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DESALINATION TRENDS AND ISSUES

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Background

Access to fresh water is an increasingly critical national and international issue, especially since demand for fresh water in many regions of the world has already outstripped supply. Based on the latest figures from the United Nation's "World Water Development Report," more than 50 percent of the nations in the world will face water stress or water shortages by 2025, and by 2050, as much as 75 percent of the world's population could face water scarcity (United Nations, 2003). Like so much of the world, access to fresh water is an increasingly critical issue in the southwestern United States. Over the past several decades, a tremendous growth in population and industry in the Southwest has increased the demand for water and has lead to unsustainable water management practices. The consequences of these practices are groundwater mining, falling water tables with ground subsidence and associated building and utility damage, and reductions in surface and ground-water quality and availability.

To meet these water challenges, populations will need to better balance water demands with available water resources in a sustainable manner. This requires a combination of approaches including water conservation, recycling, and treatment of impaired water from nontraditional resources to "create" new water. One area that can no longer be overlooked for increasing water supplies is the application of desalination technologies to treat brackish surface and groundwater resources. As shown in Figure 1, much of the United States, including the Southwest, contains extensive brackish ground water resources (Krieger et al., 1957). Since much of this supply underlies more easily-accessible and higher-quality fresh water resources, it has remained primarily untapped. As fresh water supplies become more limited, however, desalination of these brackish water resources will become more common.

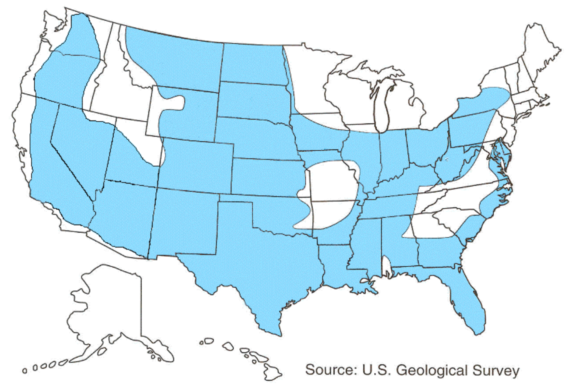

Figure 1. General location and extent of saline ground-water resources in the United States.

The Growing Utilization of Desalination

Desalination research and development efforts since the mid-1960s have led to significant improvements in the performance and costs of brackish and sea water desalination. By the late 1990s, there were more than 12,500 desalination plants in operation in the world, generating more than six billion gallons of fresh water per day and accounting for about 1 percent of the world's daily production of drinking water. Industry projections suggest that in the next 20 years, over $20 billion will be spent for new desalination facilities worldwide, doubling the volume of fresh water being generated through desalination (Martin-Lagardette, 2001). For example, the number of membrane-based desalination and water reuse plants constructed in the U.S. in the past 20 years is shown in Figure 2 (Mickley, 2001). While many of these systems have been built in coastal areas for sea water desalination, many of the newer systems are being used in inland areas for both brackish water desalination and water reuse applications. In 2000, desalination systems were in operation in almost forty states in the U.S.

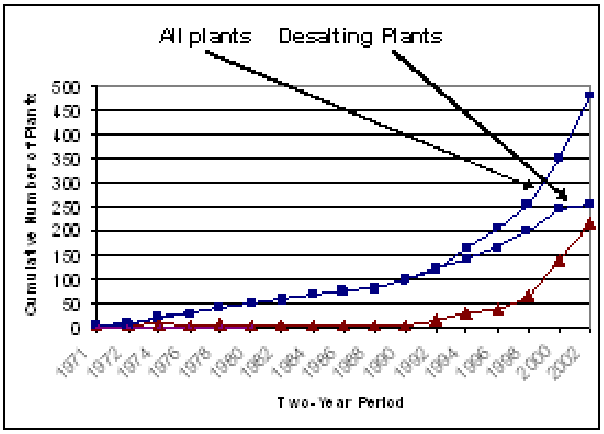

Figure 2. Construction of membrane treatment plants in the U.S.

Desalination Trends in the Southwest

From Virginia and Florida to New Mexico and California, desalination plants are being installed across the country in an effort to supplement fresh water supplies for a wide range of industrial and domestic needs. The growing interest in the Southwest and other inland areas to apply desalination includes:

- Enhancing domestic water supplies. Many southwestern water districts are evaluating brackish groundwater desalination to supplement limited fresh water supplies and provide water for a wide range of industrial and municipal uses.
- Fossil energy production. Large volumes of saline or brackish water are commonly co-produced in oil and gas production. Using desalination technologies to treat this water may offer oil-producing areas a beneficial use for this water.
- Treatment of impaired surface water. Many of the river systems in the Southwest suffer from salt buildup caused by surface runoff, agricultural irrigation practices, urban uses, and evaporation. Desalination of these impaired rivers will become increasingly important to meet more stringent water quality standards for domestic and ecological-based total maximum daily load requirements.
- Industrial and domestic water pretreatment and reuse. As water conservation and reuse become increasingly more important, desalination-based water and wastewater treatment technologies could meet water quality standards for water reuse in various applications.

The many applications of desalination are being evaluated and pursued by municipalities and industries across the Southwest. El Paso, Las Vegas, Phoenix, and Tucson are each considering desalination plant options to supplement or improve water supplies. Cities such as Scottsdale, Arizona and Ft. Stockton, Texas have already built and are operating desalination facilities. Even mid-sized cities like Alamogordo, New Mexico, with a population around 30,000, is planning to construct an approximately 10 million gallon per day (mgd) desalination plant to help supplement its fresh surface and groundwater resources to meet future growth. Pat McCourt, City Manager for Alamogordo suggests "the cost of acquiring new fresh water supplies has increased to a level that desalination of local brackish water is now competitive with developing and bringing in fresh water from remote locations." As an example of other desalination applications, oil companies in cooperation with federal and state resource management agencies in New Mexico, Colorado, and Texas are evaluating the treatment and desalination of oil and gas produced water for supplementing river flows during drought, rehabilitating rangeland, and cooling water for power plants.

Inland Desalination Concerns

Desalination in inland areas, like the Southwest, has lagged behind coastal desalination applications. Most water professionals agree there are three major concerns critical to the wider use of desalination in inland areas. These include addressing the environmental issues of concentrate and salt disposal, improving desalination efficiency, and reducing the costs of inland desalination.

There are several concentrate disposal methods practiced today: surface water discharge, discharge to sewers, deep well injection, land application, evaporation ponds/salt processing, and brine concentration. The feasibility of each disposal option depends primarily on location and desired efficiency. Surface water discharge is used extensively in coastal applications where the concentrate can be easily mixed with coastal water to dilute the concentrate, providing an inexpensive and often environmentally benign disposal option.

The other methods, while viable, each have disadvantages. In inland areas, concentrate disposal options, including surface water discharge, sewer discharge, and land application, can increase the salt load in the receiving waters and soils, which will contaminate water resources and reduce soil fertility. Evaporation ponds often require large land areas and are only appropriate in arid climates with low land values. Like other brine concentration techniques, they typically require impervious disposal areas to prevent contamination of fresh water supplies and soils. Deep well injection is not permitted in many states, but those that do (such as New Mexico and Texas), require permits, monitoring wells, and completions in deep contained aquifers to insure that fresh water supplies are not contaminated.

Concentrate disposal may be the biggest roadblock to widespread inland desalination. Mike Gritzuk, Director of the Phoenix Water Services Department, likens the potential accumulation of salts and the possible long-term negative environmental impacts from inland desalination as a "train wreck in slow motion." New research into areas such as concentrate reuse and salt sequestration technologies are needed to address the environmental issues with inland desalination concentrate disposal.

Desalination efficiency is also an important issue for the Southwest, according to Bruce Johnson, Assistant Director of the Tucson Water Department. Today, common desalination systems have recovery efficiencies of 60 to 85 percent for brackish water desalination (U.S. Bureau of Reclamation, 2002). Unfortunately this means that 15 to 40 percent of the available water is not used and often must be disposed, wasting potentially valuable water resources and requiring additional pumping. Improving recovery efficiencies to 90 or 95 percent could significantly reduce concentrate disposal volumes, extend the supply of brackish resources, and potentially reduce overall desalination costs.

To reduce costs, many coastal desalination plants are designed to treat large volumes of water, often 50 mgd or greater, and are co-located with coastal power plants to take advantage of common intake and outfall structures and less expensive power. These strategies enable coastal facilities, such as the Tampa Bay Desalination Facility, to maintain desalination costs as low as $2.00-$2.50 per 1000 gallons of water produced. Similar facilities in inland areas may cost twice as much to operate because of smaller plant sizes, higher concentrate disposal costs, higher water pumping costs, and higher energy costs (U.S. Bureau of Reclamation, 2002). These cost issues will have to be addressed and reduced to make inland desalination more cost effective and have even wider utilization.

Expansion of the National Desalination Research Program

While significant strides have been made in desalination over the past several decades, additional improvements in desalination efficiency, cost effectiveness, and concentrate disposal are still needed for desalination to become widely used as a long-term, environmentally friendly enhancement for fresh water supplies in many areas, including inland applications. The Water Desalination Act of 1996 was the first of recent efforts by Congress to accelerate desalination research and help meet growing future water demands through utilization of nontraditional and brackish water resources. Unfortunately, funding appropriations never met the program authorizations, and often as little as $1 million per year was designated for desalination research.

Recently, Senator Domenici has supported congressional legislation to develop concepts for an inland brackish groundwater desalination research center in the Tularosa Basin of New Mexico as well as the development of a national "Desalination and Water Purification Technology Roadmap." Both of these activities have been conducted jointly through Sandia National Laboratories and the U.S. Bureau of Reclamation. The Tularosa Basin Desalination Research Facility is being designed to complement the capabilities of existing national water research centers, focusing on the unique issues of brackish groundwater desalination and renewable energy applications (Sandia, 2002). The roadmap effort included nation-wide input to help identify the future desalination research objectives and goals for the U.S. in both 2010 and 2020 (U.S. Bureau of Reclamation, 2003).

The purpose of the roadmap was to help ensure that the major concerns and issues associated with future applications of desalination and water reuse are adequately addressed, helping to accelerate the development and utilization of cost-effective and environmentally friendly desalination technologies that can help supplement our limited fresh water resources and help meet the growing water demands in the U.S. as well as the Southwest. This roadmap is being used by Congress to extend the Water Desalination Act of 1996 and develop a more comprehensive and better-supported national desalination research program. The development of an expanded national desalination program is presently being debated in Congress for initial implementation in FY04.

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