Potable Reuse of Water: A View from Arizona

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The potable reuse of water—the introduction of highly treated wastewater that meets or exceeds drinking water standards into the potable water system—is receiving increased attention as growing population and finite resources spur water managers to augment water supplies. Downstream water users have been drinking upstream wastewater for millennia; for example, Arizona's Colorado River water users, including customers of the Central Arizona Project, receive treated wastewater from Las Vegas, NV. But the intentional reuse by one community of its own wastewater is new, an approach made possible by advanced treatment technologies that are capable of producing water purer than any found in nature.

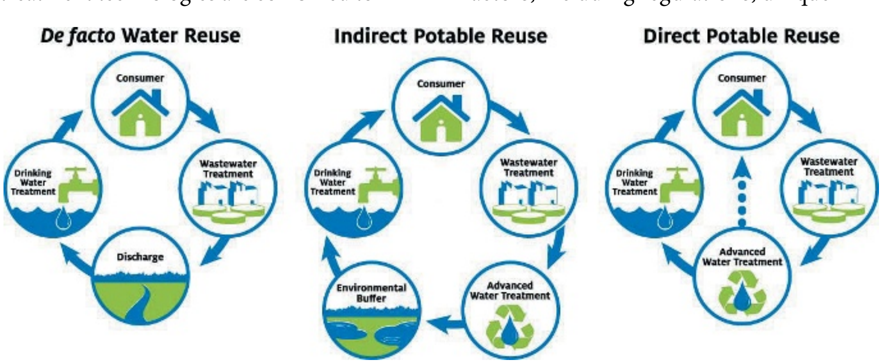
In addition to the "de facto" reuse of wastewater by downstream users (described above), there are two types of potable reuse: Indirect Potable Reuse (IPR) and Direct Potable Reuse (DPR). The difference between the two is the use of an environmental buffer such as an aquifer or reservoir in IPR and the absence of such a buffer in DPR. For reasons related to regulatory permitting and public acceptance, IPR is now more common in the United States than DPR. Both forms of treatment employ a multiple barrier approach in which multiple advanced treatment technologies are combined to reliably reduce a large suite of contaminants to vanishingly low levels, providing resilience, redundancy and robustness for a safe and sustainable water supply.

The multiple treatment processes often include microfiltration, reverse osmosis and advanced oxidation with ultra violet radiation. Other technologies, such as membrane bioreactors and granular activated carbon, can also be used in an advanced treatment train. The specific choice and order of processes depend on local factors, including regulations, unique site challenges, specific contaminants, and available technologies.

Decisions on treatment train can be dependent on source water quality. While reverse osmosis (RO) is typically used in potable reuse of high-salinity water, alternatives may be employed if salinity is not a problem. RO is energy intensive and expensive, but currently it is the only treatment method available to remove salts. Desalination through RO produces brine, a waste stream that poses a problem in places like land-locked Arizona, where the current interpretation of aquifer protection regulations prohibits deep-well injection for brine disposal. Minimizing brine and finding safe disposal methods is an area of active research; one promising avenue is use of the brine to water salt-tolerant plants.

At this time, most recycled water in Arizona goes to non-potable uses, such as irrigation and industrial cooling. Cities like Tucson and Flagstaff have invested in distribution systems to deliver recycled wastewater to non-potable users. In the Phoenix area, approximately 22 percent of the more than 300,000 acre-feet of wastewater generated annually is delivered to the Palo Verde Nuclear Generating Station, 55 miles west of Phoenix, for use in the cooling towers, and an additional 22 percent goes to irrigation. These uses can be expected to continue; however, communities may find potable reuse more efficient than maintaining separate distribution systems.

The Scottsdale, Arizona, advanced water treatment system provides both potable and non-potable supplies. The Scottsdale Water Campus has been operating since 1998 and has undergone three expansions and upgrades since then, the most recent in 2013. Golf courses in Scottsdale receive recycled water when irrigation needs are high. When the non-potable demand is lower, recycled water is recharged through vadose zone wells to replenish the city's groundwater supply. At the forefront of



IPR implementation, Scottsdale had to break new ground to obtain the necessary regulatory permits in Arizona.

There is no regulatory framework specifically for potable reuse provided by the federal government. The Safe Drinking Water Act applies to all drinking water suppliers, so water quality requirements of the Act apply equally to potable reuse. The Environmental Protection Agency offered guidelines in 2012 specific to water reuse, which included potable reuse as a viable option, and an influential report on water reuse by the National Academy of Sciences was published in the same year. An update to the 2012 EPA guidelines is under preparation.

Each state, therefore, is left to develop its own set of potable reuse regulations. Arizona's regulations prohibit DPR, but these regulations are currently being revisited and proposed rule changes are being developed with extensive stakeholder input. In Texas, regulatory guidelines for each potable reuse project are handled on a case-by-case basis. The first operating DPR project in Texas was in Big Spring, which obtained approval during a serious drought. At this time, California has the most developed regulatory structure for IPR. It provides detailed criteria for the type of treatment processes, contaminants to test for and time treated water must remain underground. A minimum of three separate treatment processes are required. The state is working on a framework for DPR to be based on the results of on-going research and discussions.

In potable reuse systems nationwide, special attention is given to contaminants of emerging concern. Although information is limited about the risks to human health, operational criteria for potable reuse systems include identifying compounds of concern in the source water, monitoring for these compounds and reducing them to near undetectable levels in the finished product. By-products of treatment can be created during the disinfection process, making additional treatment necessary. For example, Scottsdale added ozone before RO to prevent formation of NDMA, a suspected carcinogen that can be a by-product of disinfection. Although chemical contaminants are a cause for concern, removal criteria for potable reuse focus strongly on microbial pathogens, which are the most immediate threats to human health.

Because of the special care taken to ensure pure water to customers, potable reuse tends to be more expensive than traditional drinking water treatment. In particular, reverse osmosis,

with its high energy demand and brine waste stream, increases the cost of potable reuse treatment. Where environmental buffers are located at distance from the treatment plant, infrastructure necessary for water transport can add substantially to the cost of IPR. In DPR, the lack of an environmental buffer may dictate the use of additional safety measures, such as real-time monitoring, that can be costly as well. The expense of training operators to ensure reliability of the advanced treatment systems adds additional cost.

Finally, for potable reuse to become a part of the water manager's portfolio, public acceptance is a key hurdle to be overcome. It is possible to educate the public to think beyond the well-acknowledged "yuck" factor with early, consistent and transparent interactions. Potable reuse is not the answer for all communities, but where multiple barriers are in place between the wastewater and the drinking water, potable reuse has been accepted, especially where water shortage is a threat. Customer support for investments in potable reuse is likely to increase as communities in Arizona and elsewhere come to grips with their water supply challenges.

For more on this topic, see the 2016 *Arroyo*, "Potable Reuse of Water," by Nejlah Hummer and Susanna Eden, available at https://wrrc.arizona.edu/publications/arroyo-newsletter/arroyo-2016-potable-reuse-water. ■

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