



## Final Report

January 8, 2018



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# EXECUTIVE SUMMARY

As the dust begins to settle on the 2016 *New Arizona Prize: Water Innovation Challenge*, clearly the real winners are the residents of Arizona and their communities. This ambitious project generated a whirlwind of activity beginning with the design and construction of a fully operational *mobile* advanced water purification facility, comprehensive water quality testing requiring five laboratories to validate the process, issuance of Arizona's first potable reuse permit rescinding a multi-decade statewide prohibition against potable reuse, and finally followed by five months of face to face interaction and constructive dialog with citizens throughout the state about water management and expanded water reuse. But the excitement was just getting started. The project



*Figure 1. AZ PURE Water Brew Challenge advanced water purification facility in route to an outreach event.*

launched with a huge splash at the annual AZ Water Conference in May and continued to gather tsunami like momentum throughout the summer as we toured the various cities and towns reaching tens of thousands of Arizonans with our message. In addition to the numerous news articles detailing the project, citizens throughout Arizona were provided a hands-on demonstration of advanced water technologies providing a first-hand opportunity to see, touch and taste the product for themselves. The public outreach wave culminated at the September, National WaterReuse Symposium where the advanced treatment facility was on display along with multiple project presentations and a very well received reception.

Twenty six cutting edge Arizona brewers embraced the concept and joined the effort making high purity craft beer for entry into the AZ PURE Water Brew Challenge competing for substantial prizes donated by the HACH Corporation. The rapidly advancing craft beer purveyors proved not only to be excellent spokespersons for the project, but savvy water stewards in their own right. Inclusion of the brewers, and the crafting of beer made from recycled water may seem whimsical at first, but it overwhelmingly helped to peak people's interest in the project and provided a tremendous opportunity to reach a much larger audience while continually educating people about water quality and water issues while simultaneously stressing the fact that all water is recycled.

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*"The challenge for us in Arizona is not the issue of water sustainability today, it's our water future."  
- Steve Seleznow, Arizona Community Foundation*

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In total, over 5,000 miles were logged on the mobile purification trailer while transforming over 82,000 gallons of municipally treated wastewater into high purity bottled water and craft beer. More than 3,000 analytical tests were conducted to ensure that every drop met the highest quality standards including screening for pathogens, metals, organics, as well as numerous unregulated compounds and pharmaceuticals to ensure optimal protection of public health.

The target message of the project has always been to get people thinking about water, where it comes from, and where the next sources may come from. We embraced public perception from the outset and worked tirelessly to challenge misconceptions and preconceived opinions regarding potable reuse with hard facts backed by scientific data. The AZ PURE Water Brew Challenge message proved overwhelmingly that AZ PURE Water is both pure, and safe and we thank everyone for joining the challenge!

# INTRODUCTION

The New Arizona Prize and its concept of *challenges* is a remarkably creative approach towards solving the needs of a community. It forces teams to collaborate and develop solutions for the problems of today and tomorrow. The end result is an arena of ideas in which innovation thrives, ingenuity is supported, and critical thinking is harnessed to create long-term solutions to persistent needs.

The 2015 *Water Consciousness Challenge* heightened attention around water and encouraged all Arizonans to become engaged in safeguarding this precious resource. To this end, the 2016 *Water Innovation Challenge* invited collaborative teams to develop innovative and scalable, market-based solutions to advance the sustainability of Arizona's water future, whether it be a town, city, county, tribal area, or an entire region. Along with this challenge came the allure of a \$250,000 cash prize to facilitate implementation of the solution.

The Southwest Water Campus was assembled with an expert panel of water professionals focused on introducing potable reuse as a viable source for addressing future water needs within Arizona while invoking public participation and dialog throughout the state in a format that is both educational and informative. Encouraged by the New Arizona Prize challenge concept, we too chose to incorporate a challenge to gain public participation in the project through the creation of the AZ PURE Water Brew Challenge. The following is an excerpt from the winning proposal submitted on behalf of the Pima County Southwest Water Campus.

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*With increasing demands placed on existing water supplies, potable reuse requires exploration. Our solution culminates the efforts of the Steering Committee on Arizona Potable Reuse (SCAPR) and ADEQ's current regulatory review by establishing a mobile, performance based reference facility that is desperately needed for addressing public perception and demonstrating the protection of public health. If potable reuse is done incorrectly, even just once, it could set back regulation and public confidence for years to come. Our solution will ensure that it is done right, every time.*

*Our bold entry will tackle these key issues by launching public discussions about water in every town, city, county, and tribal region throughout Arizona. Our refreshingly unique, educational approach will engage discussion and public acceptance by incorporating local bottlers and brewers through a Pure Water Brew Challenge competition to coincide with the national WaterReuse Symposium to be held in Phoenix.*

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Delivering clean and safe drinking water from what was once sewage is both bold and provocative. With every team member fully aware of the stakes, public perception and public safety was paramount. Not only were we changing public opinions, but we were also changing long held state law. The time for potable reuse has come, but we all recognized that if executed incorrectly, even just once, it would set back public confidence for decades.

Team Member	Organization	Primary Role
Jeff Prevatt	Pima County RWRD	Project manager
Barbara Escobar	Pima County RWRD	Water quality & analytics
John Kmiec	Marana Water	Water quality & brewer Coordination
Tim Thomure	Tucson Water	Site logistics & water production
Channah Rock	University of Arizona	Public outreach
Charles Gerba	University of Arizona	Pathogen validation
Ian Pepper	University of Arizona	Pathogen validation
Shane Snyder	University of Arizona	CEC validation
Jim Lozier	CH2M	UF & RO system design
Michael Hwang	CH2M	UF & RO system design
George Massey	Carollo Engineers	Disinfection system design
Corrin Marron	Carollo Engineers	Disinfection system design
Lisa Freestone	Carollo Engineers	Public outreach
Alan Forrest	HDR	Public outreach
Guy Carpenter	AguaTecture	Public outreach & messaging
Lisa Culbert	WaterReuse and AZ Water	Event planning logistics
Mark Jockers	Clean Water Service	Public outreach & messaging

The Southwest Water Campus members are a comprehensive team of water experts representing multiple organizations throughout the state. To further compliment this world class team of experts and further expand our audience, we partnered with Arizona’s booming craft beer industry for assistance in delivering our water reuse message.

While the incorporation of beer into such an important topic may appear to make the project appear less serious, the real message is all about water, where it comes from, how it is managed, and how it can be used over and over again, *safely*. Brewery partners repeatedly demonstrated themselves to be excellent spokespersons and environmental stewards as well as expert conversationalists when speaking to patrons. Partnering with commercial brewers allowed access to a much broader audience of Arizonans that water professionals would normally have little, if any, substantive interactions with. Media coverage of the project focused on this beer making curiosity aspect of the project which turned out to be a key ingredient for peaking public interest.

The project is intriguing from both a technical perspective as well as a public relations standpoint and quickly gained support from a variety of contributors realizing the potential marketing exposure from a project of this magnitude.

Transportation logistics were greatly facilitated through the generosity of a chance encounter with Roger Penske. The Penske Corporation immediately embraced the project and sponsored our activities by providing the use of a tractor for the duration of the project with driving duties shared between Pima County RWRD and Tucson Water. Project contributors assembled to date include:

<b>Affiliation</b>	<b>Contribution to Project</b>	<b>Estimated Value</b>
<i>Arizona Community Foundation</i>	<i>New Arizona Prize funding source</i>	<i>\$252,500</i>
<i>Water Now Alliance</i>	<i>Event coordination and social media</i>	<i>\$50,000</i>
<i>Pima County RWRD</i>	<i>Project management, fabrication, validation testing, process operation, drivers and outreach</i>	<i>\$120,000</i>
<i>Tucson Water</i>	<i>Validation testing and analysis, process operation, drivers and tanker</i>	<i>\$50,000</i>
<i>Town of Marana</i>	<i>Public outreach, brewer coordination</i>	<i>\$10,000</i>
<i>University of Arizona WEST Center</i>	<i>Performance test validation, public outreach and education</i>	<i>\$25,000</i>
<i>Carollo Engineers</i>	<i>PURE Water process design</i>	<i>\$70,000</i>
<i>Dow Chemical</i>	<i>Equipment contribution – RO membranes and microfiltration</i>	<i>\$10,000</i>
<i>Calgon Carbon</i>	<i>Equipment contribution – granular activated carbon</i>	<i>\$2,000</i>
<i>Trojan UV</i>	<i>Equipment contribution – UV disinfection</i>	<i>\$7,000</i>
<i>Grundfos</i>	<i>Equipment contribution – Pumps and metering equipment</i>	<i>\$20,000</i>
<i>Xylem</i>	<i>Outreach materials</i>	<i>\$1,000</i>
<i>HDR</i>	<i>Outreach activities and sponsorship</i>	<i>\$12,000</i>
<i>HACH</i>	<i>Equipment contribution – In-line process control and competition prizes</i>	<i>\$20,000</i>
<i>CH2M</i>	<i>PURE Water design and process monitoring</i>	<i>\$70,000</i>
<i>Penske Leasing</i>	<i>Tractor donation for duration of project</i>	<i>\$21,000</i>
<i>Sensorex</i>	<i>Analytical equipment</i>	<i>\$14,000</i>
<i>GE Water Process Solutions</i>	<i>Analytical equipment</i>	<i>\$6,000</i>
<i>University of Arizona Cooperative Extension</i>	<i>Public outreach and education</i>	<i>\$15,000</i>
<i>City of Phoenix</i>	<i>Validation testing and analysis, tankers and delivery</i>	<i>\$19,000</i>
<i>City of Flagstaff</i>	<i>Validation testing and analysis, deliveries</i>	<i>\$3,000</i>
<i>AZ Water</i>	<i>Education and public outreach</i>	<i>NA</i>
<i>AZ Water Reuse</i>	<i>Education and public outreach</i>	<i>\$10,000</i>
<i>Pima County Communications</i>	<i>Public outreach</i>	<i>\$5,000</i>
	<b>Total:</b>	<b>\$812,500</b>

# DESIGN OF THE TREATMENT PROCESS

The first hurdle was the design of the treatment process with these efforts undertaken by the engineering consulting firms of CH2M and Carollo. A multi-barrier treatment approach was chosen as this process has repeatedly been demonstrated to produce the highest purity water with ample redundancy assurances for meeting the public health requirements for 12-log reduction for virus and protozoa.

As water providers will attest, it is difficult to guarantee 100% protection all of the time but the implementation of a multiple barrier approach has continually been demonstrated to be the most effective way to ensure potable water is kept clean, safe and reliable. The multiple barrier approach places engineered barriers at each step of the water purification process continually removing contaminants throughout treatment with critical control points at key process steps. It's an integrated system that prevents or reduces the contamination through controlled redundancy and critical control points reinforcing the performance in order to reduce risks to public health.

Process equipment components were provided via various manufacturers with construction of the advanced water treatment facility performed by Pima County RWRD staff. Biological treatment processes were quickly eliminated from consideration due to the intended mobile operation of the vehicle where extended off-line periods required for transport would have a deleterious effect on biological health.

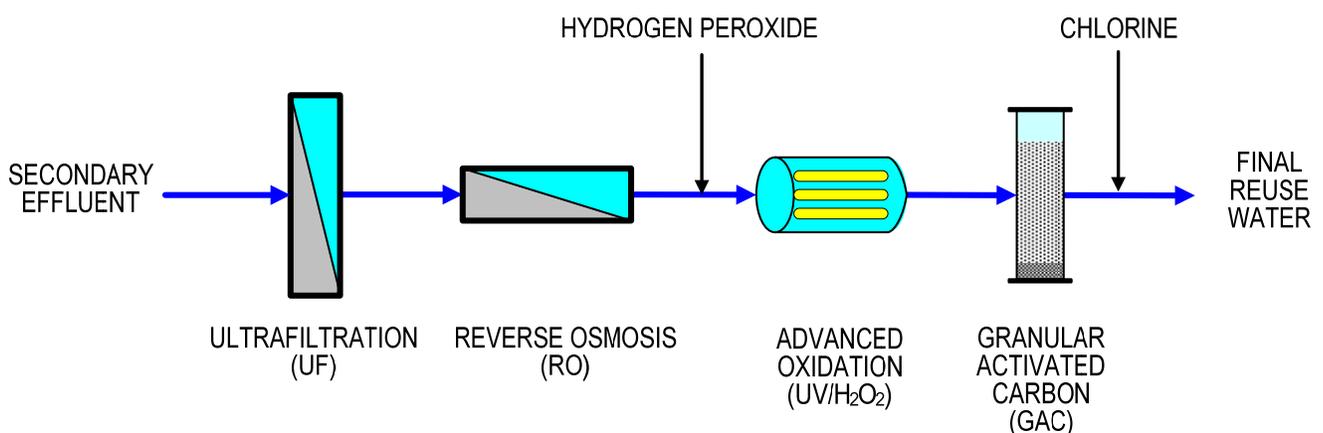


Figure 2. Purification process flow diagram for AZ PURE Water.

Purification process components were therefore chosen for both performance and robustness with the final configuration including the following treatment components:

- Ultrafiltration membrane – Quantity 1
- Reverse osmosis membranes – Quantity 6
- UV disinfection with advanced oxidation – Quantity 2
- Granulated activated carbon columns – Quantity 4
- Chlorination contact chamber – Quantity 1

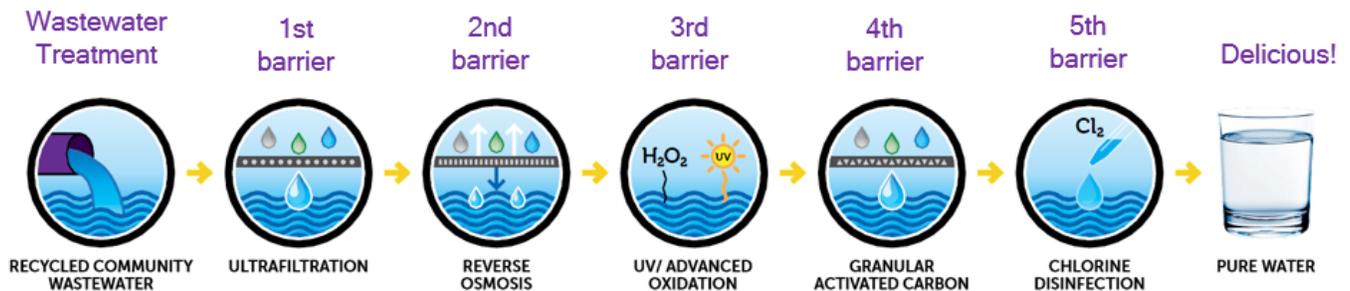


Figure 3. Graphic depiction of the multi-barrier purification steps used in the AZ PURE Water advanced purification facility.

Treatment process design was further complicated due to the fact that a vast majority of the treatment components were donated by the various manufactures rather than selected for optimization of throughput. As a result, the design required compromises for both flow and supply voltages to accommodate the mobile configuration. However, it should be pointed out that these compromises did provide a significant added benefit of clearly delineating each process component. This feature greatly facilitated tours and explanation of the multi-barrier process to our audiences.

The purification strategy for the mobile advanced water treatment process was designed to receive recycled municipal wastewater at 12 gallons per minute (gpm) and after treatment using ultrafiltration (UF), reverse osmosis (RO), ultraviolet light advanced oxidation process (UVAOP), granular activated carbon and chlorination, produce approximately 3 gpm of purified water for potable reuse. The deficit water used in the process was used for backwashing of the UF membrane and providing adequate cross flow through the RO membranes.

The objective of the UF system is to filter the chlorinated secondary effluent and provide removal of particulates and suspended solids, including pathogens. The UF system was fitted with a single UF membrane module (Dow model SFD-2860) consisting of hundreds of hollow fibers with a nominal pore size of 0.03 microns. The small pore size allows the UF membrane to remove

bacteria, *Giardia*, *Cryptosporidium* and some viruses. On an instantaneous basis, the UF system produces approximately 10 gpm of filtrate which is stored in a 150-gallon tank that feeds the downstream RO system and is used for backwashing the UF module on an intermittent basis to remove filtered solids.

The RO system further enhances UF filtrate quality by additionally removing dissolved constituents, including inorganic salts, bulk and trace organics (e.g. pharmaceuticals and personal care products) and to serve as a second barrier to pathogen (especially viruses). The RO membrane elements provide rejection of 99.4% of salts and are commonly used to desalinate brackish groundwater for drinking. Two GAC carbon block filters arranged in series were incorporated for dechlorinating the UF filtrate in order to protect the chlorine-sensitive RO membranes. An antiscalant was dosed to the RO feed water using a dosing pump to prevent precipitation of certain sparingly soluble salts on the membranes.

A high pressure pump pressurizes the pretreated UF filtrate prior to it passing through six spiral wound RO membrane elements (Dow model BW30-4040) operating in series in a single stage along with an antiscalant dosing pump to mitigate scaling of membranes, despite the sparingly soluble salts. The RO system treats a feed flow of 6.7 gpm operating at 55% recovery to produce 3.7 gpm of RO permeate collected in a 60-gallon tank supplying the downstream UVAOP system and 4.0 gpm of waste concentrate.

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*“It’s a fascinating approach to water treatment. I had experience in reverse osmosis treatment, ultra-filtration and advanced oxidation/ultraviolet treatment. But never before had I experienced these methods together in a multi-barrier process. It was impressive to say the least and I’m privileged to have been a part of it.”*

*-Robert Hackethal, Tucson Water Operator*

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The UVAOP system utilizes ultra-violet light in conjunction with hydrogen peroxide for both disinfection and removal of trace pollutants. The UVAOP system was sized to treat 3 gpm of RO permeate and comprises a hydrogen peroxide dosing point and two enclosed UV reactors in series. While UV light and hydrogen peroxide are both strong oxidizers commonly utilized in disinfection, the combination of these two process greatly enhances efficiency through the formation of extremely reactive hydroxyl radicals that destroy the DNA of any remaining viruses, protozoa or bacteria in the RO permeate. In addition, hydroxyl radicals are extremely beneficial for breaking carbon to carbon double bonds thereby providing photolysis/oxidation of trace organics, namely N-Nitrosodimethylamine (NDMA) and 1,4-dioxane, which are carcinogenic and important to remove.

Granulated activated carbon not only provides quenching of the residual peroxide used in the UVAOP process, but also provides some adsorption of any soluble organic compounds that may

present. This is accomplished through the use of four, 6' columns operating in two parallel trains. Each column is loaded with a bituminous coal based activated carbon which is adequate to treat a total flow of 3 gpm.

Finally, a 4" diameter serpentine chlorine contact chamber 18' in length was incorporated to provide a final disinfection step prior to distribution of the advanced purified water. Following GAC effluent, a solution of sodium hypochlorite was dosed with sufficient contact time to achieve a minimum of four-log virus inactivation while providing a minimum 1 mg/L chlorine residual in the purified water.



*Figure 4. A glimpse behind the doors of the AZ PURE Water advanced purification facility process as experienced by the multiple guests in attendance at outreach events. Guided tours enabled attendees to see and touch the various components first hand for greater understanding and acceptance.*

The final configuration performed flawlessly producing extremely high purity water. The overall layout along the rear wall proved highly beneficial for public tours, aesthetics and ease of operation with the side opening doors providing an excellent opportunity for maximum viewing and facilitating equipment installation.

# ANALYTICAL FRAMEWORK & VALIDATION

Analytical validation of the water purification process was an extremely critical component for demonstrating public health and safety of the finished product, both essential to the permitting requirements established by ADEQ as well as the reputations of the team members and their respective organizations. Due to the vast number of analytes requiring analysis and the need for rapid results, water quality testing was distributed between the laboratories of Pima County, Tucson Water, University of Arizona, City of Phoenix and partnering municipalities and contract laboratories of Eurofins and Test America, as necessary.

The AZ PURE Water treatment process repeatedly underwent extensive testing and validation demonstrating that potable reuse is both a safe and viable product for augmenting water supplies. To demonstrate the scalability and reproducibility of the PURE Water process, initial performance validation was conducted at the Agua Nueva WRF in Tucson, Rio de Flag WRF in Flagstaff, and City of Phoenix's 23<sup>rd</sup> Avenue facility. Water quality was continuously monitored at each production location and for every water production event.

Extensive laboratory analysis are conducted to document water quality for both conventional pollutants and chemical pollutants of emerging concern, or CECs. While current drinking water standards requires analyses for 77 conventional pollutants, water generated through the PURE Water treatment process underwent analyses for over 238 pollutants, including CECs and MS2 phage testing for documenting virus and pathogen removal. The goal is a validated treatment process capable of producing certifiable water quality performance irrespective of the source water.

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*“The treated water was tested for enteric viral and protozoan parasites by the most advanced methods possible to ensure the complete absence of pathogens.”*  
- Dr. Chuck Gerba, University of Arizona

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Despite a statewide prohibition on potable reuse in Arizona, the Arizona Department of Environmental Quality embraced the project early and facilitated permitting of the PURE Water Demonstration Facility. On June 9, 2017, ADEQ awarded Pima County the first reclaimed water permit in the state authorizing potable reuse, a major milestone in Arizona regulation. Beginning in July, PURE Water produced from the Agua Nueva WRF in Tucson was shipped to White Water

bottling in Phoenix for the bottling of souvenir bottled water for public tasting. This water was privately labeled and distributed at outreach events to promote potable reuse.



*Figure 5. AZ PURE Water bottles distributed were distributed to enthusiastic consumers with an overwhelming majority stating that they preferred AZ PURE Water over commercially available bottled water.*

Because this is Arizona’s first Individual Reclaimed Water Permit allowing direct potable reuse utilizing a multi-barrier purification system, it was extremely important to validate the process prior to water production and distribution. This required extensive monitoring of treated water for numerous parameters to demonstrate that every drop was pure, and safe to drink. Analyses included viruses, protozoa, total coliform, *E. coli*, inorganic parameters, metals, volatile organic compounds, and synthetic organic compounds in accordance with the 77 regulated pollutants listed in EPA’s Safe Drinking Water Standards (Table VI-1). In addition, we chose to analyze for a more extensive list of unregulated pollutants including pharmaceuticals. Over 211 analytes were included in the initial validation at each of the three facilities, Agua Nueva WRF, Phoenix 23<sup>rd</sup> Ave

WRF and Rio de Flag WRP. In total, 288 water quality analytes for each of the three source water locations were submitted in the permit application to ADEQ thereby demonstrating the high purity of the water generated.

One of the primary concerns when using reclaimed water for potable purposes is adequate elimination of viruses and pathogens. California and Texas have established criteria requiring 12-log reduction for viruses and 10-log reduction for bacteria and protozoa. During the initial validation test for the AZ PURE Water facility, an MS2 bacteriophage evaluation was performed by the University of Arizona's Water & Energy Sustainable Technologies Center showing that MS2 challenge test easily achieved an 18-log removal of viruses proving the effectiveness of the multi-barrier treatment processes consisting of ultra-filtration (UF), reverse osmosis (RO) and ultra-violet radiation- advanced oxidation (UV-AOP).

As part of the Southwest Water Campus team, Pima County RWRD Compliance & Regulatory Affairs (CRAO) laboratory and the Tucson Water Quality Laboratory took the lead in coordinating the sampling and analysis during the various validation and production dates. Since the CRAO lab is predominantly licensed for wastewater analyses, it required additional licensure from the Arizona Department of Health Services for certification for the analyses of metals and various other inorganic parameters in drinking water matrix.

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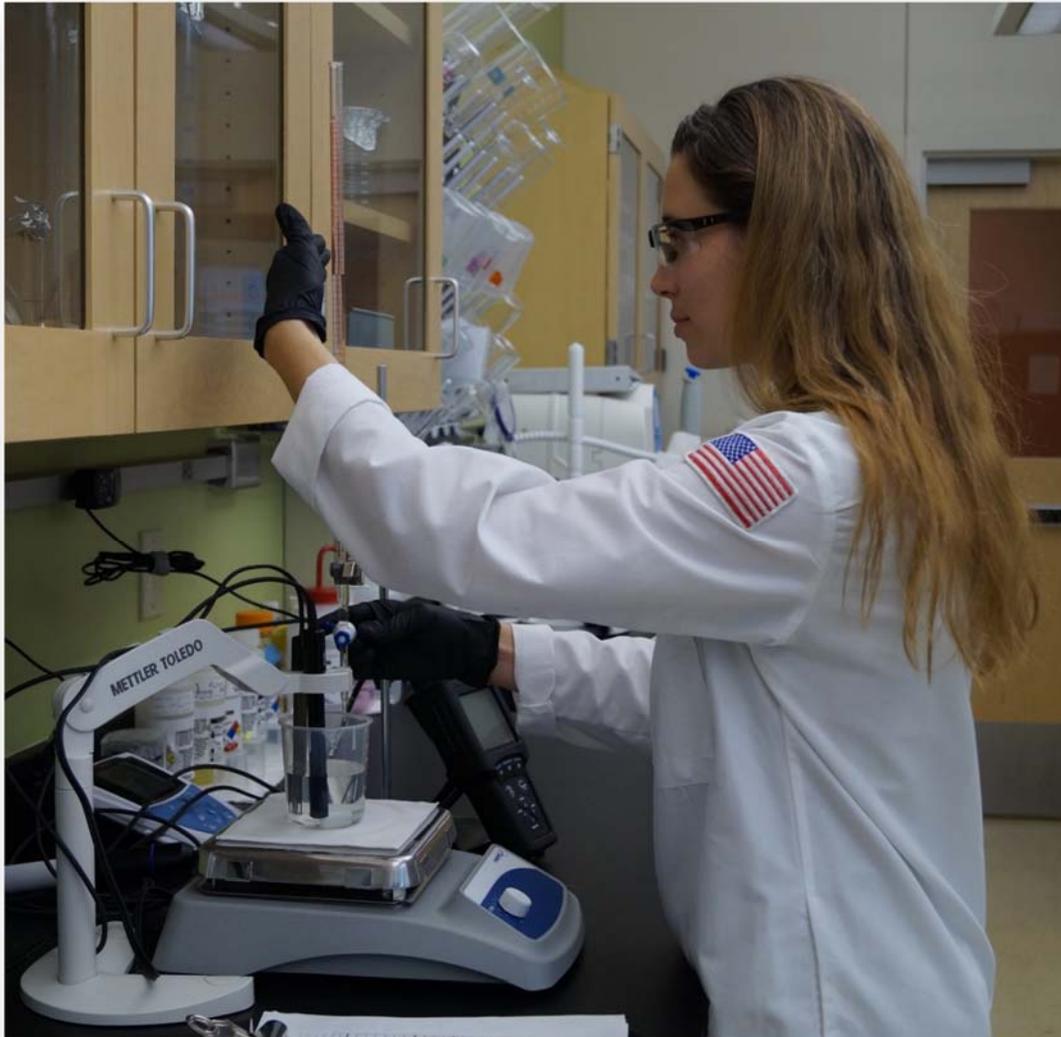
*"It's scientifically proven that purified water is clean, and safe. I confidently drink AZ PURE Water, and share it with my friends and family. The beer however, I keep to myself."*  
*-Barbara Escobar, Pima County Manager*

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The Tucson Water Quality Laboratory performed the volatile organic analyses and inorganic parameters. All remaining organic and radiochemical compounds were contracted to Eaton Eurofins Analytical, and radiochemical analyses were performed by Radiation Safety and Engineering. During the City of Phoenix 23<sup>rd</sup> Ave. facility validation, Eaton Eurofins was the primary contracted analytical laboratory for the specialized organic analyses. Contaminants of emerging concern were performed by the University of Arizona's WEST Center, Chemical Engineering Laboratory.

Scheduling water production and validation testing was challenging due to delays in construction completion for the advanced treatment facility. Being able to expedite analyses was critical for meeting the schedule for outreach events, water bottling and beer production. Each location schedule analysts that could record and perform the field tests during unit operation including hydrogen peroxide, pH, temperature, conductivity, turbidity, total organic carbon, free and total chlorine. These analyses were to be performed throughout the duration of the production time frame at each facility.

The total count for all field analyses, validation testing, and permit required testing at each of the three locations was extensive. Over 3,000 data points were collected from the advanced water purification facility between June 21, 2017 and August 4, 2017. This exhaustive analytical protocol ensured that all AZ PURE Water produced was certified and validation tested for consumer safety thereby achieving the objectives of the project and the goals of the Southwest Water Campus Team members.



*Figure 6. Extensive laboratory analyses were conducted, over 3,000 in total, to demonstrate the effectiveness of the advanced purification system and ensure that every gallon was safe and pure.*

# OUTREACH, MESSAGING & MEDIA COVERAGE

The public outreach component was by far be the most challenging, and exciting, portion of the project. To address the “yuck-factor” usually associated with potable reuse, we engaged the Arizona Brewer’s Guild for assistance in delivering our message with the hope that people would be curious enough to want to learn more, try beer brewed with our water, and more importantly, try our PURE Water. To achieve this goal we created the AZ PURE Water Brew Challenge, a community oriented competitive challenge designed to get people talking about water quality, water availability and water sustainability issues simultaneously on a statewide basis. The project was launched in April of 2017 to coincide with a screening of the documentary film *Groundwater: To Enact a Law for the Common Good* which stressed the importance of water planning in Arizona’s past and future.

Sixteen outreach events were held to promote the project with overwhelming support at every venue.

## Team Events

May 3 <sup>rd</sup> – 5 <sup>th</sup>	AZ Water Conference	Phoenix
Jun 10 <sup>th</sup>	Made in the Shade Festival	Flagstaff
Jun 24 <sup>th</sup> -25 <sup>th</sup>	AZ Get Outdoors Expo!	Flagstaff
Jul 1 <sup>st</sup>	Frontier Days Parade	Prescott
Jul 4 <sup>th</sup>	Kino Diamond in the Sky Celebration	Tucson
Jul 15 <sup>th</sup> -16 <sup>th</sup>	AZ Get Outdoors Expo!	Scottsdale
Jul 23 <sup>rd</sup> -27 <sup>th</sup>	International Waste Association Conference	Long Beach
Jul 28 <sup>th</sup>	AZ Brewcon	Phoenix
Jul 29 <sup>th</sup>	Real Wild & Woody Beer Festival	Phoenix
Aug 18 <sup>th</sup>	Beat the Heat Block Party	Yuma
Sep 10 <sup>th</sup> -13 <sup>th</sup>	National WateReuse Symposium	Phoenix
Oct 13 <sup>th</sup>	CH2M Reuse Fest	Denver
Oct 21 <sup>st</sup>	Bisbee 1,000 Stair Climb Festival	Bisbee
Oct 25 <sup>th</sup> – 26 <sup>th</sup>	Construction Career Days	Tucson
Oct 29 <sup>th</sup>	Cyclovia Tucson	Tucson
Dec 16 <sup>th</sup>	Parade of Lights	Tucson

News coverage of the project has been amazingly positive with numerous instances of print and media segments both in Arizona and nationally. In addition to traditional news outlets, a social media presence was established on Facebook, Instagram and Twitter for improving public access. A project website was created at [www.azpurewaterbrew.org](http://www.azpurewaterbrew.org) to provide a schedule of events for the project, answers to frequently asked questions, project background, and brewer registration for the PURE Water Brew Challenge.

Arizona State University's Decision Center for Desert Cities (DCDC) was retained to perform a longitudinal media survey, or LMS, of project coverage and end user experiences. The goal of the LMS was to accurately capture public perceptions and assess the effectiveness of our messaging and content to determine if we are able to shift the needle of public opinion regarding potable reuse. The LMS was intended to measure whether the AZ Pure Water Brew Challenge was able to improve public perception about water reuse through high level analysis of mainstream and social media coverage of the project.

Metrics tracked by the LMS included news media coverage, social media coverage, on-line polling and first person surveys regarding public perception and acceptance of our PURE Water message and ultimately public acceptance, or rejection, of potable reuse. DCDC provided monthly polling data tracking the overall effectiveness of our public outreach efforts.

DCDC monitored 20 mainstream print and television sources and Twitter using an initial set of keywords to identify items directly about the AZ PWBC and other items relevant to topics related to the project. Social media posts and reactions to the posts on the AZ PWBC Facebook page. The information provided in this report summarized media coverage from May through November. The LMS will continue through December as the Pure Brew team anticipates additional coverage through the end of the year.

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*“The AZ PURE Water Brew Challenge ignited a national conversation about water sustainability...perhaps the most unique, engaging and effective outreach project I have ever seen.”*  
- Mark Jockers, Clean Water Services

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Mainstream media coverage of the AZ PURE Water Brew Challenge has been remarkable to say the least. We have enjoyed significant coverage with numerous newscasts, radio interviews and web-based sources highlighting the project and no less than thirteen separate newspaper articles highlighting the project with a circulation of 1.6 million readers in Arizona. Not only did coverage of the project have significant audiences in Arizona but also experienced expansive coverage nationwide.

This widespread media coverage resulted in inquiries from the Federal Emergency Management Agency (FEMA) in the wake of Hurricane Harvey which caused widespread flooding of the Houston metropolitan area and causing an estimated \$200 billion in damages. Municipal water supplies

and sanitation were compromised and getting safe, and clean water to the affected citizens were problematic. FEMA representatives had seen coverage of our mobile advanced water treatment facility and the applicability and availability for deployment to the Houston area.

Team member CH2M sponsored event extended our outreach efforts to Denver, Colorado for the 2017 ReuseFest where media coverage was outstanding resulting in an additional 187 project mentions in both print, news coverage, and on-line journal exposure to an estimated audience reach of over 77 million people.

In addition to local news media coverage, feature segments touting the project were printed in Phoenix Magazine and Civil Engineering Magazine with combined monthly readerships of over 465,000. Likewise, team member Channah Rock spent a day with *Bill Nye the Science Guy* for a feature segment on *Bill Nye Saves the World* with an estimated viewership of which will assuredly increase project exposure nationally.



*Figure 7. Channah Rock and Bill Nye discussing water reuse for promoting water resiliency for a segment of Bill Nye Saves the World.*

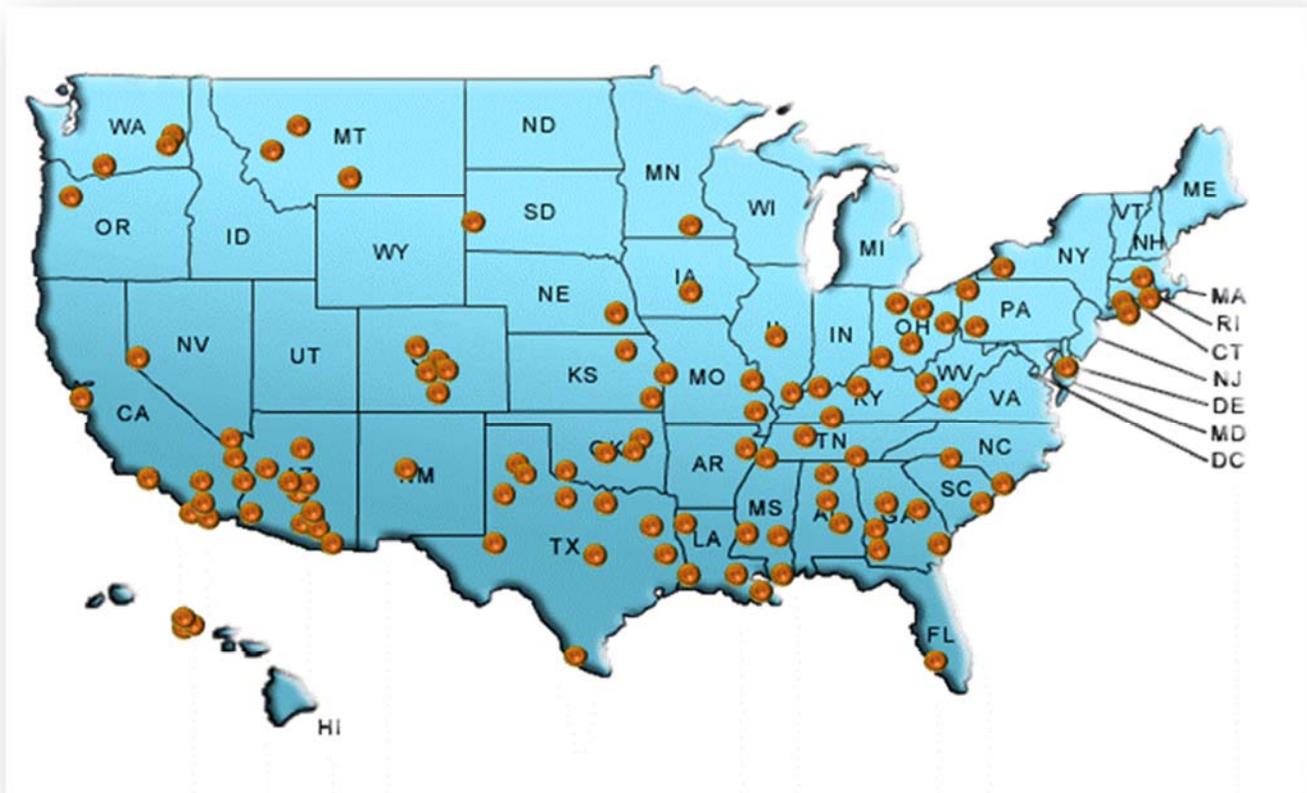


Figure 8. Map depicting television news broadcasts mentioning the AZ PURE Water Brew Challenge

The December 2017 Phoenix Magazine article highlighted the project, which is circulated to 80,000 homes each month and reaches more than 350,000 readers. Television exposures is difficult to estimate due to the lack of specific information on broadcast dates and times. However, many of the 11 television stories were broadcast in Phoenix (a top-15 media market) on network-affiliate stations and were likely seen by hundreds of thousands of viewers. Sentiment analysis indicates that the articles were generally positive and therefore a substantial number of readers likely received a positive impression of the project, and by association, of potable reuse. The AZ PWBC stories were higher in sentiment than other stories about the same general topic of water reuse.

The AZ PWBC Facebook site had 464 followers and a similar number of page likes. These are not large numbers for Facebook sites, but AZ PWBC addresses a niche audience. A good point of comparison is the WateReuse Association Facebook page, which has only about twice as many followers/likes but has been active for six years. When comparing this to the seven months that the AZ PWBC Facebook page has been active, achieving half of their counts is an impressive

achievement. AZ PWBC posts also demonstrated good engagement with 163 posts that received 1,869 post reactions, 92 shares, and 33 comments between May and November.

Overall, the AZ PWBC project performed well on Twitter, producing 355 tweets and generating 223 followers. An additional 663 related tweets were produced by people not directly associated with the project. Because some of these users had large follower counts, reach of the content extended beyond AZ PWBC's modest number of followers, with an estimated 1,265,607 "feed impressions" (i.e. the number of times AZ PWBC-related tweets appeared in other users' feeds). AZ PWBC tweets were 10%-20% higher in sentiment than tweets that were not related specifically to the project but about similar topics (e.g. water reuse, potable reuse, etc.). Additionally, sentiment of Tweets improved over the course of the project. Tweets were over 10% more positive than that of related topics at the beginning and 20% more positive at the end. Finally, the geographic footprint of project-related tweets was concentrated in Arizona and Southern California, indicating that the tweets targeted the intended audience.

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*"Water should be judged not by its history, but by its quality."  
- Dr. Lucas van Vuuren*

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The final LMS report evaluated: 1) analysis to determine if there was any impact (e.g. changes in volume or sentiment) from AZ PWBC tweets on non-AZ PWBC tweets that match the filter keywords provided by the team; 2) a spatial autocorrelation between density of AZ PWBC tweets and non-project tweets in Arizona and southern California; and 3) an analysis to determine if there was any significant difference between the sentiment of project-related mainstream media articles and relevant articles that were not about the project.

# BREW CHALLENGE

The Brew Challenge portion of the project, like all other aspects of the project, took many months to prepare and execute. Through coordination with the AZ Brewers Guild and outreach efforts with brewers early on regarding the concept of the project, the project team knew that we would have significant participation for the Arizona brewing community.

During the last weeks of July and through the early part of August 2017, municipal recycled water was processed at the Pima County Agua Nueva plant, the City of Phoenix 23<sup>rd</sup> Ave wastewater plant, and the City of Flagstaff's Rio de Flag facility to produce ultra-high purity water, or AZ PURE Water, as we like to call it. As water was processed, deliveries to local brewers in the vicinity of each facility was coordinated. The majority of the brewers took between 300 – 1,000 gallons of the treated PURE water to make their beers for inclusion in the AZ PURE Water Brew Challenge competition and to be available for sale to the general public at their taprooms. Due to these treatment logistics, each brewer, depending on where and when the water was produced, had approximately four to six weeks for brewing their submission.

## Participating Brewers

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Thunder Canyon Brewery	Tucson	Perch Pub & Brewery	Chandler
1912 Brewing Co	Tucson	Arizona Wilderness Brewing	Gilbert
Borderlands Brewing Co	Tucson	Saddle Mountain Brewing Co	Goodyear
Crooked Tooth Brewing Co	Tucson	Freak'N Brewing Co	Peoria
Dillinger Brewing Co	Tucson	Goldwater Brewing Co	Scottsdale
Dragoon Brewing Co	Tucson	McFate Brewing Co	Scottsdale
Iron John's Brewing	Tucson	Wanderlust Brewing Co	Flagstaff
Public Brew house	Tucson	Historic Brewing Co	Flagstaff
Catalina Brewing Co	Marana	Granite Mountain Brewing	Prescott
Peoria Artisan Brewing Co	Peoria	Two Brothers Tap House & Brewery	Scottsdale
Mother Bunch Brewing	Phoenix	Oak Creek Brewing Co	Sedona
OHSO Brewery	Scottsdale	Prison Hill Brewing Co	Yuma
Wren House Brewing Co	Phoenix	Dark Sky Brewing Co	Flagstaff

In addition to having bragging rights to the best crafted beer using PURE Water, the HACH Company donated prizes of substantial value to help enhance the competition. Prizes included an Orbisphere for low level dissolved oxygen measurement and a hand-held multi-analyzer, both of which can be used by the brewers to measure and confirm beer quality and brewing process control.

To ensure a professional beer competition, members sought out advice and information the Tucson Homebrew Club. A sanctioned event was created to be consistent with the Beer Judge Certification Program, or BJCP, a non-profit organization that conducts beer judging events and certifies judges around the globe for those competitions. With Arizona having many certified judges available for the AZ PURE Water Brew Challenge, the sanctioned event held in Tucson, Arizona on September 9, 2017. A “call for judges” was initiated to assemble active judges from the across the state to participate in the event. A brewing supply retailer, Mr. Beer, provided the venue for the competition event.

Guidelines for the competition were established requiring each brewer to submit a maximum of 72 ounces of their product for judging. Entries were provided in non-identifying bottles or cans and labeled specifically with labels provided by the BJCP. Labels were loosely affixed to the samples and were required to have the company name, beer name, and style of beer, at a minimum.

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*“The PURE Water Brew Challenge is more than just treating water and making beer, it brought real solutions to water issues and increased public awareness and confidence that these types of challenges are already being addressed in our state with great success.”*

*- John Kmiec, Marana Water*

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Entries from northern Arizona were transported by a team member with a Phoenix retailer of brewing supplies, BYOB, providing a drop off point for central Arizona brewers with a team member transporting them to the competition. Tucson area brewers delivered their samples directly to the Mr. Beer location in Tucson.

On the morning of September 9<sup>th</sup>, more than a dozen certified judges gathered at the Mr. Beer headquarters in Tucson. The event was attended by team members and members of the media with the competition lasting several hours. Beers were organized by style and type and distributed to teams of judges for the styles selected. For each style category, overall winners were chosen from those groups.

For the final judging, the category group winners were provided to a smaller, select group of seasoned judges for deciding the first place winner and runner up. The winning names sealed and submitted to the project team to be held in secret until the sampling event the following day at the National WaterReuse Symposium on September 10<sup>th</sup>. Arizona liquor laws even required the team to obtain a special event liquor license to sanction the tasting event.



Figure 9. BJCP judging members evaluating entries for the AZ PURE Water Brew Challenge

On Sunday, September 10, 2017, the WaterReuse Association held its national symposium at the Renaissance Hotel in downtown Phoenix. On the evening of the first day of the symposium, the WaterReuse AZ section and the AZ PURE Water Brew team hosted the first of its kind AZ PURE Water Brew Sampling event for conference attendees. Representatives from the vast majority of the participating breweries were able to serve their pure water beers to attendees from around the globe who were in attendance.

It was at this event that the first and second place winners of the judged event were officially announced. The first place winner was the *Clear Water Pilsner* entered by Dragoon Brewery of Tucson. The pilsner was an excellent style choice as it highlighted the exceptional quality of the water and is currently the only available Arizona brewed pilsner. The high dissolved solids associated with Arizona groundwater and surface waters do not lend themselves to brewing a pilsner style.

The second place runner up was the *Pure Water Double IPA* entered by Arizona Wilderness Brewery of Gilbert. As a testament to its popularity, by the day of the competition, Arizona Wilderness had sold out of Pure Water Double IPA despite brewing over 1,000 gallons!

To further engage the conference members, attendees placed ballots casting their votes for their favorite beer as well. This “Crowd Favorite” award went to Crooked Tooth Brewery of Tucson for their *Tamarind Sour Brown*.

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*“We chose to brew a Bohemian-style Pilsner to highlight the quality of AZ PURE Water. The result was a crisp, clear, balanced, award-winning pilsner that we're really proud of. The beer would not have been as true-to-style brewed with water straight from the tap.”*

*- Eric Greene, Dragoon Brewing Company*

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Figure 10. An AZ PURE Water brewery entry being transferred to keg.

# PUBLIC PERCEPTION

Throughout the summer of 2017, the mobile advanced water purification facility traversed Arizona, attending both community events and festivals while producing purified water for distribution to nearby breweries. At each event, attendees visited the AZ Pure Water Brew Challenge information booth and toured the demonstration treatment facility. The goal was to encourage each guest to learn about the Challenge and water reuse in Arizona, drink water, taste beer, ask questions, take a survey, and have fun!

Our tour volunteers, many comprised of AZ Water Association members, local engineering consulting firms, university students, and university faculty familiar with the technical aspects of the water treatment and monitoring process, were available to answer questions from participants at each event. Additionally, the AZ PWBC team recruited volunteers from local water and wastewater municipalities to support outreach events. In all, 54 AZ Pure Water Brew Challenge volunteers provided approximately 940 hours of service at community events across Arizona. Visual aids were available at the events to assist volunteers in communicating complex purification processes in a way that the general public could easily understand and appreciate.

At each event, participants were asked to take a short 14 question survey after interacting with the project team and learn about potable reuse and other water issues specific to Arizona. The purpose of the survey was to identify if there is a measurable shift in perceptions after interacting with the project, seeing the advanced water purification mobile system, asking questions about regional and local water issues, and learning about potable reuse for themselves. When asked what water type consumers most often drink, the predominant responses were;

42.85 % preferred tap water filtered either at the sink, refrigerator, or via pitcher.

32.08 % of respondents indicated a preference for bottled water.

17.79 % of respondents indicated a preference for tap water.

For those respondents that did not favor tap water, the responses were;

43.84 % indicated poor taste or smell was the predominant reason.

28.64 % indicated health and safety concerns associated with tap water.

10.66 % indicated a preference for the convenience of bottled water.

Visitors were asked about their knowledge of water purification and they responded as follows:

56.55 % of respondents indicated knowledge of advanced treated recycled water.  
43.45 % of respondents were unfamiliar with the water purification technologies prior to the survey and outreach events.



*Figure 11. Outreach event at Scottsdale's AZ Get Outdoors festival.*

Participants were asked questions related to treatment technologies to gauge whether consumers believed that current technologies were capable of treating poor quality water to drinking water standards. For example, when asked;

65.69 % of respondents indicated Yes.  
20.73 % of respondents indicated No.  
13.58 % of respondents indicated they were unsure.

This identifies a need, as well as an opportunity, to work to educate and inform communities about current technologies available to purify water, as well as how municipalities currently work to “treat” water with proven technologies.

When asked how consumers feel about using purified water as an addition to the supply of drinking water, respondents answered;

- 54.94 % strongly favored implementation of potable reuse.
- 32.22 % somewhat favored implementation of potable reuse.
- 4.32 % somewhat opposed to the implementation of potable reuse.
- 1.19 % strongly opposed to the implementation of pot able reuse.
- 7.34 % were unsure or didn't know how they felt about implementation of potable reuse.

Alternatively, when the survey asked if participants would be willing to drink beer made from purified water,

- 69.70 % of respondents indicated yes.
- 16.21 % of respondents were somewhat willing.
- 5.75 % of respondents were unwilling.

This indicated roughly a 15% increased shift in participant’s willingness to consume purified water as part of an added-value product, beer, as opposed to purified water consumed directly.

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*"One of the best ways to shift public perception is through media coverage.....from Facebook to Twitter and trusted local news sources, stories about the PWBC spread throughout Arizona and the West."*

*- Danielle McPherson, Water Now Alliance*

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In total, the AZ PWBC team collected over 2,000 surveys, treated more than 80,000 gallons of recycled community wastewater, analyzed over 3,000 water samples and traveled more than 2,800 miles educating thousands of Arizonans on the technology used to create recycled water – all within five months! By comparison, the Pure Water San Diego Facility provided tours to 3,200 people over a twelve month period in 2017, demonstrating the success of our mechanisms of “mobile public outreach”.

Overall, the surveys demonstrated the value of innovated mechanisms, such as the mobile advanced water treatment facility, where people can touch and see the technologies and taste the water/beer to change public perception related to complex topics such as water reuse and

recycling. Future work by the AZ PWBC Team includes further analysis of the survey data to utilize information gained from the consumers to help inform the messaging, outreach, and communications on potable reuse topics both in Arizona and across the Country to communities in need.

In addition to the localized interaction with consumers at outreach events, the AZ PWBC team recognized the importance of social media and other online media in the success of public outreach campaigns. In order to assist in this work, the AZ PWBC team contracted with a professor from Arizona State University's Decision Center for a Desert City to conduct a longitudinal media survey, or LMS, to capture how the project is talked about in mainstream and social media.

The goal was to assess the effectiveness of the project messaging strategy to determine if we are able to shift the needle of public opinion regarding potable reuse. The LMS is intended to measure whether the AZ PWBC was able to improve public perception about water reuse while performing set of keywords approved by the AZ PWBC team to identify items directly about AZ PWBC and other items relevant to topics related to the project. The contractor also monitored posts and reactions to the AZ PWBC Facebook page. The information provided in this report summarizes media coverage between May and December 2017.

In addition to these items, there are 186 additional items identified in the media. These stories are about an effort in Colorado to brew beer with reclaimed water. They mention Pima County and/or the purification truck, but not the AZ PWBC project specifically, so they were not included in the sentiment analysis, but are important nonetheless.

Considering circulation figures for the newspapers that published articles, these 13 stories alone reached a potential 1.6 million readers across Arizona and roughly 2.3 million readers broadly. An article about the project was published in the December issue of the Phoenix Magazine, which is circulated to 80,000 homes monthly and reaches more than 350,000 readers. Television exposure is difficult to estimate due to the lack of specific information on broadcast dates and times. However, many of the 11 television stories were broadcast in Phoenix (a top-15 media market) on network-affiliate stations and were likely seen by hundreds of thousands of viewers. Sentiment analysis indicates that the articles were generally positive<sup>1</sup> and therefore a substantial number of readers likely received a positive impression of the project, and by association, of potable reuse. The AZ PWBC stories were higher in sentiment than other stories about the same general topic of water reuse, and indicate the usefulness of a public outreach campaign such as this.

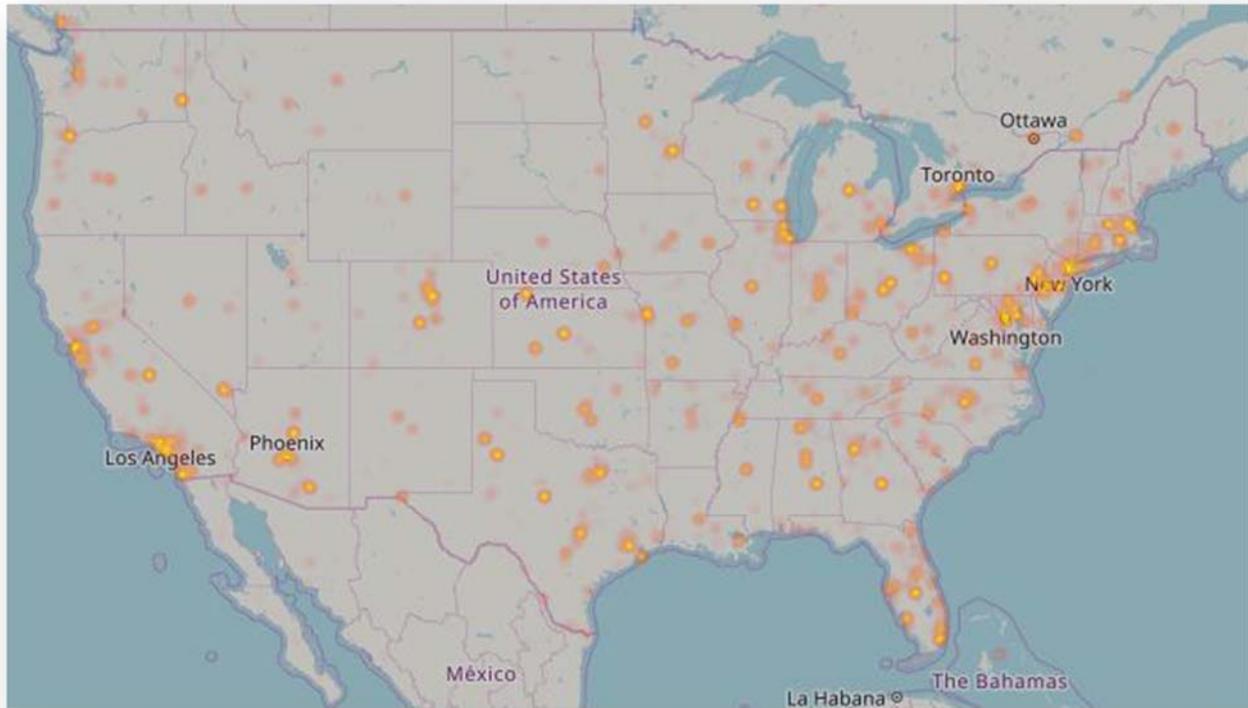
The AZ PWBC Facebook site had 464 followers and a similar number of page likes. These are not large numbers for Facebook sites, but AZ PWBC addresses a niche audience. A good point of comparison is the WateReuse Association Facebook page, which has only about twice as many followers/likes but has been active for six years. When comparing this to the seven months that

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<sup>1</sup> Please note that the sentiment analyzer we used was optimized for social media rather than print media.

the AZ PWBC Facebook page has been active, achieving half of their counts is an impressive achievement. The AZ PWBC posts also demonstrated good engagement with 167 posts that received 1,987 post reactions, 78 shares, and 50 comments between May and December.

Overall, the AZ PWBC project performed well on Twitter, producing 355 tweets and generating 223 followers. An additional 663 related tweets were produced by people not directly associated with the project. Because some of these users had large follower counts, reach of the content extended beyond AZ PWBC's modest number of followers, with an estimated 1,300,333 "feed impressions" (i.e. the number of times AZ PWBC-related tweets appeared in other users' feeds). AZ PWBC tweets were between 10%-30% higher in sentiment than tweets that were not related specifically to the project but about similar topics (e.g. water reuse, potable reuse, etc.). Additionally, sentiment of Tweets improved over the course of the project. Tweets were over 10% more positive than that of related topics at the beginning and 30% more positive at the end. Finally, the geographic footprint of project-related tweets was concentrated in Arizona and Southern California, indicating that the tweets targeted the intended audience. The team used geographic information to create a "heat map," a visual representation of where tweet locations were concentrated. In the map below, which shows the location of all relevant tweets that were collected over the study period in the United States, brighter colors in an area represent more tweets coming from that location.



*Figure 12. Twitter Heat Map depicting AZ PURE Water Brew Challenge tweets.*



*Figure 13. Flagstaff outreach event with attendee surveys.*

There was a significant geospatial autocorrelation between AZ PWBC and non-AZ PWBC tweets in the Arizona/Southern California region, meaning that people were tweeting about both the project and reclaimed water in general in this area. We also found a statistically significant effect for the volume of AZ PWBC tweets on one day, and the volume of non-AZ PWBC tweets the next day, indicating the former were driving conversation in the latter. In both analyses, the effect sizes were small, but statistical analysis shows that they did not occur by chance. So, we can conclude that the AZ PWBC did influence the conversation about recycled water and that the sentiment of the conversation it generated was quite positive.

# CLOSING THOUGHTS

From inception, the AZ PURE Water Brew Challenge has been an amazing experience for all team members. It has been an eye opening opportunity truly bringing people together throughout the state for the common purpose of educating citizens and demonstrating the full potential for water reuse. Water experts, municipalities, citizens and sponsors eagerly embraced the concept and helped to promote and spread the word bringing out a sense of camaraderie amongst the many different communities.

Not only were Arizonans treated to the best tasting purified water, backed by sound science, they were also able to enjoy truly amazing craft beers and engage one another in meaningful discussion on the important topic of water. We proudly boast that our project received the first potable reuse permit in the state and was integral for ADEQ lifting a decades wide prohibition and change of state law. The Arizona Community Foundation is to be commended for this wonderful opportunity and the impact it has made in our state.

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*“Water professionals increasingly see reclaimed water as becoming an even more critical component of Arizona’s water budget...we share the goal of ensuring that reclaimed water can be used for higher value end uses, including potable reuse if public health can be protected with utmost assurance. ADEQ supports this project as a novel and lively way to advance the reuse of reclaimed water in Arizona while providing great opportunity to engage and educate the public.”*

*-Randal Matas, ADEQ*

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A large part of the AZ PURE Water Brew Challenge success is that it is applicable to so many different communities, large or small, without boundaries thereby providing increased local control over their water supplies. This is best exemplified by the multiple states requesting exhibition of the mobile advanced water treatment facility for their communities. Arizona citizens should be proud of their local water and wastewater service providers for expert planning and bold initiatives that continually push for improvements in technology, treatment and regulatory changes to ensure Arizona is ahead of the curve, and on track, for a sound water future.

As the sun sets on this *New Arizona Prize*, a parting thought we wish to leave is for all communities to continue to be engaged and informed not only about local water issues, but to continue to work together throughout the state for the benefit of all Arizonans. *Join the Challenge!*

# ABOUT THE AUTHORS & CONTRIBUTORS



**Jeff Prevatt** - Research & Innovation leader for Pima County Wastewater and creator of the Southwest Water Campus initiative. Jeff is the Microbial Committee Chairman of the Arizona Panel on Emerging Contaminants and chairman for WER&F's LIFT disinfection and water reuse committees with over 25 years of experience in the water sector.



**Barbara Escobar** – Compliance and Regulatory Affairs manager for Pima County Wastewater, Barbara oversaw analytical testing protocols, laboratory analysis and data reporting for the project and has over 25 years of experience in laboratory management, laboratory licensure and data review. She also serves on multiple state and national laboratory accreditation councils.



**John Kmiec** – Water and Water Reclamation Director for the Town of Marana, John provided key water quality experience and serves as the brewery liaison for the project. He served on Governor Brewer's Blue Ribbon Panel and on Governor Ducey's Water Augmentation Council. John is the Chemical Committee Chairman for the Arizona Panel on Emerging Contaminants and co-chair of the Steering Committee on Arizona Potable Reuse (SCAPR).



**Channah Rock** – Channah is an Associate Professor of Water Quality in the Department of Soil, Water and Environmental Science at the University of Arizona and oversaw the critical tasks of outreach and public education for the project. She is also President of WateReuse Arizona.



**Ian Pepper** – Professor of Microbiology at the University of Arizona, Director of the NSF Water and Environmental Technology Center (WET), and Co-Director of the Water & Energy Sustainable Technology (WEST), Ian oversaw virus reduction and risk assessment activities for the project.



**Mark Jockers** – Government and Public Affairs Manager, Clean Water Services (Oregon) and Chair of Water Environment Federation (WEF) Public Communication and Outreach Committee, Mark was a key advisor for public perception and engagement for the project.



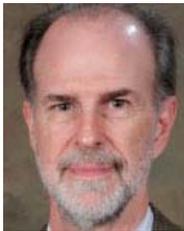
**Charles Gerba** – Professor of Microbiology at the University of Arizona and world renown expert on the transmission of pathogens and viruses through water systems and associated risk assessment, Chuck oversaw pathogen and virus analyses for the project.



**Alan Forrest** - Senior Account Manager with HDR, Alan assisted with the community outreach and messaging for the project. He serves on the board of directors for AZ Water Association and is the Arizona representative on the AWWA Board of Directors.



**Michael Hwang** – CH2M engineer with over 10 years and has with expertise in membrane separation processes for water treatment, desalination and water reuse, Mike is the process team lead for ultrafiltration and reverse osmosis systems for the project.



**Jim Lozier** – Global Practice Leader for Desalination for CH2M HILL, Jim has participated in the design of indirect potable reuse plants in California, Singapore and Australia and pioneered research on the use of microfiltration and membrane bioreactors for advanced water reuse.



**George Maseeh** – Senior Vice President with Carollo Engineers and expert in the design and construction of water resources projects, George oversaw advanced oxidation design and operation for the project.



**Tim Thomure** - Director of Tucson Water with over 20 years of experience in the water sector and Chair of the Steering Committee for Arizona Potable Reuse (SCAPR), Tim provided the operational support of Tucson Water for both water production and water deliveries to brewers and bottlers.



**Corin Marron** – Engineer with Carollo Engineers with over 6 years of experience in the planning and design of municipal water and advanced treatment facilities and pilot testing. Corin is a Udall Scholar and 2015 American Council of Engineering Companies Young Professional of the Year Award Recipient and she oversaw the design and operational performance of the UV-AOP system, GAC and chlorination for the project.



**Danielle McPherson** - Water Resource Specialist/Project Manager at the Water Now Alliance with over 6 years of program management experience in the wastewater industry, Danielle oversaw the public outreach coordination for the project.

