DESALINATION TECHNOLOGY DEVELOPMENT AND POTENTIAL APPLICATIONS IN NEW MEXICO

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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% of the nations in the world will face water stress or water shortages by 2025, and by 2050, as much as 75% 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 groundwater 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 U.S., including the Southwest, contains extensive brackish groundwater 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.

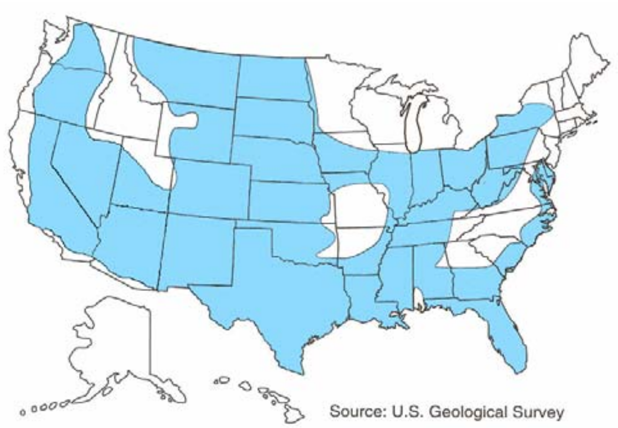

Figure 1. General location and extent of saline groundwater resources in the United States.

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 worldwide, generating more than six billion gallons of fresh water per day and accounting for about 1% of the world's daily production of drinking water. Industry projections suggest that in the next 20 years, over $70 billion will be spent for new desalination facilities world-wide, 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 40 states in the U.S.

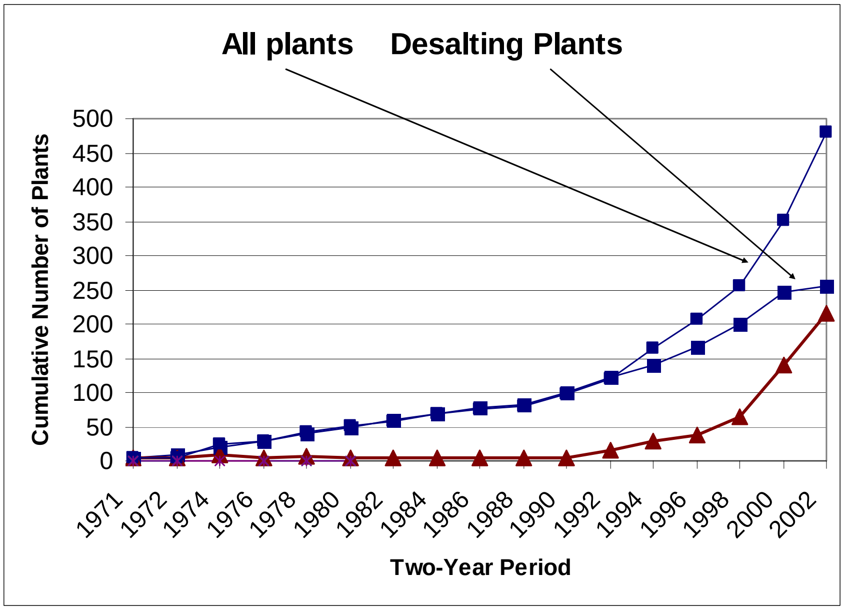

Figure 2. Construction of membrane treatment plants in the U.S.

DESALINATION TRENDS IN NEW MEXICO AND 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 the following:

- 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 ecology-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.

Desalination applications are being evaluated and pursued by municipalities and industries across the Southwest. Las Vegas, Phoenix, and Tucson are considering desalination plant options to supplement or improve water supplies. Cities such as Scottsdale, Arizona and Abilene and Ft. Stockton, Texas have already built moderate size desalination facilities. El Paso is currently planning the largest inland desalination plant in the U.S., approximately 30 million gallons per day (mgd).

Many cities in New Mexico are considering desalination plants to supplement fresh water supplies or to treat brackish water resources including Albuquerque, Santa Fe, Las Cruces, and Santa Teresa. Even smaller cities, like Alamogordo, are already planning for the construct an approximately 10 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 groundwater is now competitive with developing and bringing in fresh water from remote locations." Currently Alamogordo has received approval from the State Engineer's Office for about 3000 acre feet per year of brackish water rights to begin treatment and operations.

Additional desalination applications, especially treatment of oil and gas-produced water, are being considered throughout the west and in New Mexico. For example, oil companies in cooperation with federal and state resource management agencies are evaluating the treatment and desalination of oil and gas-produced water for supplementing river flows during drought, rehabilitating rangeland, and providing cooling water for power plants. Several studies on the treatment and utilization of brackish-produced water are currently underway in the San Juan Basin of northwestern New Mexico, and in the Permian Basin in southeastern New Mexico. In all cases, the treatment of produced water is being considered as a potential lower cost and more sustainable way to manage large amounts of produced water.

Potential future environmental regulations, such as Total Maximum Daily Load (TMDL), may limit salt discharges to surface waters and require desalination of wastewater discharges by many communities. Though salt increases in rivers, like those shown in Figure 3 for the Pecos River near Carlsbad may be an extreme, the data show the trend of salt buildup in surface streams as a function of distance downstream. Water quality regulations being considered may require significant desalination of these surface waters in the future to remove salts, which may be a big issue to cities like Albuquerque, Farmington, Las Cruces, Roswell, and Carlsbad.

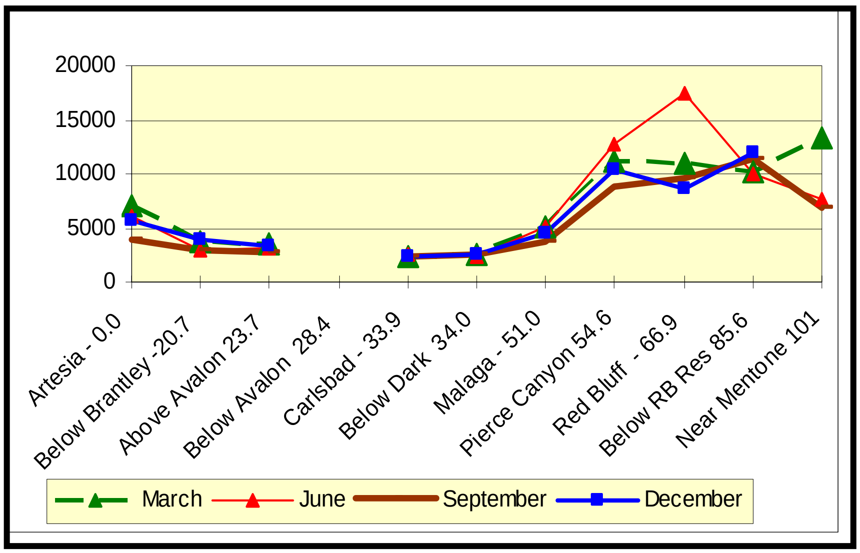

Figure 3. Example of Total Dissolved Solid Levels in the Pecos River.

A final issue and concern in New Mexico is the need to create additional fresh water supplies, which may require cities to begin to desalinate wastewater for reuse. While water recycling is currently done in many cities in New Mexico, most of the recycled water is used to irrigate parks and turf areas and in construction. In the future, as cities continue to grow and fresh water supplies continue to diminish, cities may need to implement desalination of wastewater to utilize all their water resources fully. For example, Rio Rancho, New Mexico, is currently testing and evaluating desalination type technologies for wastewater treatment to help them extend dwindling fresh water resources by enabling them to inject the treated water into aquifers for later reuse. Rio Rancho is planning in the future to rely on the reuse of treated wastewater to meet as much as 30% of their water demands in 20 years.

INLAND DESALINATION CONCERNS AND TECHNOLOGY DEVELOPMENT NEEDS

Desalination in inland areas, like New Mexico and 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 management, improving desalination efficiency, and reducing the costs.

Several concentrate disposal methods are 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. 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 could 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 ensure that fresh water supplies are not contaminated.

Concentrate disposal may be the biggest roadblock to widespread inland desalination. Most municipalities wonder what to do with the salt. 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. Today, common desalination systems have recovery efficiencies of 60 to 85% for brackish water desalination (U.S. Bureau of Reclamation 2002). Unfortunately this means that 15 to 40% of the available water is not used and often must be disposed, wasting potentially valuable water resources and requiring additional pumping for disposal. Improving recovery efficiencies to 90 or 95% could significantly reduce concentrate disposal volumes, extend the supply of brackish resources, and potentially reduce overall desalination costs.

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 inland areas like New Mexico. 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 less than $1 million per year was designated for desalination research.

Recently, Congressional legislation has helped to significantly increase funding for desalination research and development. Additionally a national "Desalination and Water Purification Technology Roadmap" was recently developed to identify future desalination research objectives and goals. The roadmap effort included national input and will help ensure major technical, cost, and environmental concerns with desalination are effectively addressed (U.S. Bureau of Reclamation 2003). This will be especially important for New Mexico, where available fresh water supplies are coming under increasing stress to meet growing populations and increasing water demands, and where the use of nontraditional water resources will increasingly become the norm.

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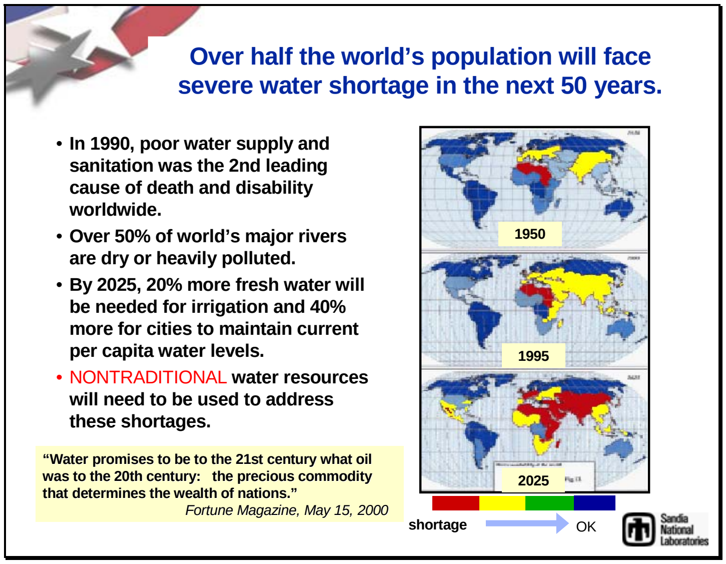
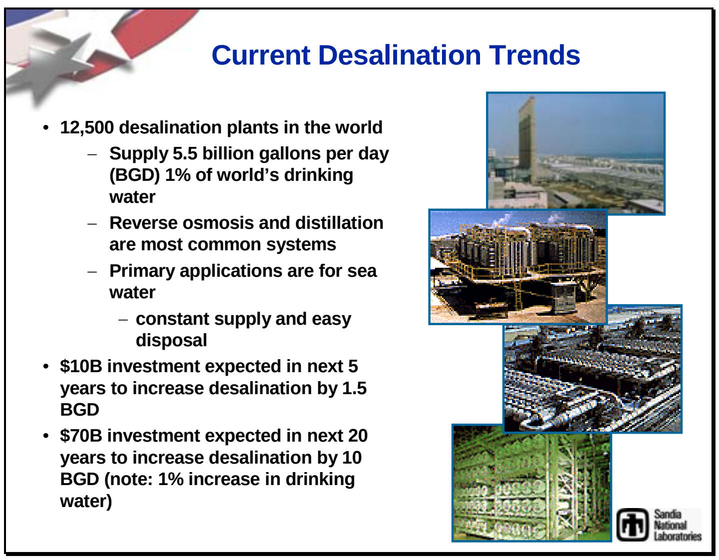
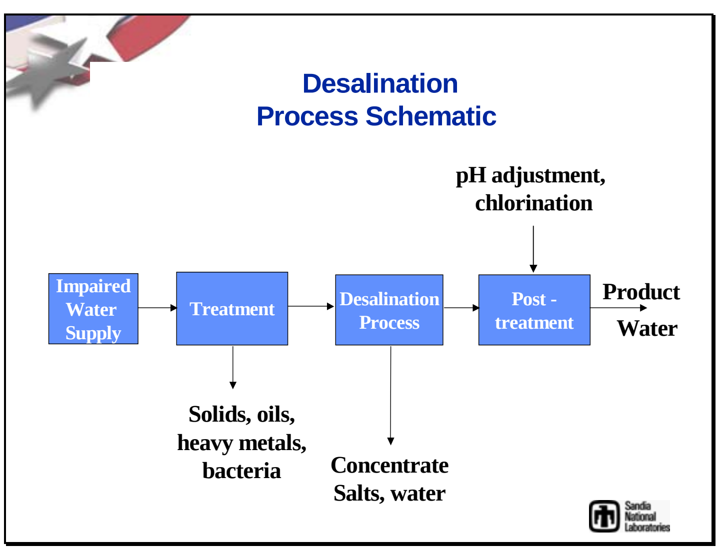


International organizations increasingly recognize water as an international security problem.





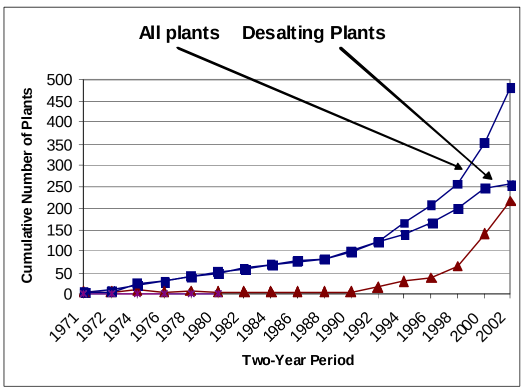
Saline and Brackish Water Characterization

TYPE	TDS
Fresh	<1,000 mg/l (500 mg/l is commonly accepted drinking water level)
Brackish	
Mildly	1,000 - 5,000 mg/l
Moderately	5,000 – 15,000 mg/l
Heavily	15,000 – 35,000 mg/l
Seawater	~35,000 mg/l
Brine	>~35,000 mg/l
Concentrate	From Desalination Process

Desalination Processes and Typical Concentrate Characteristics

Process	Reverse Osmosis Brackish	Reverse Osmosis Seawater	Multi-Stage Flash Distillation	Multi-Effect Distillation
Feedwater	Brackish	Seawater	Seawater	Seawater
Recovery, %	60-85%	30-60%	30%	20%
Final Concentration Factor	2.5 – 6.7	1.4 – 2.5	<1.15	<1.15

Growing Trend in U.S. Membrane Treatment Plants



National Trends in Desalination and Impaired Water Treatment

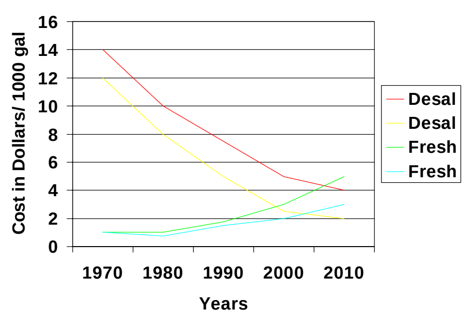
Increase in Number of Treatment Plants

	<1993	<2003
Desalting	133	253
Low Pressure	1	218
– Micro Filtration	1	181
– Ultra Filtration	0	37
Total	134	461

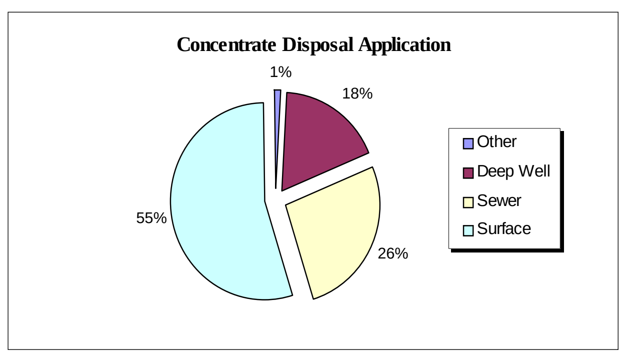
Distribution of Treatment Plants

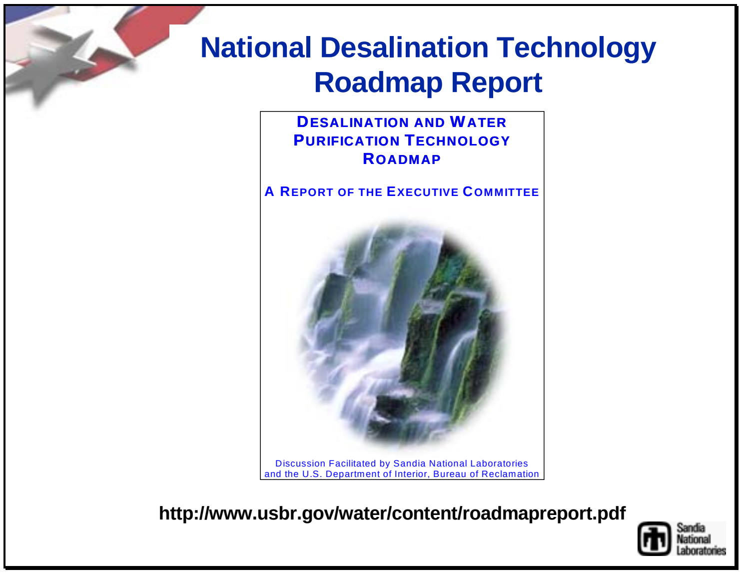
	<1993	2001
Number of States	13	37

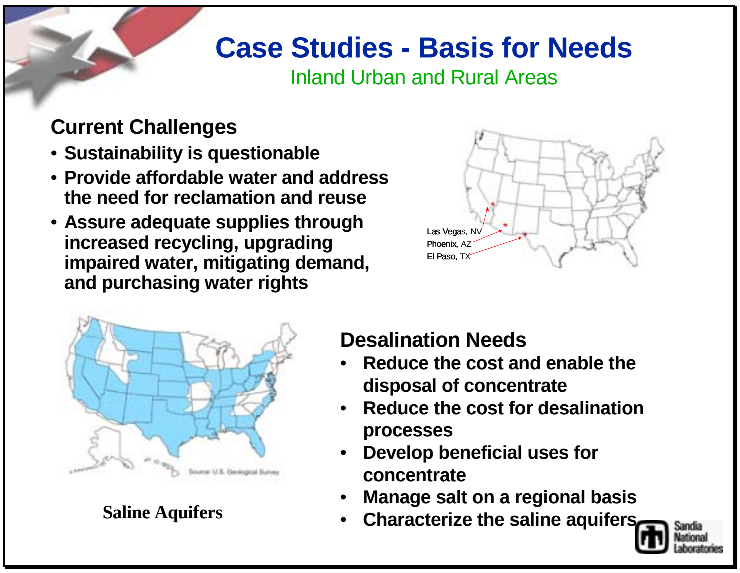
Desalination and Fresh Water Costs



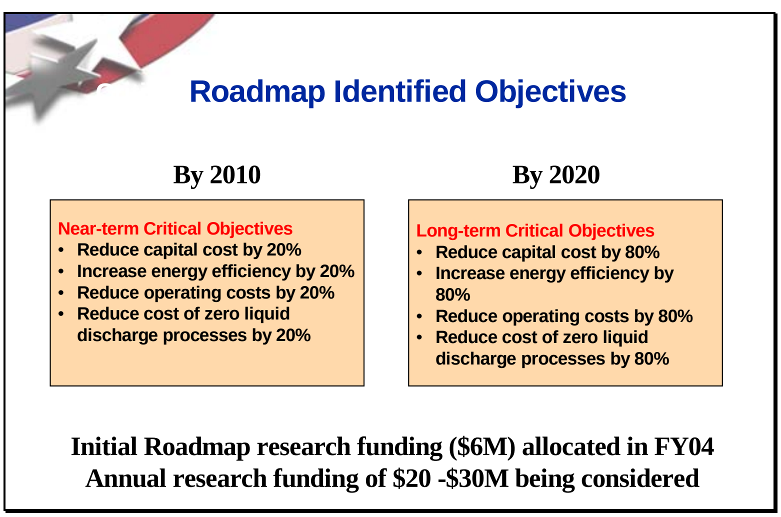
Concentrate Disposal Practices



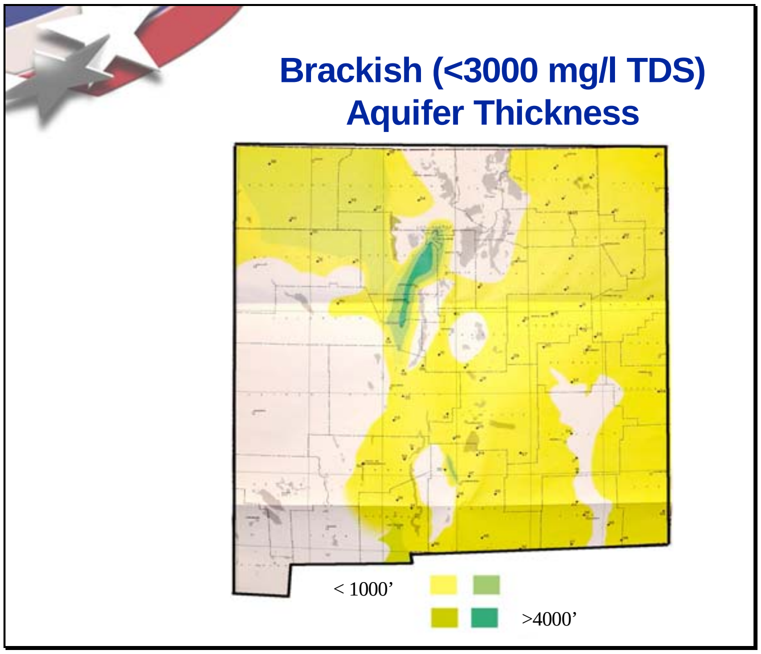


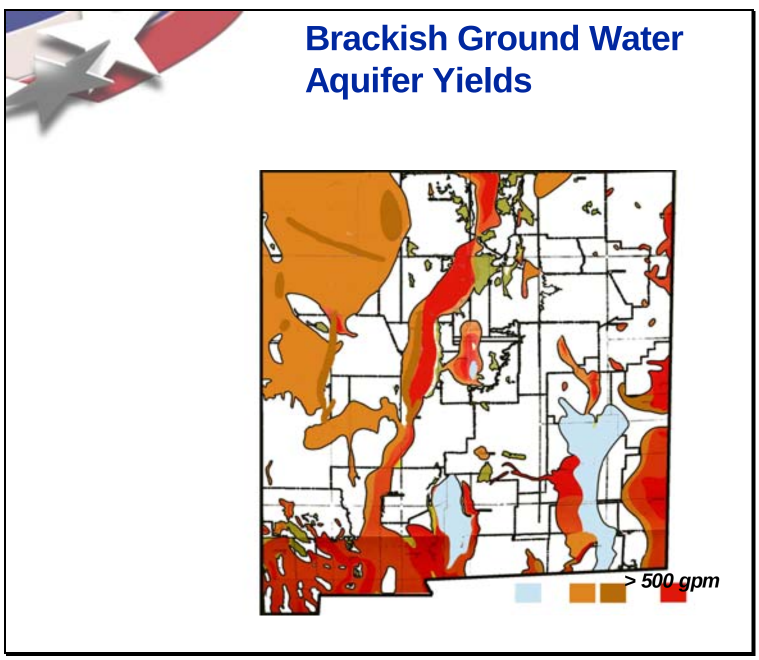


The first study is the consideration of inland municipal areas. These areas are all grappling with sustainability and adequacy concerns resulting from the persistent drought. An additional major concern is the disposal of concentrate.



The cost objectives for desalting water will probably be the most important driver. In the near term, the cost improvement for these processes is aggressive and can only be met by a well-managed and well-funded program. Zero liquid discharge (ZLD) processes are those processes that produce no liquid concentrate. ZLD processes are very important for the inland west. The long-term objectives are motivated by the desire to reduce the difference between the cost of conventionally treated fresh water and advanced treatment of impaired water. This national need will stem the movement of water away from agriculture, industry, and the environment to the urban communities.





Current Desalination Efforts in New Mexico

- Brackish Water Use
  - Many cities are actively pursuing desalination plants (Alamogordo, Horizon City, El Paso)
  - Many cities are considering desalination and reuse (Albuquerque, Santa Fe, Rio Rancho, Ruidoso)
- Produced Water Use
  - Statutes for disposition under review and revision
  - Rangeland rehabilitation and irrigation
  - Power plant cooling water in the Four Corners
  - Supplement instream flows for the Pecos River
  - Use for industrial applications including solution mining in the potash industry
- Sigificant interest in impaired water treatment and reuse using membrane technology
- Development of a national brackish ground water research center in Alamogordo

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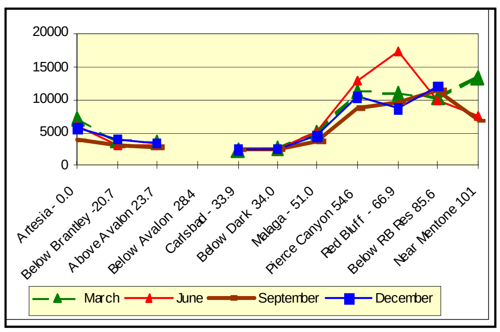
Growing Issues and Concerns Over River Salinity and Water Quality



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Tularosa Basin National Desalination Research Facility

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