BRACKISH WATER RESOURCES AND OPPORTUNITIES FOR THEIR DEVELOPMENT IN NEW MEXICO*

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New Mexico is generally characterized as a having classic high-desert environment (i.e., averaging < 10 inches of precipitation annually). However, according to the U.S. Geologic Survey, New Mexico also has one of the largest supplies of brackish groundwater (BW) in the United States (BW being defined as between 1,000-10,000 mg/l total dissolved solids--TDS) [1]. Although preliminary estimates in the 1960's and 1970's put New Mexico's brackish groundwater supply at between 5-10 billion acre-feet [2], more recent estimates of economically accessible and treatable brackish groundwater range from 2-5 billion acre-feet. While this revised estimate might seem like a significant decrease, for a state which currently consumes 3.8 million acre-feet of fresh surface and groundwater each year, those 2-5 billion acre-feet of economically recoverable BW could supplement or replace future freshwater resources in New Mexico for 1000 years or more [3].

Major advancements during the past three decades in reducing the cost, energy use, and environmental impacts of BW desalination and concentrate management offers a significant opportunity to supplement limited existing (and diminishing) fresh water supplies while supporting sustainable water use and economic development statewide [2,3]. The following sections focus on the current technical, operational, and economic status of BW desalination and the significant potential opportunity for New Mexico to develop this underused resource. These sections also address common misconceptions about modern desalination technology and suggest some unique capabilities that would enable New Mexico to become a national leader for inland brackish water desalination research, development, implementation, and utilization, as well as the potential for exportation of excess BW to surrounding states as a major driver of the state's economy.

lnland Desalination Opportunities

While the term "desalination" is often associated with the treatment of seawater, the use of desalination technologies to treat unconventional, non-coastal water resources, such as brackish groundwater or municipal and industrial wastewater, is now technically and economically feasible. These inland, non-traditional water sources have become the fastest growing source of "new water" in the U.S. since 2010, with wastewater reuse and desalination of groundwater growing at 15% and 10% per year, respectively [4]. The U.S. leads the world in these applications, with almost 25% of all global inland desalination plants--currently more than 420 inland facilities in over 30 states [5]. The world's largest inland brackish groundwater desalination plant is the Kay Bailey Hutchinson Desalination Facility in El Paso, TX, which produces up to 30 million gallons per day (MGD) of potable water using local brackish groundwater as its supply source. The world's second largest inland desalination plant opened in 2019 in San Antonio, TX, with a 25 MGD capacity. Long-term water resource planers in Texas, Arizona, Nevada, and California identify desalination as the source for up to 25% of their water supplies by 2050. Currently, the only

large-scale brackish water desalination plants in New Mexico are a 1.0 MGD municipal facility being tested in Alamogordo, and the U.S. Bureau of Reclamation's Brackish Water National Desalination Research Facility, a center for research and development of new desalination technologies which does not serve as a public source of desalinated water supply.

Decreased Desalination Costs and Increased Efficiency

Development and use of non-traditional water resources is most important potential source of new water supplies in the U.S. The reasons are simple: decreased cost and increased efficiency of operation. Until the early 1970's, the cost of desalinating sea water and inland BW (primarily using thermal distillation) was 10-15 times higher than the cost of finding new fresh water supplies. But by the 1990's, continued refinement of desalination technologies such as reverse osmosis, electrodialysis, and nano-filtration had reduced the cost of desalination by one-third. At the same time, because of growing shortages of fresh water, the cost of developing and/or importing new fresh water increased by a factor of three. These changes have made the cost of desalinating local brackish groundwater often less expensive than importing fresh water, especially if the sources are located more than 50 miles away [4]. Since 2000, for many inland cities looking to develop additional water supplies, the treatment and use of local brackish groundwater and wastewater have become preferred options because of easier access to and control of local water, as well as being cost-competitive with development of new conventional water supplies [5].

Environmental Management of Desalination Waste Streams

Disposal of the by-products of desalination concentrate (sometimes referred to as "brine") in inland areas has been and will continue to be an environmental challenge which is not faced by coastal desalination facilities. But advanced approaches, such as deep well injection, mineral resource recovery, and fit-for-use industrial and agricultural applications, are now potential options to solve or reduce many of the environmental and cost challenges of concentrate/brine management in inland areas [3,4]. Significant opportunities exist throughout New Mexico to integrate these brine-disposal options with existing industrial, energy, and agricultural operations in joint-use facilities offering significant economic opportunity and cost savings.

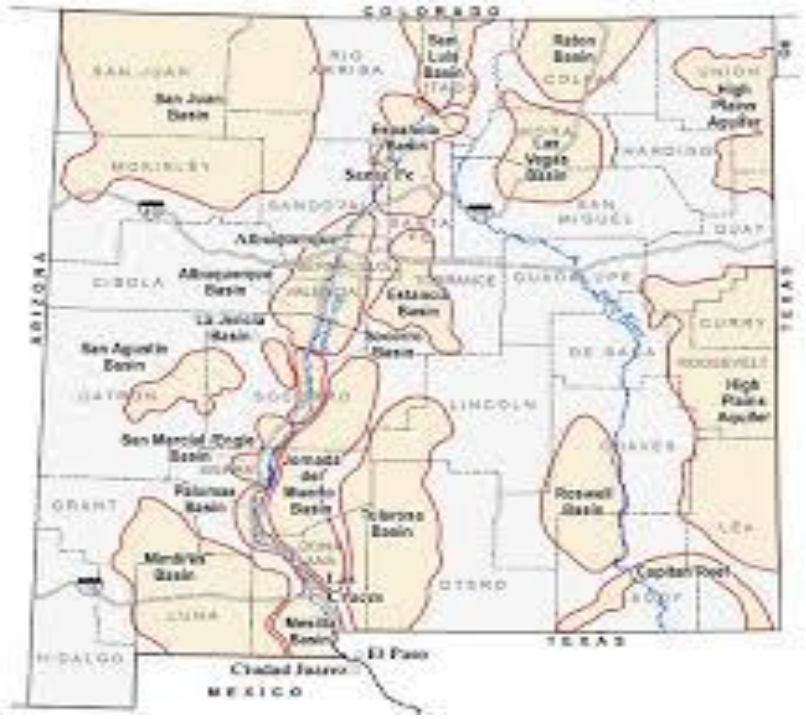

Figure 1. Major Groundwater Basins in New Mexico (source: NMBG&MR Open-file Report 583)

Shallow Brackish Water Availability

As shown in Figure 1, there are approximately twenty major groundwater basins in New Mexico. The most recent detailed study regarding the location, quality, and quantity of brackish groundwater within these basins was compiled and published in 2016. This study suggests that brackish water is relatively common within both shallow and deep basins [6,7]. Data from this New Mexico Bureau of Geology and Mineral Resources (NMBGMR) study of approximately 8,000 shallow groundwater wells (< 2500 feet deep) showed that only 5-10% had total dissolved solid (TDS) levels above 4000 mg/l and that—contrary to expectations—wells deeper than 2500 feet had even lower TDS levels, averaging around 2500 mg/l [7]. These results are similar to studies conducted by Los Alamos National Laboratory and Sandia National Laboratories on the water chemistry of brackish groundwater wells ranging from 1000- 5,000 mg/l TDS—and the majority of these wells were less than 2500 feet below ground level. The importance of shallow brackish water resources is that they are easily and economically recoverable because of lower pumping costs. This suggests an opportunity to inexpensively supplement freshwater resources across the state by using desalination to treat local, shallow, and already-permitted brackish wells that are currently unusable because of the mildly brackish waters they produce.

Deep Brackish Water Availability

Under New Mexico water law, water rights from the Office of the State Engineer for new wells less than 2500 feet deep are subject to a difficult-to-obtain and often expensive permitting process, while those >2500 feet deep only require a Notice of Intent (NOI) to drill and develop. While a few of the large groundwater basins (e.g., Salt, Tularosa, Mesilla, and Albuquerque Basins) have been evaluated for brackish water at depths below 2500 feet [7], only limited reliable data on water quality and quantity exists elsewhere for water at these depths. But the limited extant data suggests that there is significant

deep BW statewide at 1,000 to 10,000 mg/l TDS which can be treated practically and economically. In addition, there are large amounts of saline groundwater (>10,000 mg/l TDS) which, although they exceed current limits for economically useful inland desalination, could be exploited as technology evolves. And where surplus renewable energy is available from solar or wind generation, or where these higher salinity waters can be used for industrial applications, such as drilling, fracking, or mineral recovery, even these deep saline waters provide local economic development opportunities. Making full use of New Mexico's significant deep (> 2500 feet) brackish water resources requires more extensive research, data compilation, and mapping of their water quality and quantity than currently exists. Efforts are currently underway to obtain funding for an estimated $35 million needed by the NMBGMR to complete preliminary field studies and pilot treatment programs needed before there can be a detailed state-wide confirmation of the magnitude of New Mexico's brackish water resource's quality and quantity.

Desalination Supporting Future Economic Development

Because use of brackish water (and even saline water) is well-suited for certain commercial and industrial applications, collaboration with the state's current and future business partners provides opportunity for long-term local and regional economic development. This paper has focused mainly on the potential for BW development to supplement or even replace fresh water supplies used for municipal, industrial, and agricultural applications. But concurrently, New Mexico has an opportunity to establish itself as a world-class hub for water treatment and desalination research and development because of its unique combination of significant brackish water supplies and institutional R&D capabilities, including:

• water treatment and desalination research capabilities at New Mexico State, New Mexico Tech, University of New Mexico, and the Los Alamos and Sandia National Laboratories, all of which have desalination expertise to develop clean water for civil, military, emergency, industrial, and municipal applications;

• the US's premier brackish water treatment, testing, and evaluation facility located at the U.S. Bureau of Reclamation's Brackish Groundwater National Desalination Research Facility (BGNDRF) in Alamogordo;

• our state's numerous nationally-recognized hydro-science institutions and water treatment companies;

• an existing industrial base that understands brackish water issues and challenges and which needs cost-effective solutions, including the oil and gas, mining, agricultural, and electronics manufacturing sectors.

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***** Much of the technical information in this paper is based on information originally developed for the New Mexico Desalination Association's Publication *NMDESAL 2018-100*. The New Mexico Desalination Association (NMDA) encourages a renewed focus on investigation and use of the state's enormous potential BW supply to create a major new economic sector based on research, development, manufacturing, and implementation of advanced water treatment and desalination technologies. These efforts could stimulate both near-term and long-term economic development in New Mexico, as well as creating opportunities for possible exportation and sale of the state's surplus treated brackish water to nearby water-deficient states, providing a new and stable export-base economy to replace New Mexico's current dependence on oil and gas production.