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# Soft Water Creates Hard Choices

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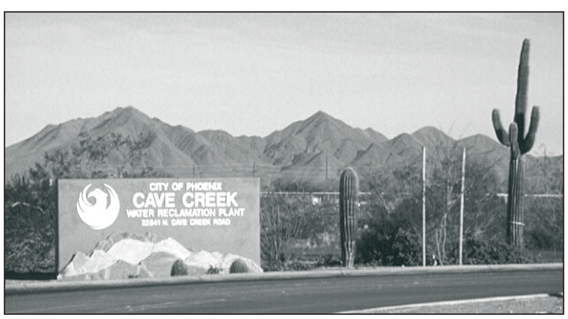
## Facts – What We Know

*"The water here is so hard that it 'clinks' when it comes out of the tap!"* It's a well-known fact that western water is hard. Naturally-occurring minerals cause problems – corroded pipes, dull laundry, soap scum, and white spots on dishes, block walls and cars. The simple answer has been to soften it. Two additional well-known facts are our explosive growth and continued drought in the West. These pose another more serious problem – the need for more water. The answer is a water reclamation plant that treats the wastewater to safe standards for reuse, irrigation, and groundwater recharge. Here is where these problems merge. Softeners increase the salinity of wastewater. Reclaimed water customers, specifically golf courses, must deal with rising sodium levels in the soil. Groundwater recharge of treated effluent may degrade the aquifer water quality. All reuse options are impacted – that's the new fact.

New golf courses that are required to irrigate with treated effluent in north Phoenix and north Scottsdale have documented the effects of the high total dissolved solids (TDS) and high sodium content of treated effluent. The Desert Marriott Resort's Wildfire Golf Course has tracked sodium levels in the irrigation water as well as in the fairways and greens since they opened in 2000. In 2000, the golf course used potable water for irrigation. Since 2001, the course has used treated effluent from the City of Phoenix's Cave Creek Water Reclaim Plant (CCWRP). The sodium level in the irrigation water has risen 260% from 60 mg/L in the potable source to 150-200 mg/L in the treated effluent. At the same time, sodium levels in the soil have increased over 400% in the fairways.




The City of Scottsdale has investigated the increase in TDS, sodium, and chloride levels of their reclaim water over that found in CAP water. Calcium is about the same – 71 mg/L in CAP water vs. 73 mg/L in Water Campus effluent. Sodium however, increased 147% to 232 mg/L vs. 94 mg/L in CAP water. Chloride level rose 270% to 326 mg/L vs. 88 mg/L in CAP water. This points to a significant use of water softeners in the Water Campus' sewer shed.

Water softener use is a key contributor of sodium and TDS to the sewer but softeners are not being targeted as the "bad guys." These studies were aimed at increasing our knowledge base of the use of softeners. We must recognize that the problem that needs our combined wisdom is how to economically remove salt from our water – both supply and reclaimed.

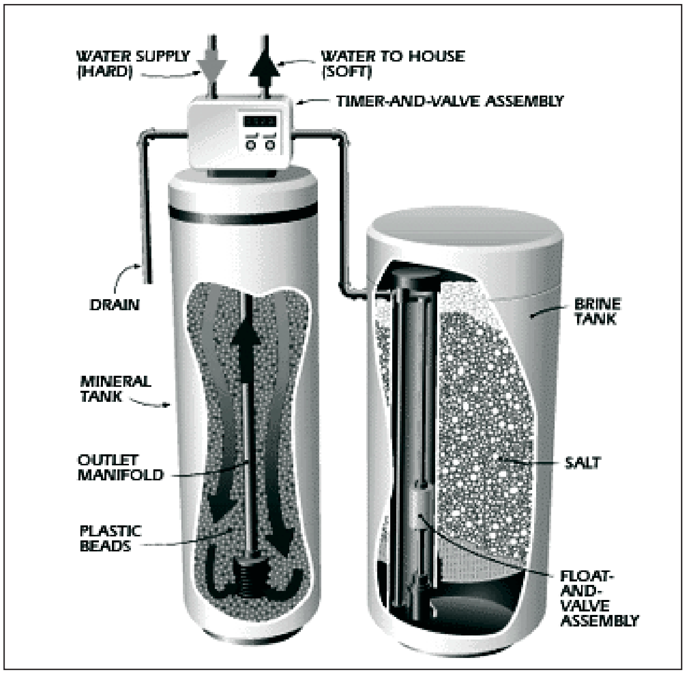
## Water Softeners

Water softeners chemically exchange sodium for calcium and magnesium. A resin tank contains negatively charged plastic (ion exchange resin) beads with positively charged sodium attached. The stronger positively charged calcium and magnesium in the hard water are attracted to the negatively charged resin beads and displace the less positively charged sodium. The sodium goes into the water. A nearby brine tank holds salt (sodium chloride) pellets and about 3 gallons of brine solution.

*continued on page 29*

# SOFT WATER CREATES HARD CHOICES

continued from page 1




That solution is used to flush the resin tank, forcing the calcium and magnesium ions off the resin bead and replacing them with sodium. A meter at the top of the resin tank regulates these flush (regeneration) cycles. It is set based upon the hardness value for the water – one grain-per-gallon equals 17.1 mg/l total hardness. Phoenix area water ranges between 17 and 22 grains of hardness.

A typical 2-3 person household water softener is 1 cubic foot of resin and has a rated capacity of 30,000 grains. It will process about 1,000 gallons of Phoenix-area water in one week before needing to regenerate. Each regeneration cycle uses between 9 and 10 pounds of sodium chloride and generates 30 gallons of waste with a TDS spike of up to 35,000 mg/L during the 100 minute cycle.

## Investigation – How much salt, today?

Two recent investigations have identified and quantified commercial and residential contributors of salinity. The projected commercial and residential growth gives a picture of the future and the total salinity that will need to be addressed.

The Bureau of Reclamation conducted a survey of homeowners in growth areas as well as established neighborhoods in the Phoenix Valley. This new information revealed that softener usage is higher than had been previously known and is increasing. Twenty-five percent (25%) of all households surveyed own a water softener. Penetration in the growth areas is 39%, 2.44 times higher than in the established areas (16% penetration). Forty-seven percent (47%) of the homes built in the 1990's and 51% of the homes built since 2000 have softeners. While only 17% of homes built before 1970 and 27 % of homes built in the 1980's have softeners. The average household adds 40 pounds of salt per month to their softener's brine tank.

A combined residential and commercial study of the Cave Creek Water Reclaim Plant sewer shed was funded through the Central Arizona Salinity Study (CASS). CASS is led by the Bureau of Reclamation and the Sub-regional Operating Group cities of Glendale, Mesa, Phoenix, Scottsdale, and Tempe. The CCWRP case study measured conductivity, flow, hardness, TDS, and specific ions contributed to the sewer from three residential communities (growth areas built between the mid-1990's to early 2000's). In addition, similar measurements were conducted at large commercial sites including a hospital, a large mall, a resort, and an office complex. Interviews with commercial sites ranging from coffee shops and restaurants to offices and hotels revealed the amounts of salt typically purchased by these commercial sites. The single largest salinity contributor to the sewer shed is also the largest user of treated effluent for golf course irrigation.

Cave Creek is currently a small 2-MGD water reclamation plant. Point source contributors of salinity, especially sodium-based softener salt, were defined to build a reasonable model of a growth-area sewer shed. Contributors included a category not normally considered – that is the salt added by supply water disinfection sites, factored for the volume that enters the sewer. The percent contribution today by each type of source is around 61.4% from residents, 29.1% from commercial, and 9.5% from water disinfection. The commercial contribution is larger than had previously been estimated and size of the water disinfection contribution ranks third highest in this sewer shed.

## Projections – How much salt tomorrow?

The fact of growth in the Cave Creek sewer shed is acknowledged in the build-out plans for the Reclamation Plant. Like any projections, those which estimate the softener salt contributions are based on "best guess" assumptions. The 2012 CCWRP Northgate build-out plan projects slow to fast growth ranging between 6 and 9 MGD. It is reasonable to assume that at least another 15,000 homes will be build, 50% with softeners. To support that population, small and large retail will double, additional schools and hospitals will be built, and it is already projected that a large mega-mall will be built. These projections

continued on next page

# Soft Water Creates Hard Choices

*continued from page 29*

yielded percent contribution in 2012 of around 72% from residents, 20.5% from commercial and 7.5% from water disinfection. The residential contribution will likely exceed the commercial because this area is supported by neighboring commercial development to the east and south.

## Possible Solutions

Commercial and residential salinity contributors have a greater impact on a small water reclamation plant because the salt isn't diluted by abundant flow. Solutions to improving the quality of the reclaimed water include:

- diverting high salt flows to a large wastewater plant;
- promoting potassium salt for softener regeneration;
- evaluating non-salt regeneration chemistry as used in Europe;
- developing a water softener portable exchange unit program to reduce salt load to the sewer system; and,
- regulating commercial dischargers with fees used for water treatment at the WWRP.

Each of these potential solutions has a price that will need to be paid. When and by whom, has yet to be determined. Two facts will drive the decision to choose one or more of the solutions; namely, water quality and volume demand due to population growth.

## Acknowledgements

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