

Industrial Aquifers - Designation of Brackish Groundwater Resources to Support Economic Development and Sustainable Fresh Water Use in New Mexico

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The New Mexico Desalination Association (NMDesal) is a 501-C6 non-profit corporation established to promote, educate, and assist the desalination industry in New Mexico and the Southwest by developing professional and stakeholder knowledge of current and emerging desalination approaches, technologies, and applications. The goal of NMDesal is to unite and educate stakeholders on the potential for desalination in New Mexico; to support the creation of new water supplies through development of all brackish water resources to support long-term economic growth; while protecting the environment and maintaining the social and cultural traditions of New Mexico.

This White Paper summarizes some important aspects of the technical and scientific understanding of brackish water resources and desalination in New Mexico and the Southwest, with the objective of presenting these resources for use in industrial applications. In the near term, it is possible that brackish water could supplement limited freshwater resources and provide resilience during droughts, supporting regional water management strategies and economic development.

The White Paper uses the most recent scientific and technical information on brackish water resource availability and quality in New Mexico, and incorporates knowledge of current trends in the cost, efficiency, and environmental impacts of inland brackish ground water desalination in the Southwest. The information and trends presented are based on recent technical reports and studies conducted by New Mexico Tech, the University of New Mexico, New Mexico State, and Sandia and Los Alamos National Laboratories, among others.

For additional information on this White Paper or other related issues, please contact the:

New Mexico Desalination Association
c/o Todd Burt
7500 Jefferson NE
Albuquerque, NM 87109

BRACKISH WATER USE TO SUPPORT SUSTAINABLE INDUSTRIAL DEVELOPMENT IN NEW MEXICO

Overview

New Mexico is believed to have extensive brackish groundwater resources (1,000-20,000 mg/l of dissolved salts) in up to 20 different basins across the state [1, 2, 3]. Rough calculations made by NM Desal indicate that there may be between 500 million to 1 billion acre-feet of brackish water in those basins. Given that New Mexico consumes approximately 2 million acre-feet of fresh surface and ground water each year, 500 million acre-feet of potentially recoverable brackish ground water could provide a considerable supplement to fresh-water resources and supplies across New Mexico over the next 100 or more years.

Significant improvements have been made over the past 50 years in reducing the cost of treatment, improving water recovery efficiency, and reducing environmental impacts of desalination. During that same time, New Mexico has experienced multiple recurring severe droughts. The southwestern United States is in a long-term cycle of aridification, with expected shortages of fresh water to increase going forward. Competition for fresh-water resources will increase, with preference going to municipal and agricultural needs. Importantly, we have recognized that not all water used for industrial purposes needs to be of low salinity-this water can vary widely in quality, described as “fit-for purpose” water.

Therefore, we propose that brackish water resources can and should be used to supplement fresh-water use in industrial applications as fit-for-purpose water, when possible. Doing so would directly support more resilient fresh-water resource use, while accelerating or sustaining economic and industrial development statewide [4].

The following sections discuss the known availability, quality, depth, and regulations surrounding brackish water in the state; and present a thought process and some steps taken toward building the concept of “industrial aquifers”. The approach discussed is intended to support New Mexico leadership in the decision-making process surrounding the use of brackish ground water to support and accelerate industrial development and economic growth.

Growth of Brackish Groundwater Use in the U.S.

Desalination has normally been associated with the treatment of sea water; however, the treatment of non-traditional water resources, such as municipal and industrial wastewater or brackish groundwater, has been the fastest growing water supply sector in the U.S. since 2010. Waste-water reuse and use of brackish water resources are growing at 15% and 10% per year, respectively [5]. With almost 25% of all inland brackish ground water desalination plants constructed in the continental U.S., the U.S. leads the world with over 300

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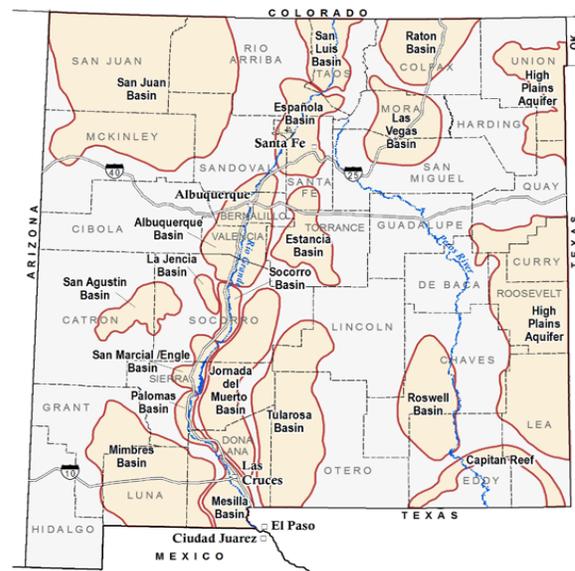
medium to large-scale desalination facilities in over 30 states [6]. The largest use of brackish ground water for municipal supplies is currently occurring in the Southwest, at El Paso's Kay Bailey Hutchinson Desalination Facility. The KBH plant currently produces up to 27 million gallons per day (MGD) of potable water with plans to expand to 40 MGD by 2022. The City of San Antonio, Texas recently placed the first phase (10 MGD) of a 30 MGD desalination plant into operation [5].

Additionally, many industries and municipalities in the Southwest use or treat brackish water or wastewater to meet their industrial or municipal water needs. This includes over 50 facilities in Texas, 30 in California, 10 in Arizona, and a few in New Mexico, including Artesia, Farmington, Rio Rancho, Radium Springs, and Alamogordo [6, 7, 8]. Since 2000, many inland areas looking at developing additional water supplies in the Southwest, have considered the use and treatment of locally available brackish ground water and wastewater as the preferred alternative to new fresh water supplies because of cost or access advantages [5].

New Mexico Brackish Ground Water Availability

There are twenty major groundwater basins in New Mexico (Figure 1-adapted from Land, 2016 [3]). The most recent data compiled from 2006 to 2016 suggest that brackish water is relatively common in both shallow and deep locations [2,3,9,10]. Here, we focus on shallow brackish water resources and define these waters as existing at less than 1,000 feet below ground surface (bgs). An important aspect of these shallow brackish waters is that they are more easily and economically recoverable than water from deeper reservoirs.

While some of the larger ground water basins, such as the Salt, Tularosa, Mesilla, and Albuquerque Basins have been evaluated down to depths of 2,000 feet bgs or greater, there is general agreement that little reliable data on water quality and well yields exists for water in many regions of these basins. *This information must be collected to accurately estimate the costs to recover and treat waters at these depths.* The data we do have suggest that there are significant resources with water qualities of from 1,000 to 10,000 mg/l total dissolved solids (TDS), which can still be economically treated. We note that water resources with salinities greater than 50,000 mg/L are typically much more costly to desalinate, and we do not consider these resources in this paper. In addition, the most accessible waters are those available in the upper 1,000 feet of an aquifer, because of the costs to pump the water to the surface. There may be situations, however, where deeper or more saline waters will be useful for industrial applications such



as drilling, hydraulic fracturing, and mineral recovery without desalination, and could provide local economic development opportunities.

Making full use of these significant brackish water resources will require extensive compilation and mapping of the water quality, hydrology, and capacity of basin and inter-basin areas to quantify resource development potential and utilization priorities. The costs of pumping, treatment, and waste disposal will need to be included in an economic evaluation. Potential water users and industries will need to be located. Some work has already been done to evaluate the locations and qualities of these waters by the NM Petroleum Recovery Research Center (NM PRRC), the NM Water Resources Research Institute (NM WRRRI) and the U.S. Geological Survey.

Regulatory Framework and Using Brackish Groundwater for Industrial Development

In New Mexico, deep non-potable aquifers are defined as zones where the top of the aquifer is encountered at 2,500 feet bgs or deeper, and the zone contains water of a quality containing greater than 1,000 mg/l TDS. A different permitting process, separate from the current water rights application process, exists for wells tapping these zones, through the office of the State Engineer. Shallower zones above 2,500 ft bgs are still required to follow the permitting process delineated in New Mexico statute §72-12-3, “Application for use of underground water”, through the office of the State Engineer.

For these reasons, some groups have suggested that the State of New Mexico might be best served by requiring new industrial development to use deep brackish ground water where possible. Alongside this, the shallower brackish water (<1,000 ft bgs) remains untapped. New Mexico would benefit in several ways from this type of approach, including:

- Improve the sustainability of current fresh water resources while encouraging economic development,
- Maintaining fresh water resources for applications that require higher-quality, lower-cost water, like municipal users,
- Match industrial fit-for-use or fit-for-purpose water requirements with the appropriate supply, and
- Match higher-cost water treatment needs to the groups most able to afford it.

Because these deeper and more brackish waters may be best suited for industrial applications, collaborating with industrial partners could provide opportunities for long-term local and regional economic development and industrial, commercial, and municipal growth. A review of the ability of industrial sectors to treat and use brackish or industrial waste water supplies showed that different industries can effectively use or reuse these resources in many applications, depending on overall water quality compositions and some specific constituent levels. These sectors included oil and gas exploration and production including drilling and fracking, mining and mineral processing, selected manufacturing processes, electric power generation, and sometimes

even agriculture [11,12,13]. Therefore, it seems prudent to encourage the future use of brackish water resources by industry.

Developing the Concept of an “Industrial Aquifer” Containing Brackish Ground Water

The NM Desalination Association (NMDesal), following the objective of promoting the use of brackish and saline water to conserve fresh-water resources in New Mexico, has taken several steps to evaluate the feasibility of the Industrial Aquifer concept. These included:

In early 2019, members of the NMDesal met with the New Mexico State Land Office (SLO) in Santa Fe to discuss ways to help accelerate economic development through the use of New Mexico’s brackish water resources under State land. We discussed the possibility to create a State funding source via fees, royalties, or other payments for the use of the brackish water and the use of State lands for establishing pumping and treating facilities. In that meeting, representatives of the SLO stated the following preliminary position regarding brackish water desalination and use with respect to State lands:

- Brackish ground water under state lands could be available for use with payment of a royalty to the SLO, similar to a standard mineral royalty, to be determined by the SLO,
- The concept that brackish waters < approximately 3,000 mg/l TDS would be reserved for future municipal use, while waters with higher salt concentrations would be appropriate for industrial use, and
- State lands could be used to site water development infrastructure such as wells, pumps, and treatment facilities with the payment of a land use royalty, to be determined by the SLO.

At the same time, NMDesal had discussions with ground-water hydrologists at Daniel B. Stephens & Associates, Inc. (DBS&A) and John Shomaker & Associates, Inc. (JSAI), who were independently considering ways that brackish groundwater might be made more readily available to sustain oil and gas development in Southeastern New Mexico and increase or help maintain the economic growth and economic benefits that have accrued to the state while reducing fresh water use in oil and gas operations. We discussed options to make the acquisition of brackish groundwater less time-consuming and uncertain, and use the brackish water to reduce the use of fresh water by the oil and gas industry in the New Mexico portion of the Permian Basin.

An approach to achieve these goals would be for the Office of the State Engineer (OSE) to declare selected deep underground basins and develop administrative criteria for aquifers or portions of aquifers that consider the operational nature of water use by the oil and gas industry or other industries. Current OSE administrative practices are based largely on municipal, domestic and irrigation water uses, which are minimal in some portions of the Permian Basin. For example, one significant difference in water use between the oil and gas industry and other uses might be the anticipated duration of groundwater withdrawals.

In addition to these efforts, HB 546, including the “Produced Water Act” was passed by the legislature in Spring 2019. Within this legislation is wording to the effect that it is in the best interests of the State to utilize other sources of water (in this case, produced water) to minimize the use of fresh water for industrial (here, oil and gas) purposes.

The general operational premise of the concepts listed here could be along the lines of the following:

- Have the SLO identify existing water rights for this application,
- Establish a coordinating entity to model, monitor, and operate the area as an “industrial aquifer”,
- Have the Office of the State Engineer establish a resilient and appropriate annual withdrawal volume based on a 30-year (or other appropriate time frame as determined) operational life,
- Have SLO establish an equitable royalty payment rate to New Mexico for use of the brackish water and land surface,
- Permit selected “industrial aquifers” as needed across the state, and
- Reduce and ultimately eliminate the use of fresh water, where appropriate and feasible, for industrial applications.

Finally, we note the great success achieved at the Bureau of Reclamation’s Brackish Ground Water National Desalination Research Facility (BGNDRF) in Alamogordo on desalination technology development. Randy Shaw and his team have provided test facilities and technical assistance to multiple desalination and water treatment pilot projects over the last 13 years. The advancements made through this facility by the different groups bringing research projects have reduced costs, increased efficiencies, and improved process designs for many different desalination and water treatment scenarios. Continued cooperation and collaboration with state agencies, technology providers, and industrial clients could help pave the way for accelerated use of New Mexico’s extensive brackish water resources to support economic and industrial development while minimizing fresh water use.

Closing Summary

This white paper outlines the presence of potential brackish and saline resources in New Mexico, and a concept for using these resources for industrial uses, in order to conserve precious fresh-water resources. *In no way* does this minimize important issues such as carefully evaluating the amount and quality of the waters for use, estimating the possible higher costs for pumping and treatment over existing fresh-water resources, evaluating the need for waste disposal, identifying industries and other potential users, and verifying an appropriate regulatory structure to support extraction and use. This document is intended as the start of a conversation around the potential of Industrial Aquifers in New Mexico. NMDesal is ready to provide information and technical assistance to those interested in this concept. We encourage interested parties to contact us at: board@nmdesal.org; or visit our website at: <http://nmdesal.org>.

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