A Survey of Technological, Regulatory, and Public Outreach Challenges and Opportunities for Direct Potable Reuse with an Emphasis on Tucson and Pima County, Arizona

Denise Meeks, EWRS 596B
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Image source:
https://cdn.shopify.com/s/files/1/0654/8893/files/CleanWaterMillTheme-840x840_b57db5d3-91cc-49a6-b3ca-d3fe34bc1332_500x.jpg?v=1501889728

Methodology

- ADEQ (Zoom interview)
  - Chuck Graf, Hydrologist, ADEQ (ret.)
- Pima County Regional Wastewater Reclamation Department (Teams interview, personal communications)
  - James Brown, Pima County CRAO Permit and Regulatory Compliance Officer
  - Jeff Prevatt, Deputy Director, Treatment Division
- Scottsdale Water (written responses)
  - Gretchen Baumgardner, Water Policy Manager
  - Suzanne Grendahl, Water Quality Director
  - Gina Kirklin, Finance Director
- Tucson Water (Teams interviews)
  - Natalie DeRoock, Senior Public Information Officer
  - John Kmiec, Interim Director
- Hazen & Sawyer, Tempe (Zoom interview)
  - Troy Walker, Water Reuse Practice Leader

Methodology

- Reviewed
  - applicable Arizona Administrative Codes
  - ADEQ, and EPA regulations
  - California and Texas water regulations
  - Tucson and Scottsdale Water websites
  - Water Resources Research Center and WateReuse Foundation documents

- Researched 9 U.S. and international indirect potable reuse (IPR) and direct potable reuse (DPR) case studies

Water stress

- Billions of people lack access to clean water
- Political, social, and economic inequalities
- Mismanagement, poor sanitation, deteriorating infrastructure, climate change
- Demands exceeding supplies, public health crises, economic disasters, mass migrations, and conflicts (Felter & Robinson, 2021; Macpherson & Snyder, 2013)

Image source: Dream Time, https://www.dreamstime.com/photos-images/water-shortage.html

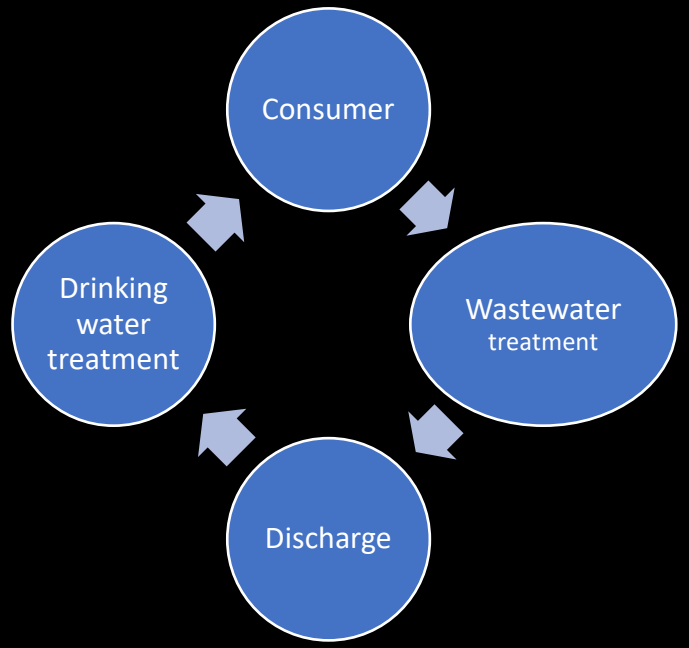
Water reuse

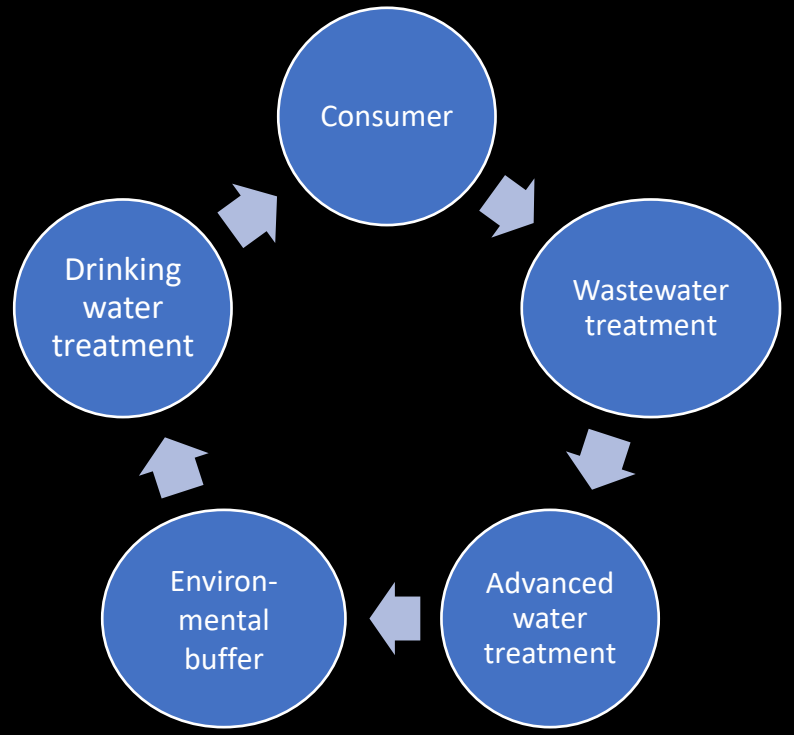
- *De facto* reuse: treated wastewater is reused but not officially recognized or planned, for example, drinking water is used downstream from a wastewater treatment plant (Environmental Protection Agency, 2012; Graf, 2022)

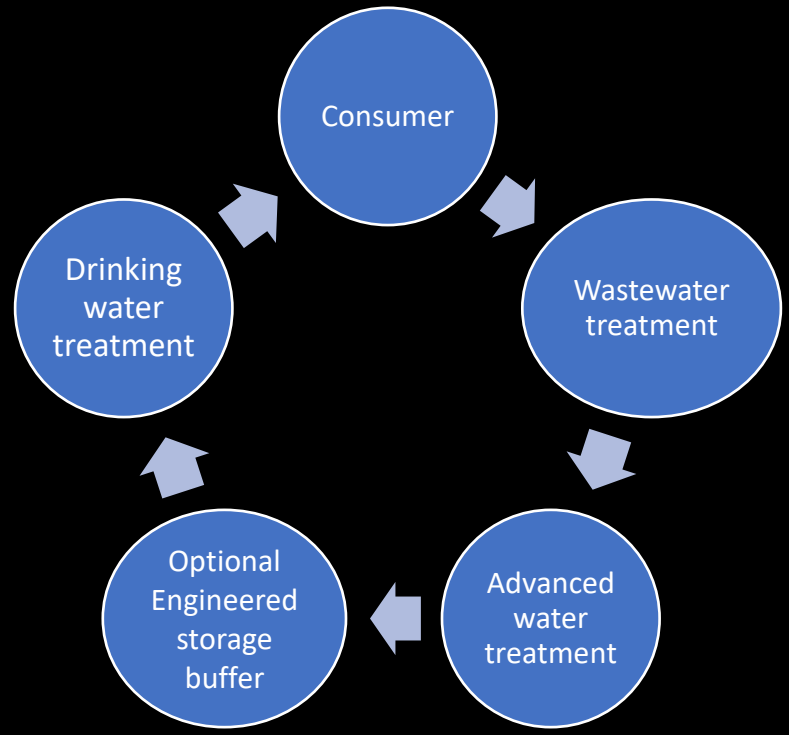
- Indirect potable reuse (IPR): a surface or groundwater drinking source is augmented with reclaimed water followed by time in an environmental buffer before drinking water treatment (Environmental Protection Agency, 2012; Water Research Foundation, 2015)

- Direct potable reuse (DPR): introduction of reclaimed water, with or without retention in an engineered storage buffer, directly into a drinking water treatment plant, either located with or remotely from the advanced wastewater treatment system for the purpose of augmenting the potable water supply (Environmental Protection Agency, 2012; Miller, 2015)

Water treatment







De facto:

- Consumer →
- Wastewater treatment →
- Discharge →
- Drinking water treatment →

IPR:

- Consumer →
- Wastewater treatment →
- Advanced water treatment →
- Environmental buffer →
- Drinking water treatment →

DPR:

- Consumer →
- Wastewater treatment →
- Advanced water treatment →
- Engineered storage buffer →
- Drinking water treatment →

Image source: per Eden et al .,2016, Potable reuse of water: A view from Arizona. https://wrrc.arizona.edu/sites/wrrc.arizona.edu/files/July-2016-IMPACT-Potable-AZ.pdf

IPR disadvantages and DPR advantages

- Why compare?
  - Lessons learned from IPR implementation provide guidance for DPR implementation (Texas Water Development Board, 2022; Scruggs, et al., 2019)
  - IPR has been the accepted standard, because the public believes that an environmental buffer is necessary to remove contaminants (Nappier et al., 2018)

- IPR disadvantages
  - May involve significant transportation and removal costs
  - Stored environmental buffers, subject to degradation from natural or chemical contaminants, polluted groundwater, agricultural and urban runoff, requiring additional treatment (Gerrity, et al., 2013; Leverenz, et al., 2011; Tchobanoglous, et al., 2011)

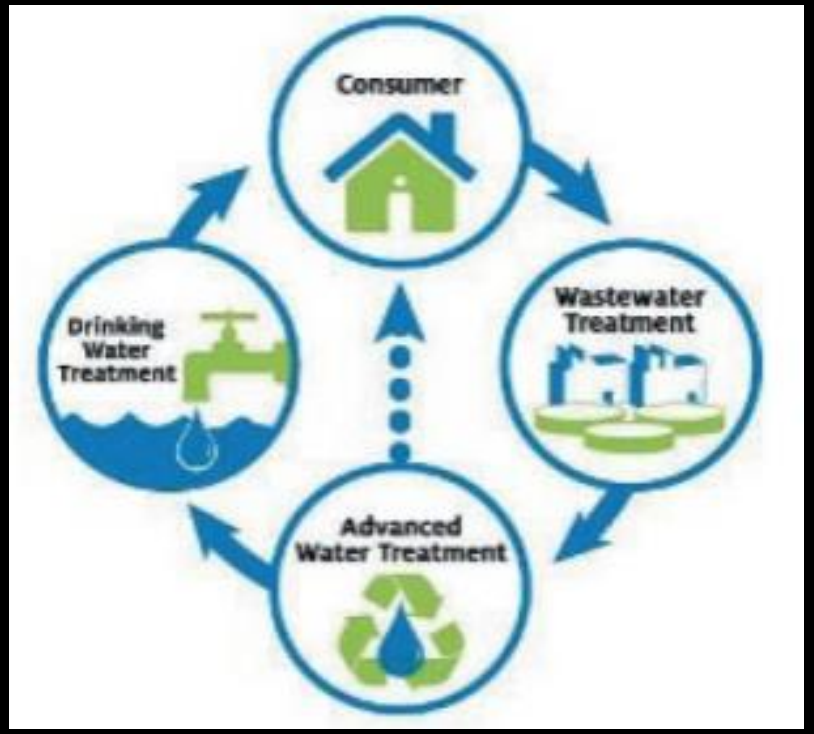
- DPR advantages
  - No use restrictions on DPR since nearly all contaminants can be removed (Rock, 2016; Graf, 2022)
  - Engineered storage buffers are contained, controlled, and secure environments that prevent contamination and evaporation, constant sampling and monitoring possible (Tchobanoglous, et al., 2011).
  - In some circumstances, may be more cost-effective than IPR (Lahnsteiner, et al., 2018)

Current and future DPR systems

- International Space Station:
  - relies on a 2008 NASA DPR water recovery system
  - collects humidity and distills about 85% of water in urine
  - uses physical and chemical processes to remove contaminants from wastewater to store in a tank for reuse (Environmental Protection Agency, 2012; Hummer & Eden, 2016)

- Windhoek, Namibia:
  - Goreangab Water Reclamation Plant began producing high-quality effluent for DPR using only domestic sewage
  - world's first DPR project in the 1960s (Lahnsteiner, et al., 2018; Sanchez-Flores, et al., 2016)

- El Paso, TX:
  - EPWater's advanced water purification facility proposal approved by Texas Commission on Environmental Quality
  - U.S. Bureau of Reclamation $3.5 million grant to cover 25% of the costs for design and pilot testing EPWater providing the remaining 75%.
  - 30% of the design was completed as of 2019 (Brown, 2019)



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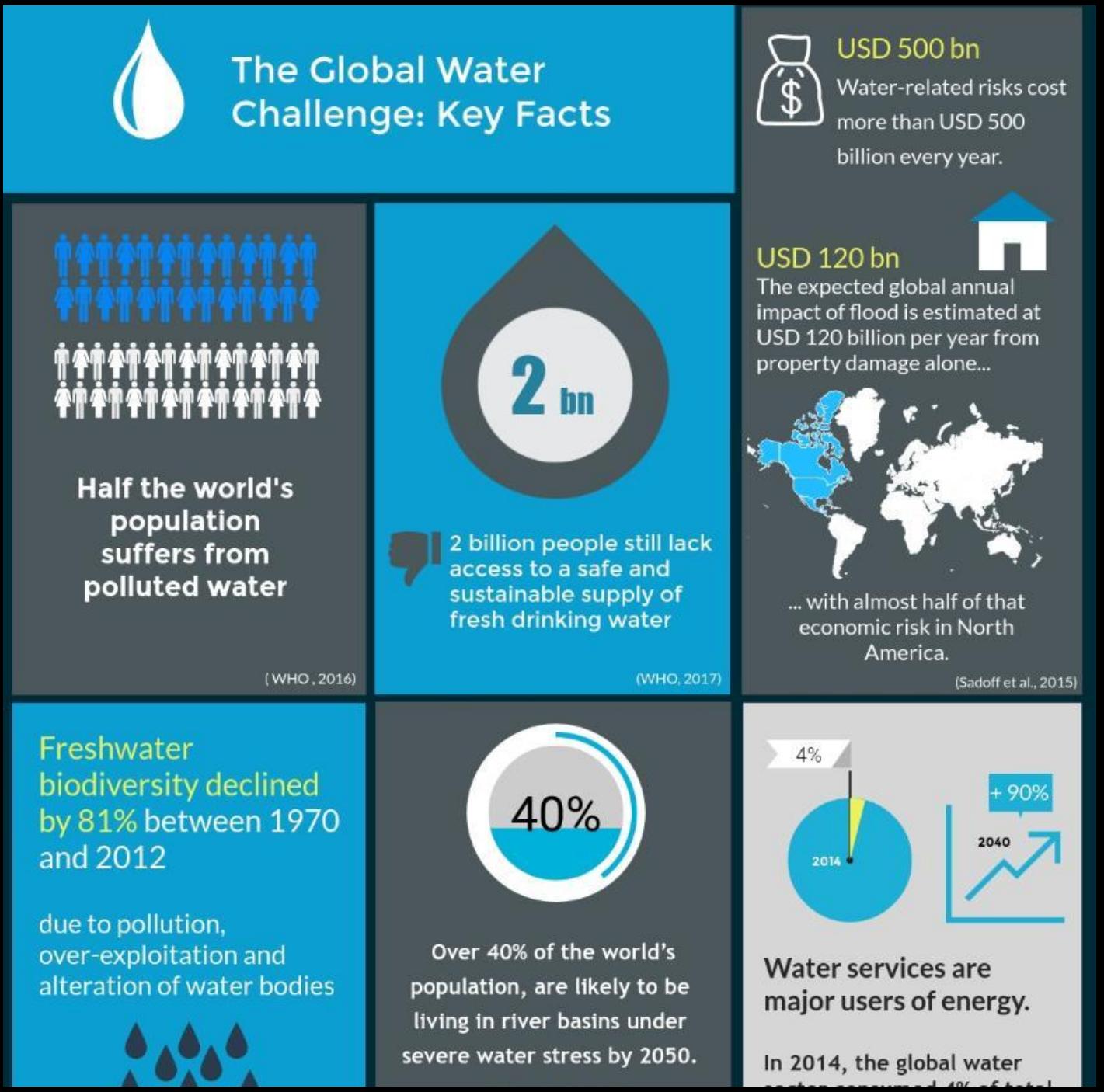


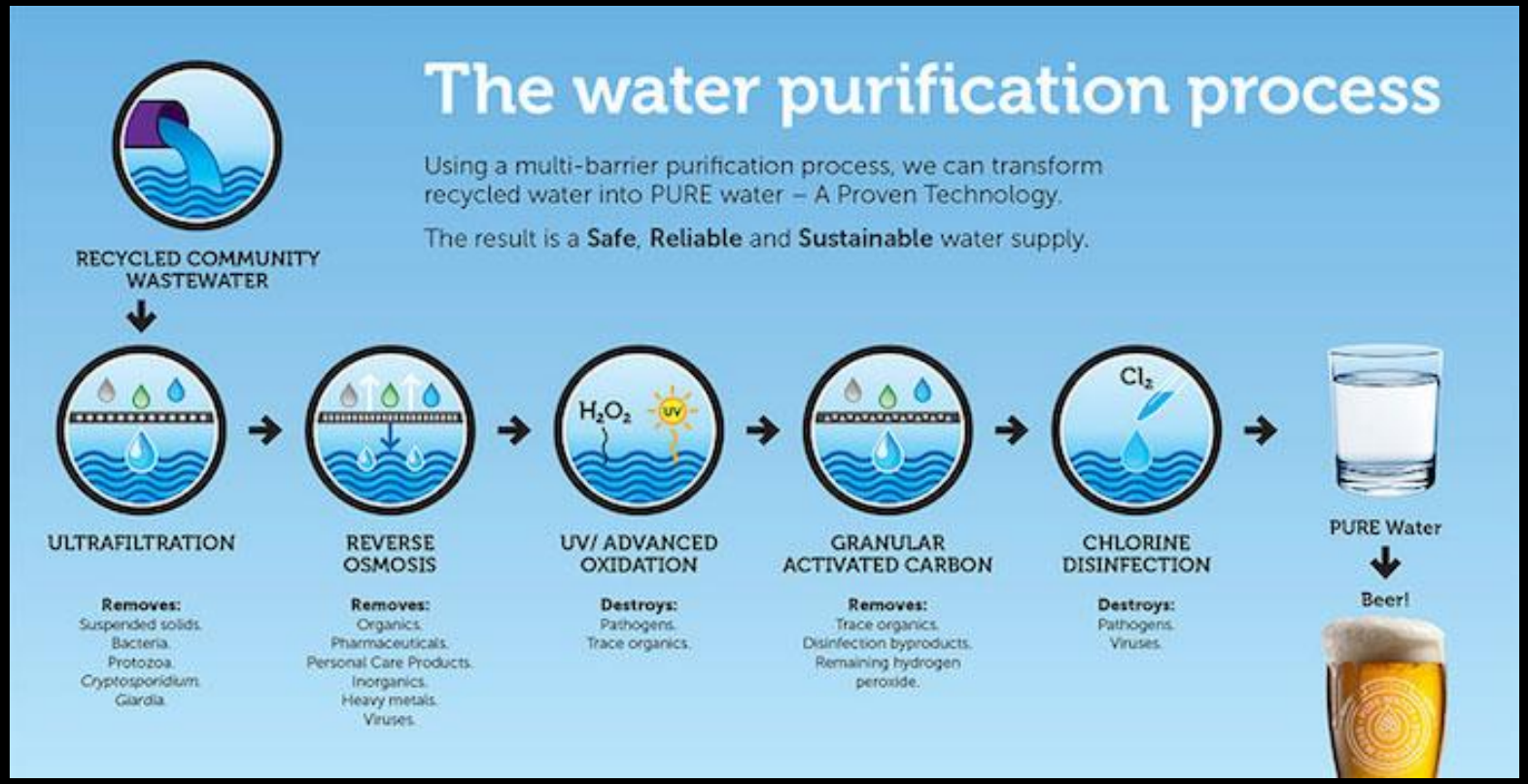
DPR challenges and opportunities

Water managers and experts face three types of challenges and opportunities:

- Technological
- Regulatory
- Public outreach

Image source: OECD Water, https://www.oecd.org/water/infographic-global-water-challenge-key-facts.htm

Technological challenges



- Protecting public health
- Treatment performance, reliability, maintenance, and management programs
- Multiple technical, operational, and management barriers
- Policies for blending DPR with other water sources.

Image source: Pima County, https://webcms.pima.gov/cms/One.aspx?portalId=169&pageId=372885

Regulatory challenges

- No federal regulations addressing reclaimed water use or potable reuse (Rock, 2016)
- States and local agencies are responsible for establishing potable reuse standards (Gerling, 2016), provided they meet SDWA and CWA standards (Environmental Protection Agency, 2022a)
- 2017, California State Water Board's Division of Drinking Water drafted a single criterion for DPR, recognizing multiple DPR scenarios (California State Water Resources Control Board, 2019)
- Texas Commission on Environmental Quality approves DPR projects on a case-by-case basis per Texas Administrative Code 30 TAC §290.42(g) (Mosher, J. & Vartanian, D., 2018)
- A few Colorado utilities have created DPR pilot projects, requesting the Colorado Department of Public Health & Environment develop DPR regulations -- DPR rule expected in 2023 as part of Regulation 11 of the Colorado Primary Drinking Water Regulations (Colorado Department of Public Health & Environment, 2022)
- The Florida Department of Environmental Protection drafting several rules addressing DPR, including Chapter 62-550 F.A.C. Coded Draft Rule May 2021, (Florida Department of Environmental Protection, 2022)

Public outreach challenges

- Communication and engagement with stakeholders and the public
- Establishment of outreach challenges, goals, and measures of success
- Creation of materials and support for effective DPR programs

Negative publicity can have long-lasting effects on public perception, but renewed education efforts can also change minds.

San Diego's 1998 IPR project was a failure, but in 2009, *Pure Water San Diego* hired a public information officer, explained to the public why alternative drinking water sources were necessary, demonstrated the water's purity, enlisted the support of professionals and the media to ensure that water messages were factual and clear (Environmental Protection Agency, 2019)

Phase 1 of the city's IPR Pure Water program began in August 2021. The project is intended to provide nearly 50% of the city's drinking water by 2035 and reduce the need for imported water

Image source: Times of San Diego, https://timesofsandiego.com/tech/2020/08/07/san-diego-opens-bids-for-north-city-water-recycling-project-1000-green-jobs/

Big Spring, Texas DPR Success

Technological opportunities

- By 2013, 2.5 mgd of treated effluent diverted to an advanced water treatment facility
- Water blended with treated water from the system's three reservoirs, piped into the plant, treated to SDWA standards (Sanchez-Flores, et al., 2016)

Regulatory opportunities

- Colorado River Municipal Water District (CRMWD) and Texas Commission on Environmental Quality conducted extensive operation, monitoring, reporting (Tchobanoglous, et al., 2011)

Public outreach opportunities

- 2005 to 2007 CRMWD explained DPR in public town-hall meetings
- Media assistance from the *Big Spring Herald*, accurately portraying project and
- Texans' appreciation of the importance of water, nearly eliminated public opposition

Long-term drought and low reservoirs resulted in the construction, which began in 2010, of the advanced wastewater treatment facility

Image source: Hazen and Sawyer, https://www.hazenandsawyer.com/work/projects/big-spring-raw-water-production-facility-third-party-process-review/

What about Tucson and Pima County?

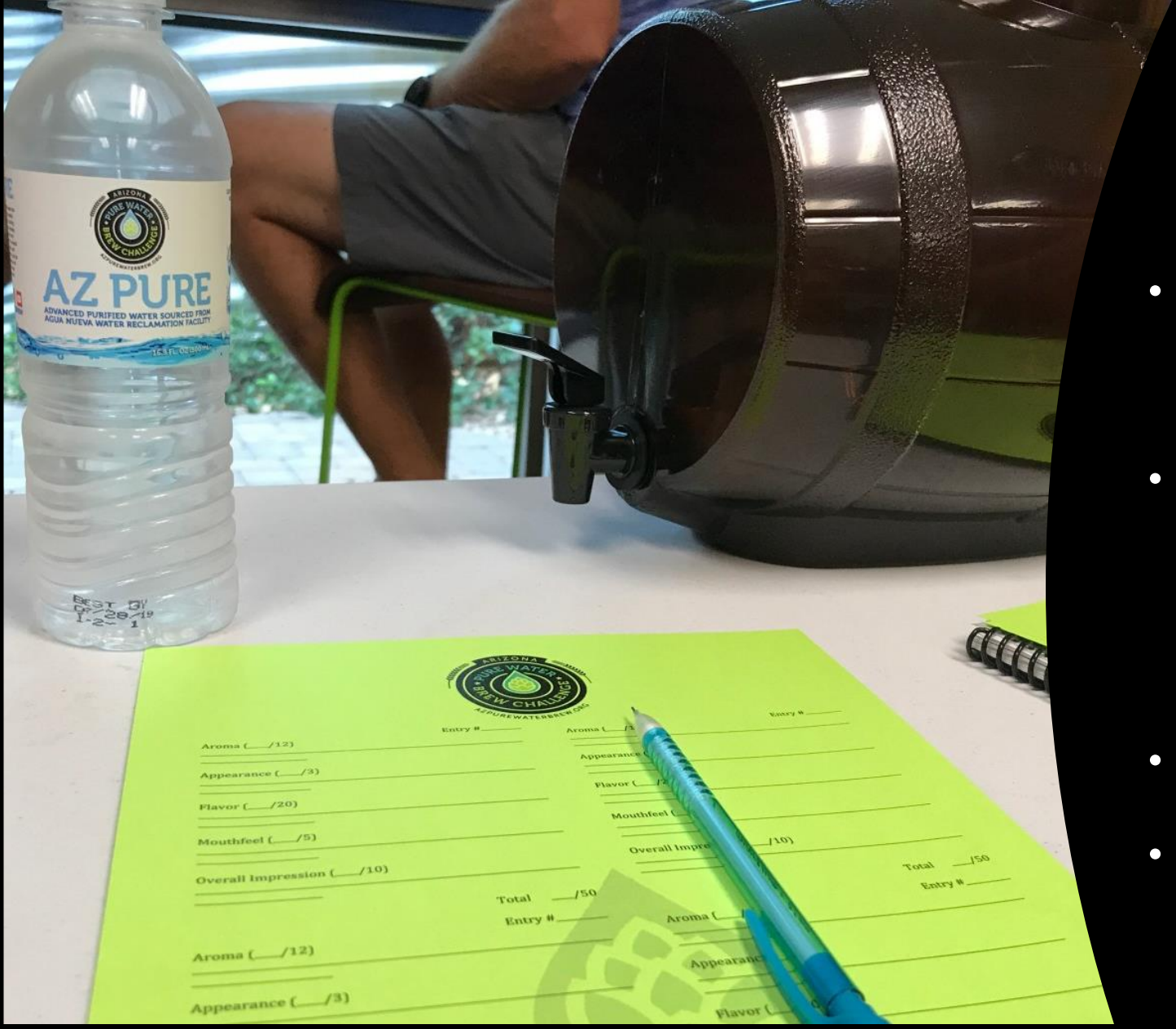
"Tucson Water is doing the legwork to ensure that the rules and guidance are there to ensure safety, quality, effectiveness, and efficiency are all part of the process"
John Kmiec, Interim Director, Tucson Water (2022)

Large cities have adequate water supplies, but smaller towns, like Williams are considering DPR.
Troy Walker, Water Reuse Practice Leader, Hazen & Sawyer, Tempe (2022)

- The U.S. Census Bureau estimated that by 2030, the U.S. population will reach 360 million people, with more than 8.5 million residents projected to live in Arizona (Hummer & Eden, 2016)
- Between 2010 and 2020, Pima County's population increased by 63,170 residents to more than 1.04 million residents (United States Census, 2022). Maintaining the same growth, by 2030, there will be more than 1.1 million residents
- Between 2010 and 2020, the largest western population gain was Maricopa County, which increased by 397,031 residents (Thompson, 2020)

"If you subscribe to the one-water concept of reusing water over and over, it's not that big of a leap to purify the water to the highest extent possible and it keeps water locally. It's always going to be the least expensive alternative source of water" Jeff Prevatt, Deputy Director, Treatment Division, Pima County Regional Wastewater Reclamation Department (2022)

Let them drink beer



- In 2016, Arizona Pure Water Brew Challenge won the Arizona Community Foundation $250,000 Water Innovation Challenge
- The challenge's purpose was to "advance the sustainability of Arizona's water future and engage all Arizonans in safeguarding water as a precious resource" (WaterNow Alliance, 2017)
- 23 proposals were submitted
- Goals were to engage the public in discussions about water reuse and build acceptance of DPR as a drinking water source (WaterNow Alliance, 2017)

Image source: AZ Food & Beer, https://azfoodandbeer.com/weekly-picks/pure-water-brew-challenge/

Let them drink beer

Technological opportunities

- Team comprised of personnel from of Pima County RWRD, Marana Water, Tucson Water, U of A, CH2M, Carollo Engineers, HDR, WateReuse, AZ Water, and Clean Water Service (Arizona Community Foundation, 2018)
- Built mobile advanced wastewater treatment facility in an old shipping container (Sheehy, 2018), traveling around Arizona and providing breweries with purified wastewater, labeled as AZ PURE
- Treatment train included an ultrafiltration membrane, RO membranes, UV disinfection, advanced oxidation, granulated carbon columns, and a chlorine contact chamber (Arizona Community Foundation, 2018)
- 26 breweries use the purified water for September 2017 beer competition, receiving between 300 and 1,000 gallons of AZ PURE (WaterNow Alliance, 2017; Arizona Community Foundation, 2018)
- Challenge won by Tucson's Dragon Brewery (Sheehy, 2018)

Let them drink beer

Image source: Pima County, https://webcms.pima.gov/cms/One.aspx?portalId=169&pageId=445691

Regulatory opportunities

- On January 1, 2018, the Arizona Administrative Code preventing water providers from using recycled water for DPR was repealed (Graf, 2022), and replaced by Part E. Purified Water for Potable Use R1809-E701 Recycled Water Individual Permit for an Advanced Reclaimed Water Treatment Facility (State of Arizona, 2019a)
- The new regulation specified that an advanced water treatment facility could submit an application for a recycled water permit to ADEQ that included information on how the facility would meet the SDWA
- Other application requirements include professional engineer certification, water source flow data, chemical and microbial maximum contaminant levels, treatment monitoring, laboratory analysis methods, pilot water treatment results, operation and maintenance plans, contingencies for the relocation of non-compliant water; operator training plans; and technical, financial, management capability (State of Arizona, 2019)

Let them drink beer

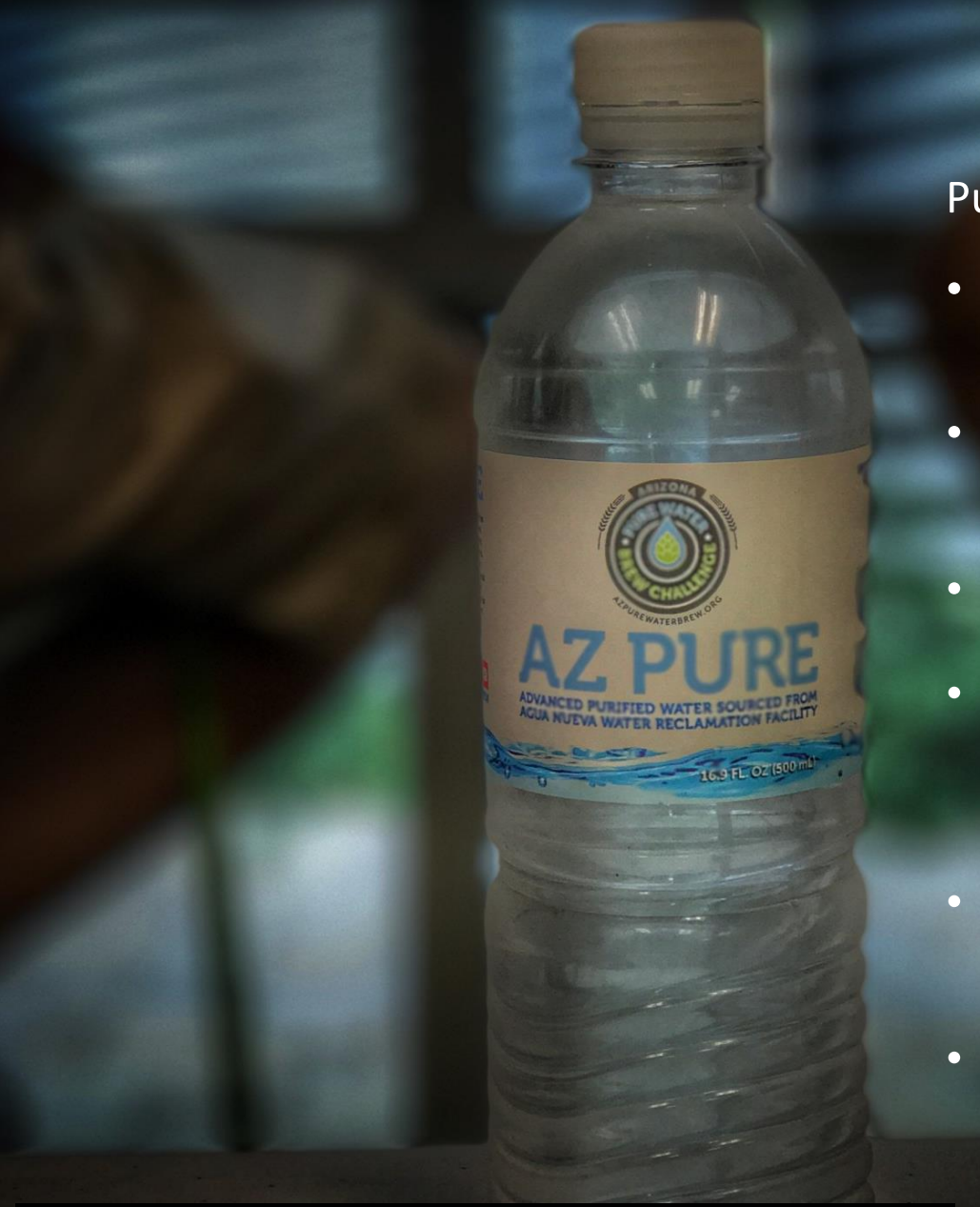


Image source: AZ Food & Beer, https://azfoodandbeer.com/weekly-picks/pure-water-brew-challenge/

Public outreach opportunities

- Team attended state-wide events, gave tours of the mobile facility and provided visitors with a bottle of purified water
- In 2017, truck traveled more than 5,000 miles, treating more than 82,000 gallons of municipally treated wastewater
- Surveyed and collected more than 2000 responses about DPR
- Reminded the public that “all water is recycled” and “judge water by its quality, not its history,” while avoiding terms including “effluent” and “recycled wastewater”
- Used social media, and drafted family, friends, colleagues, and water experts to volunteer (WaterNow Alliance, 2017)
- 58 stories about the beer challenge reaching 1.6 million Arizonans and 1.3 million Twitter users
- As a result, the AZ PWBC received $1.5 million in in-kind equipment and consultation service donations (WaterNow Alliance, 2017)

What would you do?

- You are the director of a public water utility in Small Stream, Arizona. After a study you discover that in a few years you will have insufficient groundwater, well water, or other water sources needed to sustain your growing population due to climate change and drought.
- It is too expensive to truck in or pump water from Metropolis, Arizona, but your town has a wastewater treatment plant, so you are considering DPR.
- How do you deal with the three challenges? Which is the most difficult?

Image source: Silvia Jansen, Getty images, https://www.verywellfamily.com/water-to-soothe-childs-anxiety-4098581

Questions?

Toowoomba Australia 2006 IPR Failure

Technological challenges

- Toowoomba, eastern Australia, home to about 95,000 people (Walker, 2022)
- Relied on surface water from dams, experiencing a major water crisis
- Minimal water use restrictions began in 2003, reaching a much higher level in 2006
- Restrictions were still in effect in 2010 (Hurlimann & Dolnicar, 2010)

Regulatory challenges

- In Australia, use of recycled water for drinking purposes is subject to many national guidelines (Hurlimann & Dolnicar, 2010)
- City Council announced the *Water Futures Initiative*, submitted an IPR proposal to the National Water Commission

Toowoomba, Australia

Image source:Wikipedia Toowoomba, Australia, https://en.wikipedia.org/wiki/City_of_Toowoomba#/media/File:Toowoomba.jpg

Toowoomba Australia 2006 IPR Failure

Public outreach challenges

- At a club meeting, the mayor told attendees that “they would soon be drinking sewer water” (Scruggs, et al., 2019)
- February 2006, Citizens Against Drinking Sewage, formed by wealthy influencers, led citizens to believe that water reuse was dangerous, obtained 10,000 signatures on a petition against IPR (Hurlimann & Dolnicar, 2010; Scruggs, et al., 2019)
- Council began a 10-week public relations campaign, too little, too late
- IPR rejected in a July 2006 referendum, by 62% of Toowoomba citizens
- Complicit was the *Courier-Mail* newspaper, claiming that IPR included pesticides and heavy metals, complained about the expense and accused officials of a cover-up

Outcome

- Need for a new water source remained
- In 2008, a pipeline connecting Toowoomba’s Lake Cressbrook with Brisbane’s Wivenhoe Dam was completed, at a cost higher than the proposed IPR project (Tortajada & Nambiar, 2019)
- Toowoomba received its first water from the pipeline in 2019 (TripleMMM, 2019)
- Toowoomba’s *Regional Council Water Vision 2050 Annual Report: Direct Potable Reuse*, published in 2020, states that community acceptance of DPR is very low (Engeny Water Management, 2020), likely due to the negative publicity of IPR years earlier