

AQUIFER STORAGE & RECOVERY: Using Innovative Technologies to Secure our Water Future

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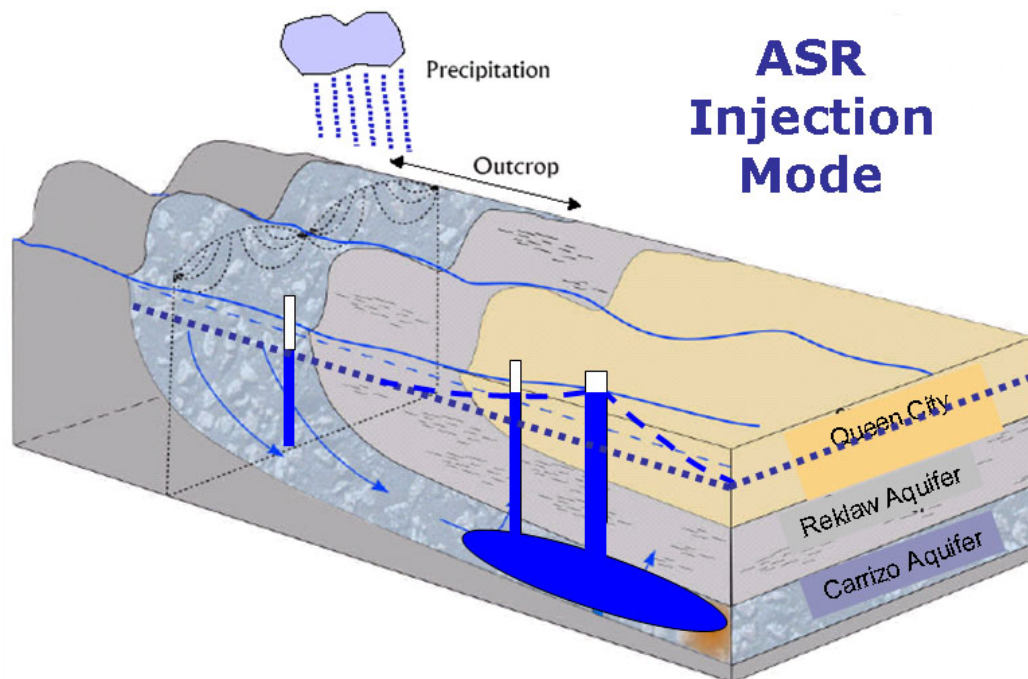
The San Antonio Water System Twin Oaks / Aquifer Storage and Recovery facility is a key component of SAWS' 50-year water supply plan. Adopted in 1988 and update in 2005, the plan addresses the critical need to develop and manage water resources for a growing population while protecting regional environments and maintaining affordability.

Exactly what is “Aquifer Storage & Recovery”?

It is an environmentally-friendly way of storing drinking water out of the Edwards Aquifer (limestone) in the Carrizo-Wilcox Aquifer (sand). This water stored during the rainy seasons will be sent back into the city during the dry, hot months. It maximizes the use of pumping allocations from the Edwards Aquifer throughout the year.

Why did we need an ASR Plant in San Antonio?

Allocations from Edwards Aquifer are being limited by legislation. During wet periods there was no method to store allocations that were not used. There is no carryover or credit for pumping rights that are not used in a given year - *use it or lose it*.



We are saving for a “sunny day”.

During wet years, up to 30,000 acre-feet of excess Edwards Aquifer water is diverted into storage in the Carrizo sand aquifer (Injection Mode). A great benefit of injecting into this type of aquifer is that the water, for the most part, stays right where you put it.

During the summer, this stored water is withdrawn during dry periods (Recovery Mode), and is sent back into town. This helps maintain spring flows in New Braunfels and San Marcos to ensure protection of endangered species habitats.

Phase I of the project, completed in 2004, includes a 30 MGD treatment facility, 16 wells, a high service pump station, 3 MG storage tank and 30 miles of main to convey water to the Artesia and Seale pumping stations.

The 3200 acres of property purchased by SAWS was immediately leased right back to the original owners. This ensured a smooth transition for the ranchers and farmers to continue their work without missing a beat.

The Treatment Process

The native Carrizo-Wilcox water is usually higher in manganese and iron while having a lower pH and hardness than the Edwards water. During “Production Mode”, up to 6400 acre-feet of the available native Carrizo-Wilcox water goes through a three-step process to make the water compatible with Edwards water already in the distribution system.



1) Cascade Aeration:

Carbon Dioxide and/or Lime may be added during this process to adjust pH, alkalinity and hardness. This aeration also helps to oxidize the iron and increases dissolved oxygen.

2) Clarification:

Polymers, potassium permanganate and/or chlorine can be added in the solid contact units to aid in settling out manganese and other suspended solids.



3) Filtration:

Dual media filters are used to remove any of the remaining particles of solids. All backwash flows and settled solids go to a backwash clarifier and then to three storage lagoons.



Finished Water Goals

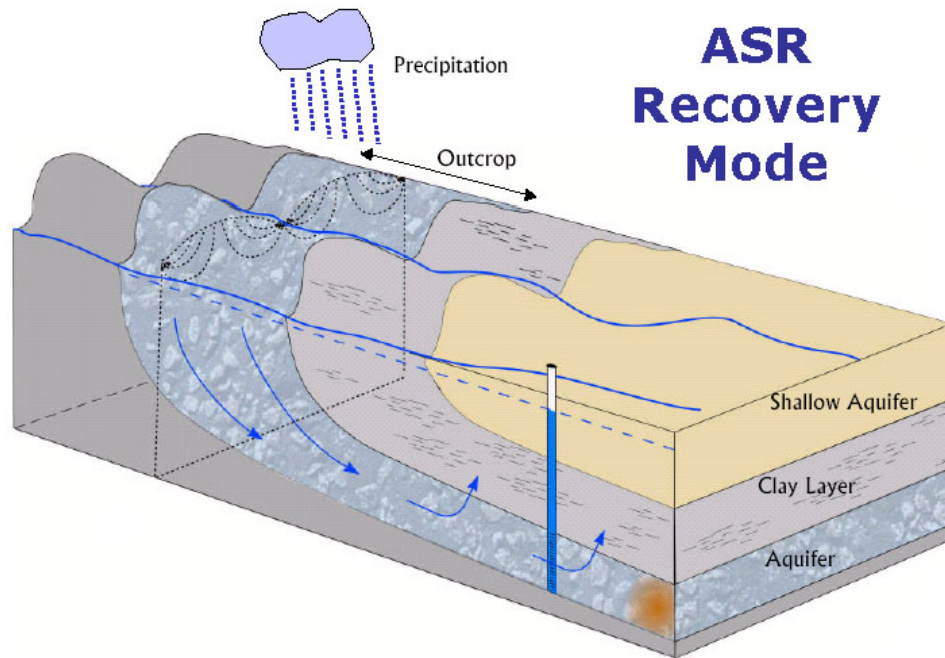
The finished water goals for the Twin Oaks / ASR Water Treatment Facility are shown below. These goals were arrived at by evaluating several factors including the following:

- Meet or exceed all regulatory requirements of TNRCC including all primary and secondary MCLs.
- Condition the water in such a way as to avoid water quality problems in the distribution system.
- Meet or exceed the aesthetic quality expected by SAWS customers.

| Finished Water Goals | | | | |
|--|---------------------------|------------------|-------------------|---------------------|
| Contaminant | Units | Raw Water Design | MCL | Finished Water Goal |
| Primary Drinking Water Contaminant Levels | | | | |
| Radium-226&228, Total | pCi/l | 4.50 | 5.00 | <3.0 |
| Arsenic | mg/l | <0.01 | 0.05 ¹ | <0.01 |
| Secondary Drinking Water Contaminant Levels | | | | |
| Color, True | color units | 20 | 15 | <3.00 |
| Hydrogen Sulfide | mg/l | 2 | 0.05 | <0.03 |
| Iron | mg/l | 15 | 0.3 | <0.2 |
| Manganese | mg/l | 0.30 | 0.05 | <0.03 |
| Ph | | 5.50 | >7.0 | >7.8 |
| Odor | T.O.N | 200 | 3 | <2.5 |
| Other Parameters | | | | |
| Alkalinity, Total | mg/l as CaCO ₃ | 30 | NA | >100 |
| Calcium | mg/l | 23 | NA | >40 |
| Dissolved Oxygen | mg/l | 0.10 | NA | >2.0 |
| Hardness, Total | mg/l as CaCO ₃ | 35 | NA | >100 |
| Radon | pCi/l | 160 | 300 ² | <100 |
| Turbidity | NTU | 0.20 | <0.5 | <0.1 |
| Corrosion Indices | | | | |
| Langelier Saturation Index | | -2.0 | NA | >0.20 |
| Ryznar Index | | 10.1 | NA | <7.1 |
| Disinfection By-Products | | | | |
| Bromate | Mg/l | NA | 0.010 | <0.005 |
| Total Trihalomethanes (TTHM) | Mg/l | 0.007 | 0.080 | <0.040 |
| Haloacetic Acids (HAA5) | Mg/l | 0.004 | 0.060 | <0.030 |
| ¹ A lower arsenic MCL of 0.01 has been proposed but not yet approved and implemented. | | | | |
| ² Radon is not currently regulated, MCL shown is proposed | | | | |

During “Recovery Mode” of the stored Edwards Aquifer water, amazingly, there is

virtually “no treatment” required. This water can be sent back into the system after only the addition of chlorine for disinfection purposes.



Summary of ASR Benefits

This process allows for more flexibility in the management and storage of valuable water resources throughout the year. Storing water underground results in “no evaporation” and it is less vulnerable to possible contamination. This is an enormous advantage over surface storage. Almost all of the land directly above the ASR site continues its previous use.

The Future of the Twin Oaks / ASR Facility

Phase I was constructed in 21 months at a cost of \$185 million. While it is not required by state law, a mitigation program has been implemented to assist area well owners impacted by “drawdown”.

Phase II construction includes 12 additional wells, interconnecting pipeline, a second clearwell and other improvements. We will be able to send or receive water from the Randolph pump station, which is 37 miles away. Scheduled completion, for all of the various phases of construction, is during the Winter of 2007. The facility will serve as a key relay and treatment point for additional water sources currently under development. Upon completion of Phase II, Twin Oaks will be the second largest ASR facility in the nation.