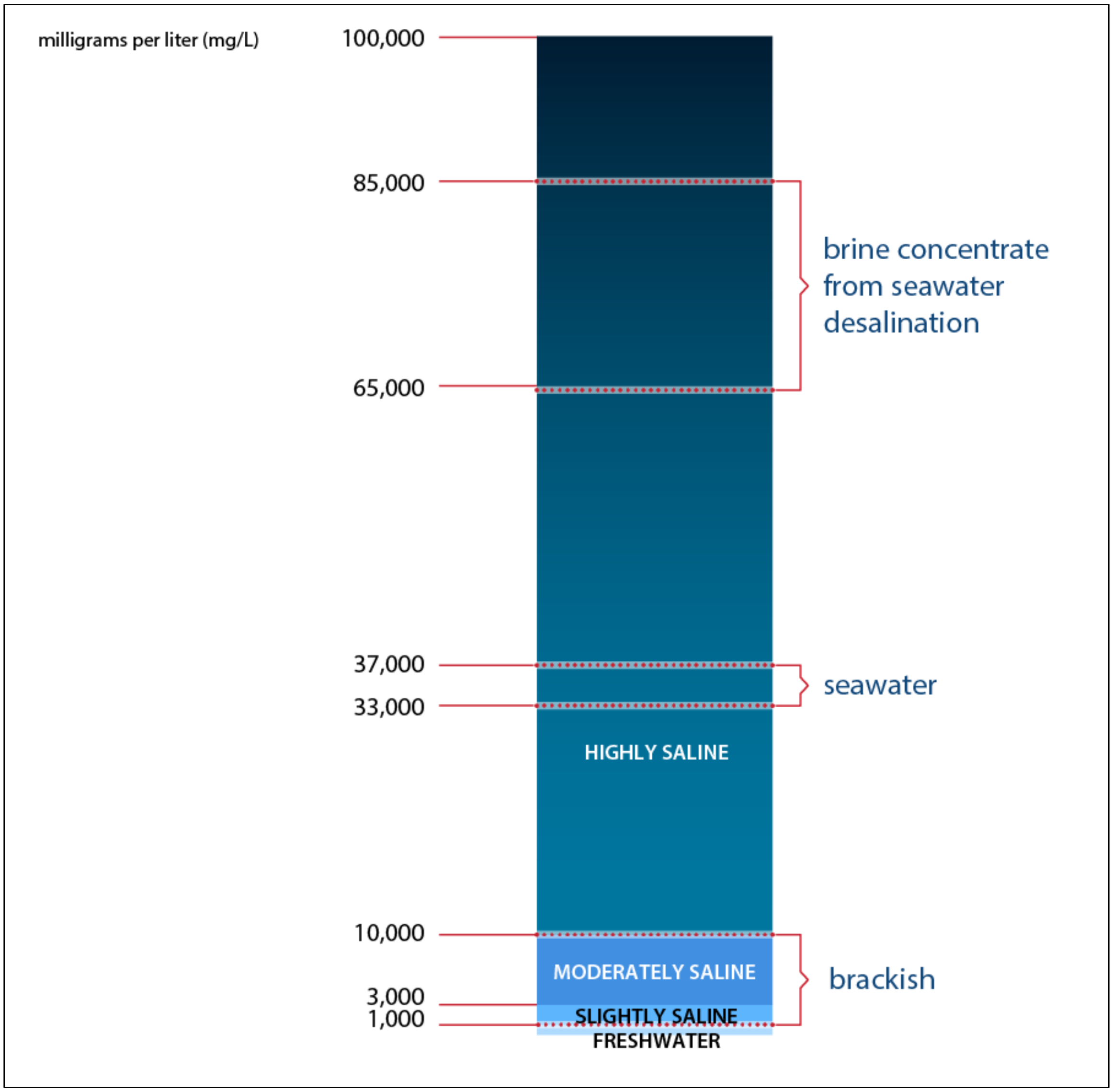
Desalination may now or in the future play a significant role in the supply of potable water for some municipalities, a possibility that has created growing congressional interest in desalination technologies. Additionally, desalination technologies have applications in military and disaster relief operations, agricultural production, and industry including manufacturing.

In municipal applications, desalination involves treating saline water to produce freshwater, in the process creating a separate, saltier *brine concentrate*. While multiple coastal communities are investigating desalinating both seawater and *brackish* sources, various inland communities are desalinating brackish surface water and groundwater. **Figure 1** illustrates various terms used herein.

Congressional Research Service
https://crsreports.congress.gov
IN12378

Figure 1. Salinity Spectrum Relevant to Desalination

Represented using the concentration of dissolved material (i.e., *solids*) in a volume of water



Source: CRS.

Note: The brackish water range is defined by the U.S. Geological Survey but varies among researchers.

U.S. Municipal Adoption

A municipality's adoption of either brackish or seawater desalination is influenced by the other available water supply and demand management options. Desalination's alternatives include water recycling, aquifer recharge, stormwater capture, construction of water storage projects, water conservation measures, and efficiency investments for existing infrastructure and end uses. Each option represents trade-offs in terms of dependability, reliability, capital and operating costs, and inputs (e.g., electricity). Desalinated supplies may offer a more "drought-proof" water source than those reliant on annual or multiyear precipitation, runoff, and recharge. Other trade-offs may include the regulatory process, environmental impacts, financing costs, and availability of grants and low-cost loans.

Brackish water desalination provides water for numerous communities in states like California, Florida, and Texas (e.g., a facility in El Paso can produce 27.5 million gallons per day [MGD]). In response to congressional direction (42 U.S.C. §10367(c)), a 2017 U.S. Geological Survey report illustrates the national distribution of groundwater by salinity level and depth from the surface.

Two large-scale seawater desalination facilities (i.e., facilities producing more than 10 MGD) are operational in the United States—a publicly owned, privately operated 25 MGD Tampa Bay, FL, facility and a private 50 MGD facility delivering water to San Diego, CA. Other full-scale seawater desalination facilities advancing toward construction include a 5 MGD Doheny Ocean Desalination (CA) project and a City of Corpus Christi (TX) 30 MGD facility (with a 2024 estimated cost to build of $758 million), among others being investigated in California, Texas, Florida, and other states.

A 2018 effort to track U.S. municipal facilities using desalination technologies identifies 13 seawater desalination facilities and almost 400 brackish desalination facilities (including those using nanofiltration for water softening, which removes some salts). An update is estimated to add 50-70 additional facilities.

Advancing Desalination

In 2016, Congress directed development of a desalination plan (P.L. 114-322, §3801(d)); the resulting 2019 Coordinated Strategic Plan to Advance Desalination for Enhanced Water Security (2019 plan) identified goals and priorities, while not setting specific responsibilities or time frames. Often, desalination advancement efforts target desalination's energy intensity and brine management, and issues associated with the scale and financing of facilities, among other topics.

- **Energy Intensity.** Desalinated water, particularly from seawater desalination, may be among the more energy-intense alternatives for municipal water supplies. Fossil-fuel-powered desalination raises concerns about emissions and desalination's role in climate change adaptation. Expansion of electricity-driven desalination raises questions about grid impacts. These concerns foster interest in powering desalination with renewable sources or waste heat, and in developing new desalination technologies. The Department of Energy (DOE), the Bureau of Reclamation (Reclamation), and the Department of Defense, among others, have supported energy-related desalination research and development (R&D). Desalination has been mentioned in the context of solar energy, fusion energy, nuclear energy, and marine energy, among other energy sources. Some research targets technologies able to operate under variable conditions (i.e., more adaptable processes).
- **Brine Concentrate Management.** Brine concentrate disposal can pose challenges for both inland and coastal facilities. The 2019 plan identified R&D and technology commercialization goals for minimizing brine and reducing the impact of seawater desalination facilities' brine discharge on marine ecosystems. Reclamation and DOE have supported research on brine minimization and management and recovery of economically valuable elements from brines.
- **Scale and Financing.** For seawater desalination, larger facilities often are more economical than smaller facilities; however, larger facilities require larger capital investment to build and may involve financing and contracting arrangements that are novel for U.S. municipal water infrastructure. Consistent with the 2019 plan's priority to develop small-scale, modular desalination systems and address rural and remote desalination, DOE has supported research on modular desalination systems. Federal and state funding of facility construction also have increased since 2019. Federal programs funding construction of desalination and related infrastructure (e.g., seawater intake and brine disposal facilities) include Reclamation-administered programs (including those

funded by the Infrastructure Investment and Jobs Act [P.L. 117-58]), U.S. Environmental Protection Agency loan programs, and assistance from the U.S. Army Corps of Engineers, among others.

Technologies

In the United States, the most prevalent municipal desalination technology is *reverse osmosis* (RO), which applies pressure to pretreated saline water; a semipermeable membrane traps salts on one side and lets the treated water through. Costs and energy intensity of many developed desalination technologies have dropped in recent decades, but significant further decline may not occur for these technologies. Therefore, in addition to R&D to further improve desalination systems using developed technologies such as RO and established thermal technologies, researchers are investigating emerging desalination technologies that use electrical, chemical, and crystallization processes or combine existing technologies such as membrane distillation. Some technologies operate best at smaller scales (e.g., solar stills for household or small community use). Some technologies can treat highly saline waters; others are largely limited to treating less saline waters.

Considerations

Congress may consider the following questions:

- What are the trade-offs of using federal funds to support construction of desalination facilities employing current technologies (i.e., support for an energy-intense but reliable water supply), compared to investments in other municipal water supply and demand management alternatives, or R&D of emerging desalination technologies?
- Where may changing water resource conditions (e.g., relative sea level rise exacerbating saltwater intrusion into U.S. coastal aquifers and surface waters) alter the demand for desalination?

Author Information

Nicole T. Carter
Specialist in Natural Resources Policy

Disclaimer