Public Engagement on Water Reuse Beyond Community Surveys

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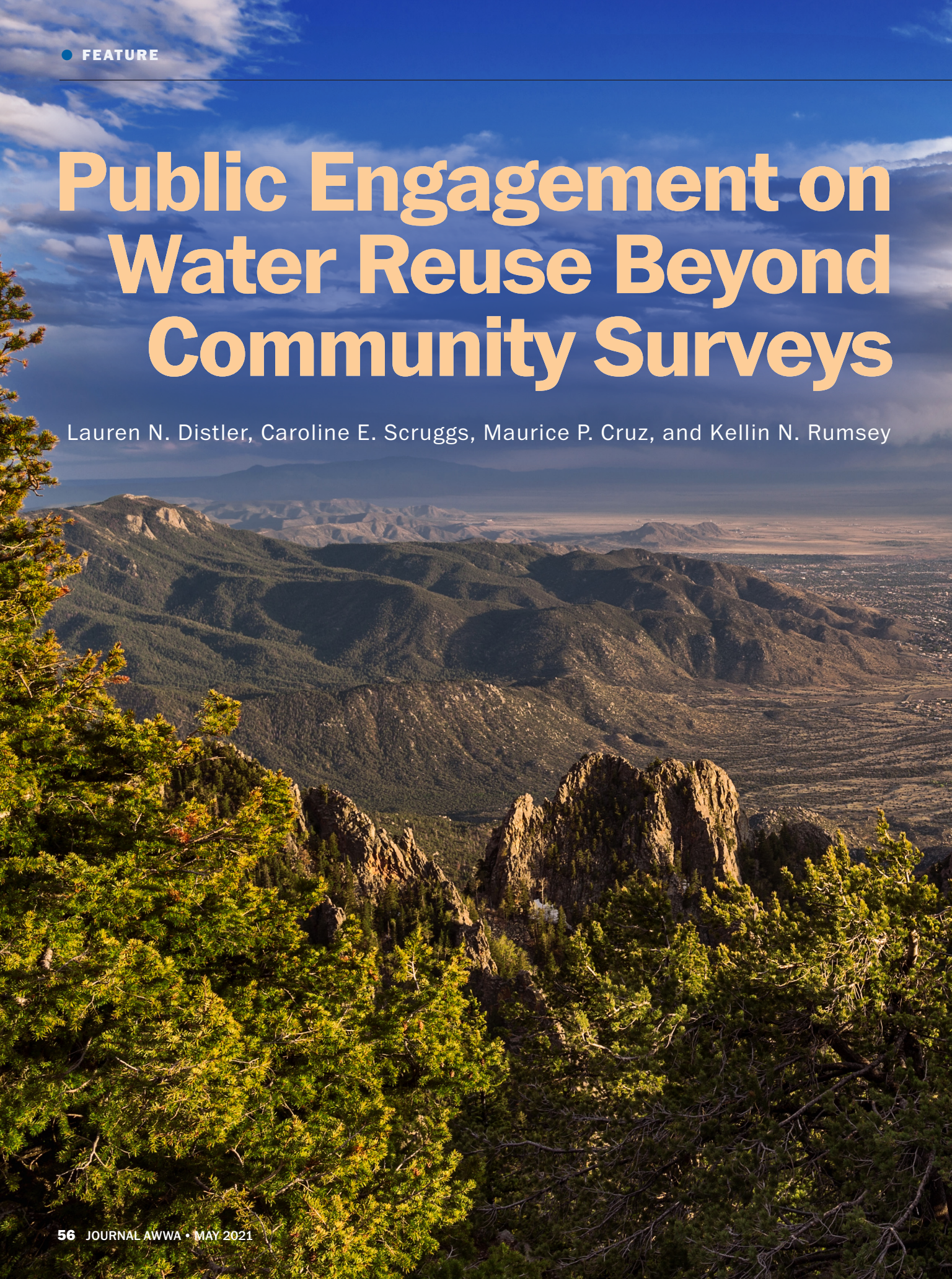

Key Takeaways

Wastewater reuse and other nontraditional water supply options may become necessary for communities facing extended drought due to population shifts and climate change.

A community survey and subsequent analyses uncovered misconceptions and gaps in public knowledge surrounding water resources and water reuse.

Surveys are useful for understanding public knowledge and opinions but must be supplemented with meaningful education and outreach.

Without genuine public engagement and trust-building, water infrastructure projects might not align with a community's values and interests.

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Many communities with stress on their water supplies from climate change and population increases are considering potable water reuse in their water resources planning. Technologies exist to purify water from alternative sources so that it can be reused safely, and potable water reuse facilities around the world have been providing safe water to customers for years.

In potable water reuse, highly treated wastewater is recycled back into the potable water supply, either directly (i.e., direct potable reuse, or DPR) or indirectly, following residence time in a reservoir or aquifer (i.e., indirect potable reuse, or IPR).

Several potable reuse project proposals over the past few decades have been met with opposition from concerned residents. Two notable case studies—in Australia in Toowoomba, Queensland, and in San Diego, Calif.—have been described by Hurlimann and Dolnicar (2010) and Trussell et al. (2002). As a result, researchers have conducted numerous studies to better understand reasons for public opposition and determine optimal strategies for public education and outreach on the topic of potable water reuse, as summarized by Scruggs et al. (2019). However, few studies have focused on arid inland communities, and Ormerod and Scott (2012) and Scruggs et al. (2019) have shown that local context matters when it comes to public perceptions of potable reuse.

Researchers have conducted numerous studies to better understand reasons for public opposition and determine optimal strategies for public education and outreach on the topic of potable water reuse.

For utilities serving communities in arid inland areas, and more generally for those considering potable reuse, we conducted a community survey and analyzed the data to propose a path forward for navigating public education and engagement. And while this is useful, utility leaders should understand that survey results of this kind are only one element of the public engagement needed to ensure public understanding and informed decision-making regarding water resource issues.

Albuquerque, N.M.

The Albuquerque Bernalillo County Water Utility Authority (ABCWUA), which provides water for more than 600,000 people in the Albuquerque metro area, has included DPR and IPR in its 100-year water plan as possible components of its future water supply portfolio. As a community located in an arid inland area with an interest in potable reuse but not much history with it, Albuquerque presents an ideal opportunity to better understand public perceptions of potable reuse relatively unaffected by misinformation. Further, cyclical drought has occurred in the region for centuries, and with more than 300 days of sunshine and an average of less than 10 inches of rain per year, New Mexicans seem to know that water is scarce.

Drawing on previous survey research that has focused on other communities—such as the work of Millan et al. (2015), Macpherson and Snyder (2013), and Dolnicar et al. (2010)—we developed a survey to better understand public opinion and knowledge on a variety of topics related to water resources and potable reuse. The survey had four objectives:

- Understand residents' knowledge of water resource issues, their level of concern for water scarcity, and water-related misconceptions.
- Determine the level of public acceptance of two potential potable reuse scenarios and the most common reasons for support and opposition.
- Investigate who the public trusts to provide accurate information on water reuse.
- Understand what effect educational materials have on acceptance of potable reuse.

Designing the Survey

Our survey was designed and administered following the tailored design method developed by Dillman et al. (2014); see Distler and Scruggs (2020a) and Distler et al. (2020) for extensive detail on our methods and their limitations. Our goal was to design a survey that would (1) be easily understood by our population, (2) require a reasonably short amount of time to complete (10–15 minutes), and (3) yield results representative of the population.

The preliminary steps for designing and conducting the survey included a series of eight focus groups and 12 one-on-one debriefing sessions with members of our sample population, as well as a pretest. The focus groups and debriefing sessions allowed us to

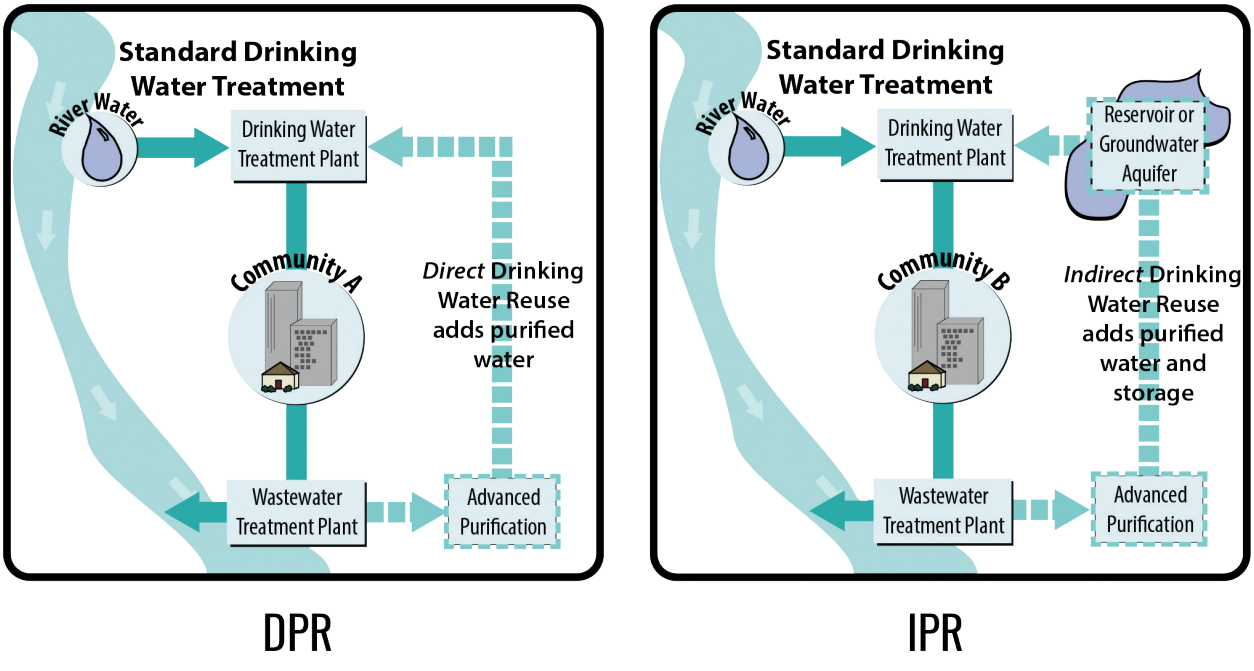
- test potential survey questions and materials,
- understand if questions were being interpreted as intended,
- determine the time required to take the survey, and
- see if participants experienced unforeseen problems in completing the survey.

Our survey sample was taken from ABCWUA's residential customer address list, and we limited focus group participation to water utility customers who were at least 18 years of age. The focus group and debriefing sessions were conducted at familiar, accessible locations across town from July through November 2016.

By including a broad range of questions and content suggested by the literature, our initial draft survey was fairly long. It included visual and factual information about reuse treatment technologies (e.g., reverse osmosis and advanced oxidation), flow diagrams of treatment schemes, and information about the costs of different scenarios and treatment options. In addition, we intended to ask questions about four potable reuse scenarios, similar to those developed by Macpherson and Snyder (2013). However, members of our first focus group were overwhelmed because the survey was too long and complicated. Several participants reported that the technical content caused them to "shut down" and be less inclined to complete the survey because they did not feel knowledgeable enough about the content to have opinions about it.

In reexamining the potable reuse survey literature on which we based our questions and content, some of the previous research used recruiting methods that likely resulted in unrepresentative samples, had low response rates, and/or were conducted in communities where implementation of potable reuse was already an ongoing discussion among residents (i.e., details of the survey topics were already at least somewhat familiar to participants). Further, many previous surveys did not use focus groups or pretesting to see how respondents would understand or react to the questions included in the survey. Without pretesting, it is impossible to know whether the survey questions are being interpreted correctly, and

Hypothetical Potable Reuse Scenarios for DPR and IPR in the Survey



Adapted from Distler and Scruggs (2020a) with permission from ASCE

DPR—direct potable reuse, IPR—indirect potable reuse

Each scenario included the statement, "All water is tested and monitored 24/7 by trained staff to meet strict water quality standards."

Figure 1

a low response rate could result if potential respondents are frustrated by the length or other aspects of the survey.

Throughout the course of the focus groups and debriefing sessions, we refined and simplified our survey, changing almost every aspect and eliminating the diagrams related to specific treatment technologies. Rather than details about the different treatment scenarios and levels of treatment achieved, most participants simply wanted a general diagram of how reuse compared with traditional treatment and to be assured that the reused water would be safe, so we added that information to the survey instead. Figure 1 shows how DPR and IPR were ultimately depicted in the survey.

For the few focus group participants who *were* interested in the technical aspects of potable water reuse, we put tear-off links and QR (quick-response) codes on the back of the survey, leading interested participants to layperson-friendly information about water and wastewater treatment, water reuse, and water quality standards and regulations.

Since our data were limited to ABCWUA customers' residential addresses, we conducted both the pretest and main survey by mail, with an option to complete them online. We pretested our final draft survey on a random sample of 200 ABCWUA account holders, which allowed us to refine and finalize the survey and our administration process before mailing it to a random sample of 4,000 ABCWUA account holders. We systematically contacted our sample of potential respondents five times over several months, collecting responses from April through September 2017 and achieving a response rate of 46% (n = 1,831).

Main Findings

Our detailed survey results and the full survey instrument can be found in three open-access publications (Cruz et al. 2020, Distler et al. 2020, Distler & Scruggs 2020a), and we discuss the highlights here. Anonymized survey data are freely available as well (Distler & Scruggs 2020b).

The survey began with basic questions related to respondents' level of concern for water resource issues, their thinking related to water supplies and climate change, their water use and conservation at home, and their familiarity with potable water reuse. From there we moved on to more complex and sensitive questions about respondents' acceptance of two hypothetical potable reuse scenarios, along with reasons for support or concern, trust in various entities to provide accurate information on potable reuse, and demographics. In this article we feature some of the key findings from our survey.

Water Source and Scarcity Awareness

Survey results showed that 48% of respondents knew that their water came from two sources—i.e., the Rio Grande via the San Juan Chama Project (SJCP) and the local aquifer. Another 21% of respondents selected only groundwater as a source, which was the case for Albuquerque up until the SJCP was brought online in 2008. While only moderately aware of the sources of drinking water in Albuquerque, respondents were very

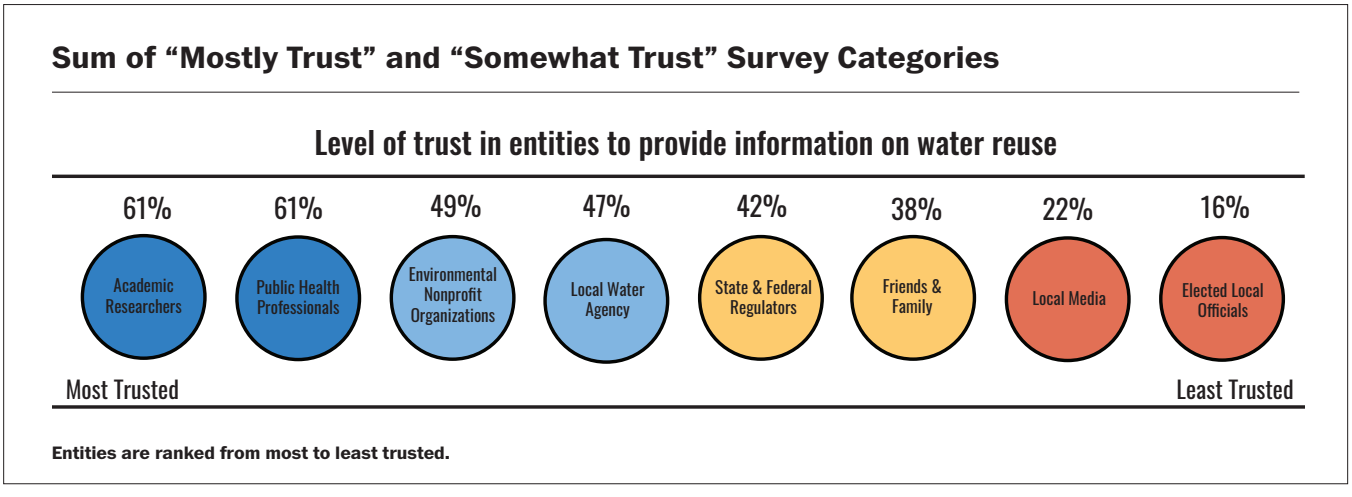


Figure 2

aware of water scarcity, with 81% responding that they believed water was a scarce resource in the area. Overall, Albuquerque water users seemed to have a good level of awareness of water source and scarcity issues compared with other populations.

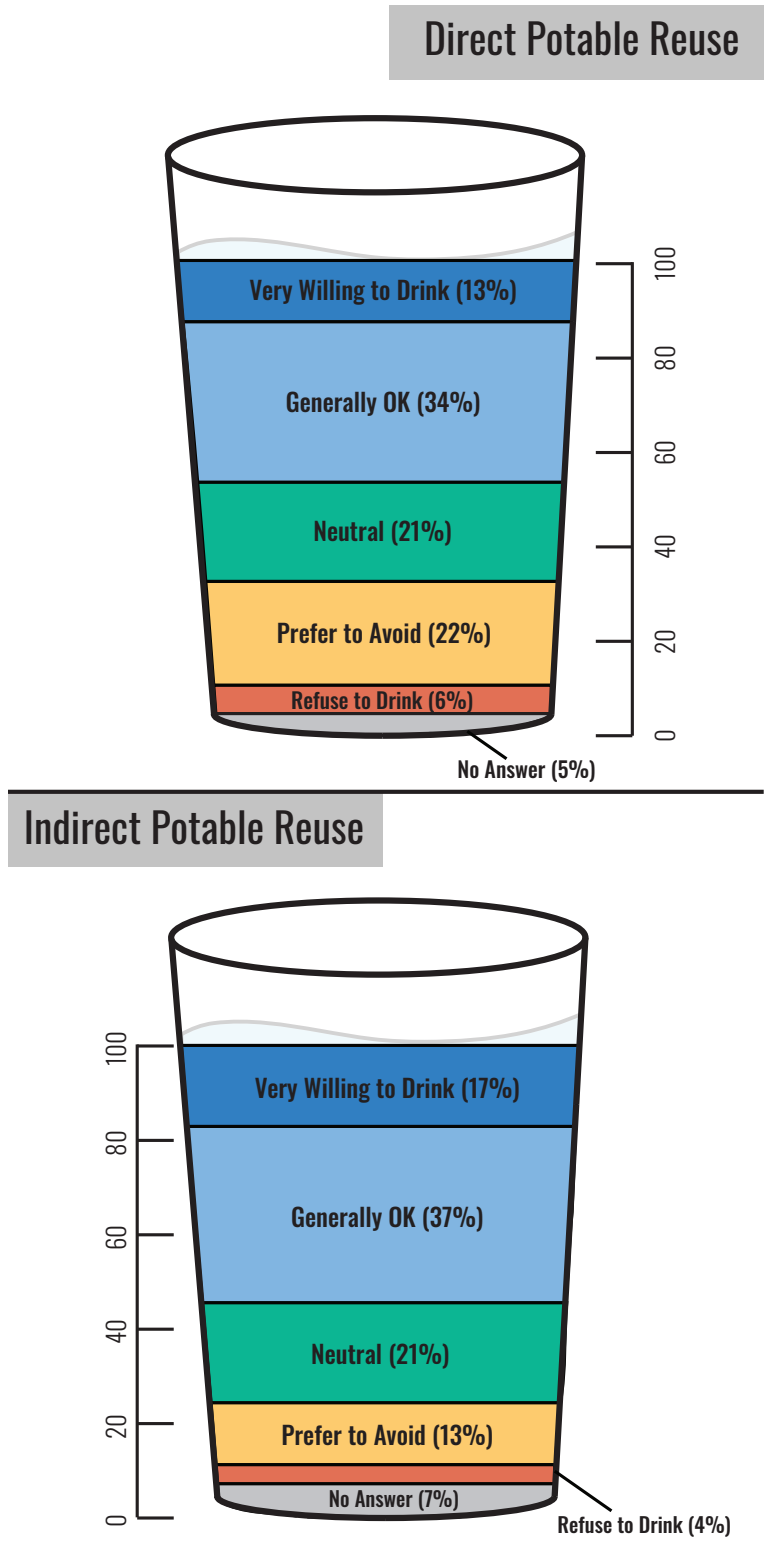
Water Use at Home and Perceived Safety of Bottled Water

When asked about the type of water most often consumed at home, the majority of respondents (43%) indicated that they drink city tap water that is filtered again at home. Twenty-eight percent indicated that they drink city tap water as is, and 18% indicated that they drink bottled water. Our survey also asked respondents to indicate whether they believed bottled water to be safer than the local tap water. When examining respondents' answers to both of these questions together, the data suggest that bottled-water drinkers have misconceptions about its quality: 77% of bottled-water drinkers believe it is safer than tap water, compared with 15% of tap water drinkers and 31% of filtered-tap-water drinkers. A similar cross analysis of survey questions by Millan et al. (2015) yielded nearly the same result.

Prior Awareness of Potable Reuse

Sixty-nine percent of our survey respondents indicated that they were aware of the concept of purifying wastewater and reusing it for drinking water. This is only slightly lower than the 73% of California voters in the Millan et al. (2015) survey who indicated they were at least somewhat familiar with recycled water. Other studies have suggested that prior awareness or knowledge of

Level of Willingness to Drink Tap Water for DPR and IPR Scenarios



DPR—direct potable reuse, IPR—indirect potable reuse

Figure 3

reuse influences acceptance of reuse (Macpherson & Snyder 2013).

Trust in Entities to Provide Information on Reuse

Our survey also asked respondents to indicate their level of trust in various entities to provide accurate information on water reuse and the safety of drinking water reuse. Figure 2 ranks these entities from most to least trusted, based on the sum of the top two trust categories, "mostly trust" and "somewhat trust."

The data showed that academic researchers and public health professionals were among the most trusted entities to provide accurate information on reuse, although we acknowledge potential bias in this response. That being said, it is clear that respondents' trust in New Mexican elected officials and local media is lacking, and respondents reported mixed trust in the local water agency. Other studies have also reported low trust in local officials, although lack of trust seems particularly prevalent in our results.

Water utilities are generally trusted, according to other studies, yet they consistently do not appear among the most trusted entities to provide information on water quality and water reuse (Millan et al. 2015, Macpherson & Snyder 2013, Ormerod & Scott 2012). These results suggest that any attempts by the local water agency to engage the public on water resource issues should involve partnering with a trusted source and/or doing some preliminary work to build trust within the community before starting education and outreach efforts.

Meaningful engagement and trust-building must occur for communities to believe that their water is safe and to form informed opinions about proposed infrastructure projects.

Acceptance of Potable Reuse

In asking respondents about the two hypothetical reuse scenarios of interest, DPR was presented first, followed by IPR; diagrams were shown, as in Figure 1. Survey respondents were asked to indicate their willingness to drink the tap water in a hypothetical community that practiced DPR (Community A) and IPR (Community B) on a five-point scale that ranged from "refuse to drink" to "very willing to drink." Figure 3 shows that respondents were slightly more willing to drink tap water from an IPR facility, with 54% of respondents falling into the top two categories of willingness, compared with 46% for DPR. Additionally, the proportion of respondents indicating they would "refuse to drink" water in these scenarios (4% for IPR, 6% for DPR), was much lower than what has been reported by Millan et al. (2015) and other past studies.

These results suggest that Albuquerque water users are generally willing to accept potable reuse, and that strong opposition does not appear prevalent. Similar to other research, such as that performed by Millan et al. (2015), Albuquerque respondents had higher levels of comfort with IPR than DPR, likely because of the natural processes included in IPR, although the degree of preference was less striking than in other studies. We also asked respondents to indicate one or more reasons for support of and concern about potable water reuse. The results presented in Figure 4 are for DPR; results were similar for IPR.

Impact of Demographic Variables on Willingness to Accept DPR and IPR

	Impact on Willingness to Accept Reuse (+/–)	
Demographic Variable	**DPR**	**IPR**
Gender: male	+	+
Ethnicity: Spanish/Hispanic/Latinx	–	–
Education: lower education levels	–	–
Long-term New Mexico resident: yes	+	+
Children at home: yes	NA	–
Age: older	NA	–
Political affiliation: independent/no affiliation	NA	–

DPR—direct potable reuse, IPR—indirect potable reuse, NA—not applicable

Table 1

In line with the study by Millan and colleagues (2015), "water shortage, drought, and limited supply" was the most commonly selected reason for support for both DPR and IPR. Also similar to other studies, the most common reason for concern was a lack of confidence in the safety of the water, and health concerns. On the other hand, "I don't trust the government or water utility" was a concern for 23% of respondents in our survey, compared with 1% of those surveyed by Millan et al. (2015). This reiterates that lack of trust in elected local officials and other entities is a prevalent issue among those surveyed. Finally, we note that for this question, 15% indicated they would not be willing to drink the water, compared with the 6% who indicated they would "refuse to drink" tap water in a community that practices DPR (Figure 3). We discuss possible reasons for this discrepancy later in this section.

Do Demographics Play a Role?

Beyond these basic results, we wanted to see if demographics could explain our population's attitudes toward reuse. In other words, which characteristics are linked to a person's willingness or unwillingness to accept potable reuse?

By examining respondents' willingness to accept potable reuse while accounting for their demographic information, we developed predictive models that allowed us to estimate with reasonable accuracy the probability of an example respondent's acceptance on the basis of demographic characteristics.

Gender, ethnicity, education level, and long-term residence in New Mexico had predictive capacity for both the DPR and IPR models.

Overview of DPR Predictive Model and an Example Profile

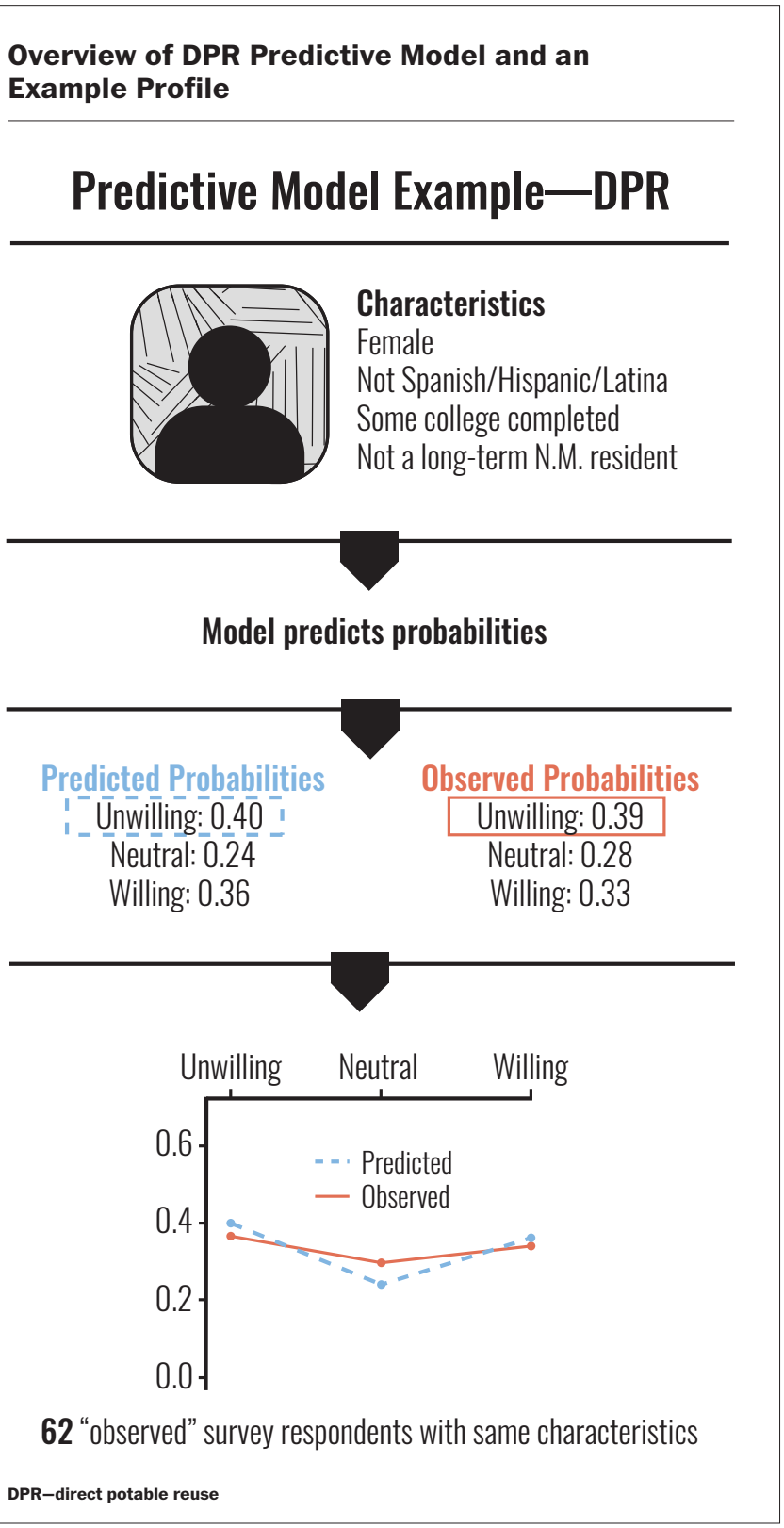


Figure 4

For the IPR model, several additional variables showed predictive capacity: age, children living at home, and political affiliation. Table 1 summarizes whether each variable had a positive or negative impact on willingness to accept potable reuse.

Results should be interpreted in relation to the category or categories for each variable not listed in the table. For example, for gender, being male has a positive impact on willingness to accept DPR, compared with female respondents. More detail, including the magnitude, *p*-values, and other information associated with these effects, is described elsewhere (Distler et al. 2020).

Figure 4 provides an overview of how the model predicted the probability that a person with specific characteristics would fall into each category on the "willingness" scale and how these predicted probabilities compare with the willingness of actual survey respondents with the same characteristics. The example respondent in Figure 4 would most likely be unwilling to accept DPR on the basis of the demographic information provided. As shown, the model predicts probabilities of willingness with reasonable accuracy.

Community surveys are important in gaining a baseline understanding of public knowledge and perceptions around water-related issues; they can serve as useful planning tools for water resource professionals.

We also tested for independence to determine if there were relationships between several demographic factors (i.e., gender, ethnicity, education level, long-term New Mexico resident) and factors known to positively affect reuse acceptance (i.e., trust in the local water agency, state and federal regulators, and elected local officials; prior awareness of potable reuse; knowledge of water scarcity). In general, the strongest evidence of relationships was found between the demographic variables and both prior awareness of potable reuse and knowledge of water scarcity. Strong evidence of a relationship was also found between education level and trust in regulators, and to a slightly lesser extent between ethnicity and trust in regulators. These results help to explain why certain demographic factors appeared as predictors in our models of acceptance of potable reuse. This analysis and the associated results are discussed in more detail by Distler et al. (2020).

Effect of Educational Materials

One of this study's objectives was to determine the effect that educational materials have on acceptance of potable reuse. In examining response differences between those who received educational materials versus those who did not, our results indicated that educational materials had a positive, but not statistically significant, effect on reuse acceptance. However, our educational materials were brief, in an effort to keep the survey short. It is possible that a significant result would have been observed if the materials were more substantial, but a longer survey might have come with the tradeoff of a lower response rate.

The Need for More Information

In the case of a survey about acceptance of potable reuse in which many potential respondents were not already familiar with details about the topic, there is a tension between keeping the survey short and providing enough information so that respondents can make informed decisions about how to answer questions. A danger is that the survey becomes a tool for attempting to both educate customers and gather opinions about the topic, going outside the bounds of what a typical survey is supposed to accomplish. There were at least two indications that our survey was trying to accomplish too much (i.e., both educating participants about a complex topic and asking for their opinions about it).

First, our survey provided a comment box so that participants could leave open-ended commentary on concerns they had about water reuse that were not addressed by the survey. While the responses varied widely, a number of comments directly addressed the need for more education on the topics of potable water reuse, water treatment, and water resources. A sample of quotes from this survey question is shown in Figure 5.

Second, before the demographic questions at the end of the survey, we included another question about respondents' willingness to accept potable reuse: "Based on the information provided, with which of the following statements do you most agree?" (Answer options: "I'm more willing to accept drinking direct water reuse," "I'm more willing to accept drinking indirect water reuse," "Both types of reuse are equally acceptable to me," "Neither type of reuse is acceptable to me.") Fifteen percent of respondents selected "Neither type of reuse is acceptable to me," compared with the 4% and 6% of respondents who indicated they would refuse to accept IPR and DPR, respectively, shown in Figure 3. This is the same as the percentage of

those indicating they would not be willing to drink the water when asked about potential reasons to support DPR (Figure 6). This variability in results might indicate that respondents needed more information and/or had not made up their minds regarding their preferences on drinking reused water. Such a sentiment was voiced by several respondents in the open-ended comment box—i.e., statements indicating that they "just don't know enough" about the topic to make a decision or form an opinion on the issue.

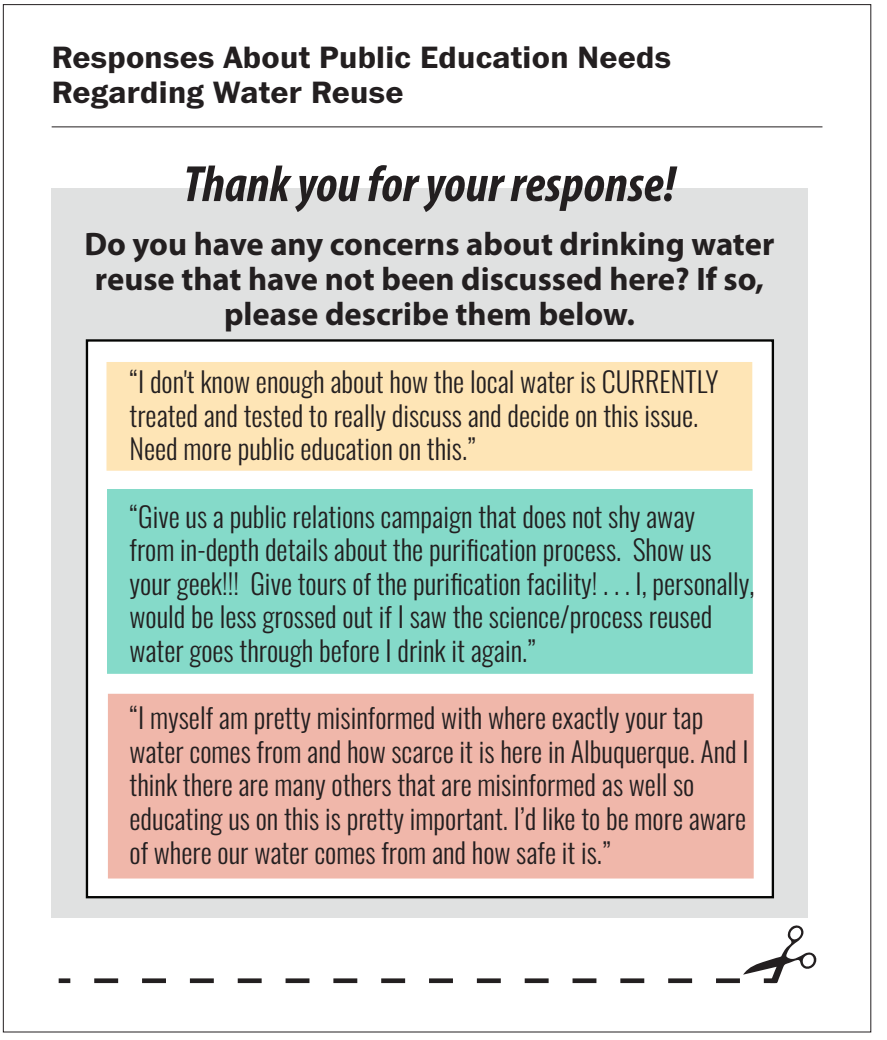


Figure 5

Using Survey Results to Inform Public Engagement

Given that much of the potable reuse survey research to date has focused on coastal communities, our survey expands the water industry's understanding and perspectives on water resources and reuse in arid inland areas. However, we emphasize that our survey results are not sufficient for making decisions about water reuse. In our focus groups, we found that many people did not know about potable reuse, so we designed the survey to also educate respondents, to some degree, on topics related to water resources and reuse. Our survey results suggested that the amount of educational material provided might not have been sufficient, and respondents may have needed more information to decide about the acceptability of potable reuse.

A theme among the write-in responses involved questions and confusion about current processes and a need for broader education about the local water system. Many respondents said they wanted more information on the treatment processes associated with new and existing treatment schemes, where their water currently comes from, and how water quality produced by the existing water treatment facility would compare with that from a potable reuse facility.

Other comments reiterated a deep distrust in New Mexican officials, with numerous respondents citing the water crisis in Flint, Mich. (which was ongoing at the time of the survey), and other concerns relating to environmental injustice and racism. Proposals to implement new technologies in communities where trust has not been built will likely be met with opposition. Meaningful engagement and trust-building must occur for communities to believe that their water is safe and to form informed opinions about proposed infrastructure projects.

Visualizing Survey Data Using Geographic Information Systems (GIS)

Our analyses based on demographic characteristics have limited utility on their own, and we were curious to see if an approach that accounts for location could provide additional useful information for designing tailored

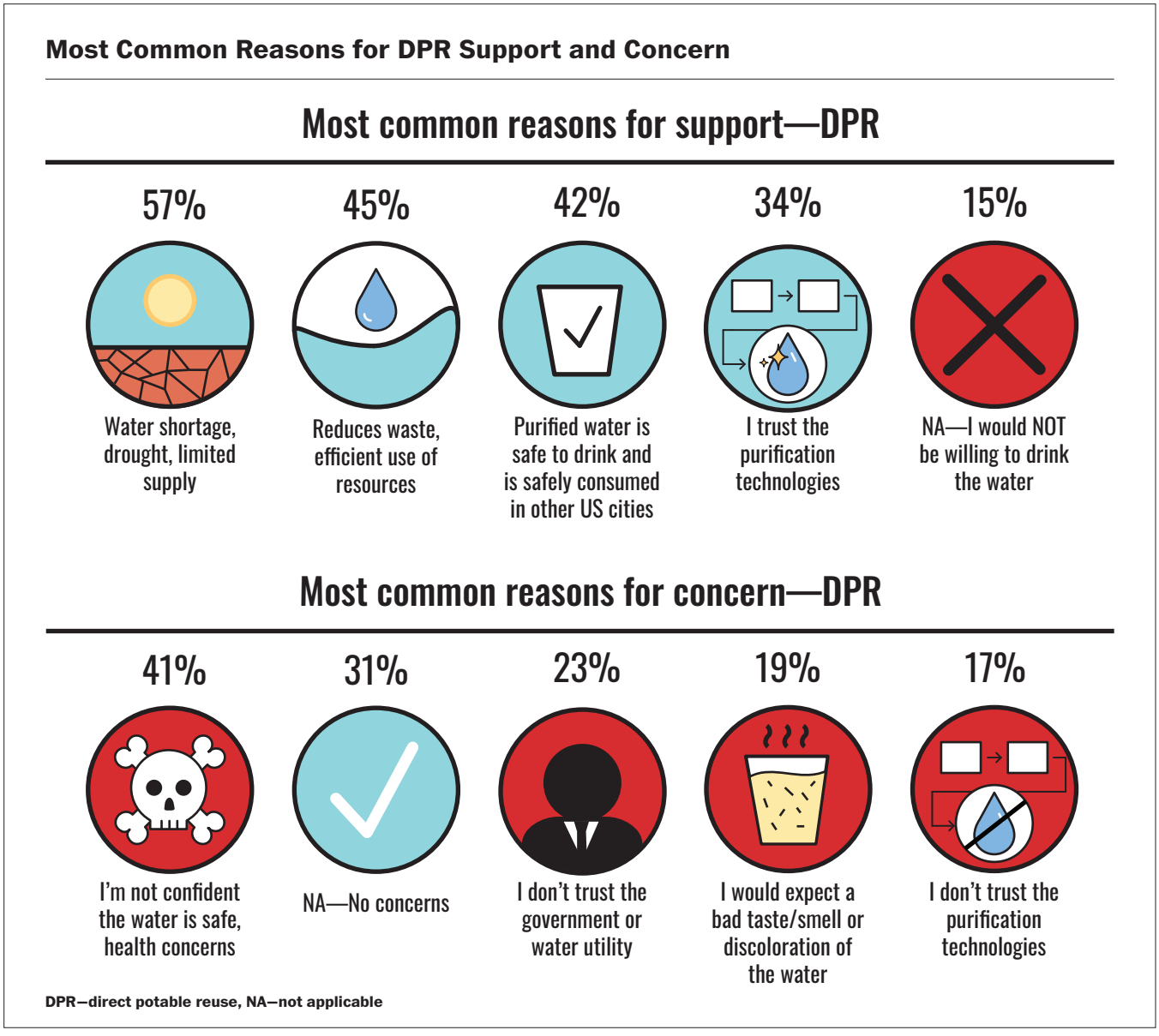
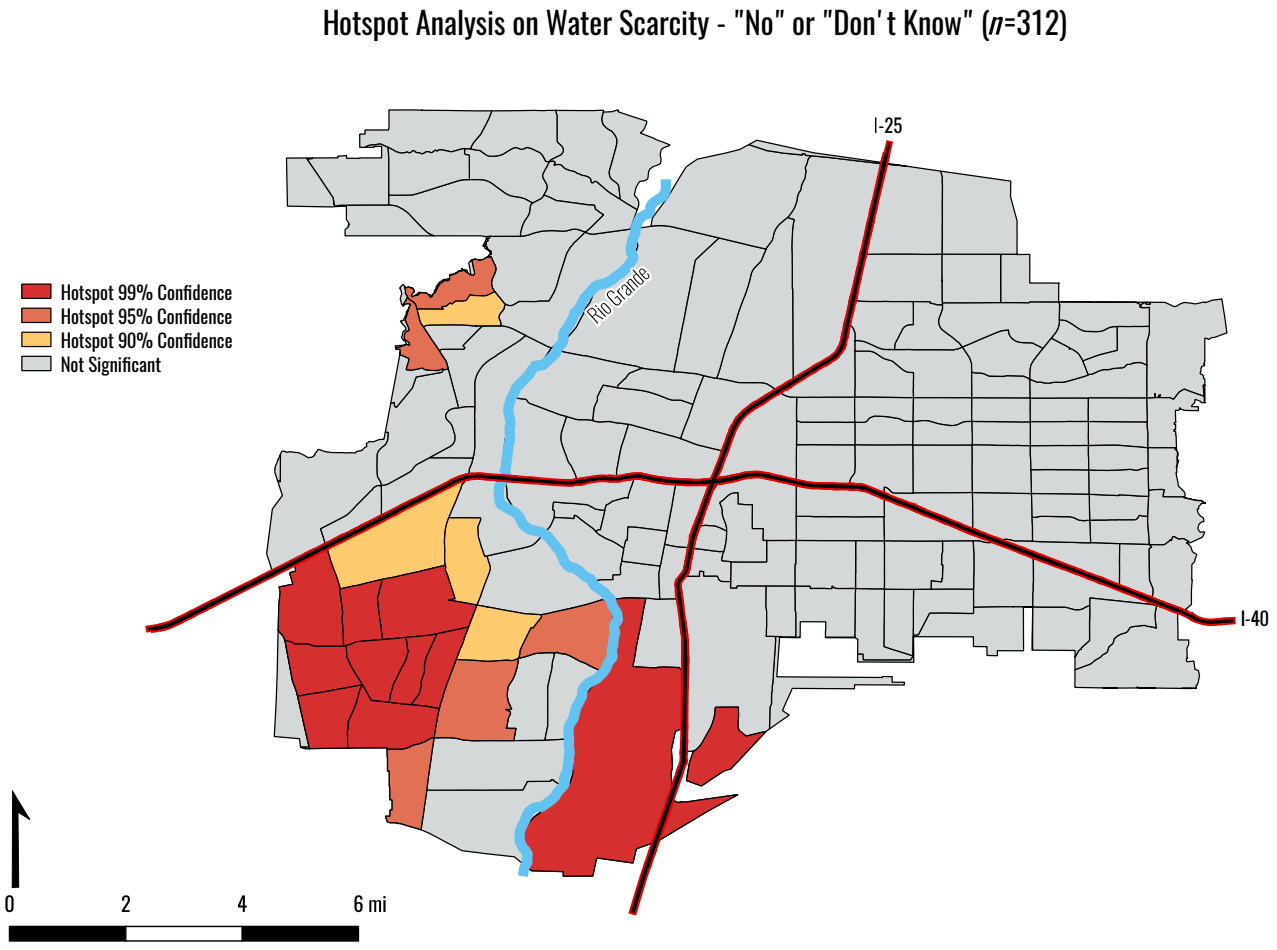


Figure 6

outreach programming. Thus, we demonstrated an approach that employs GIS tools to visualize specific patterns in survey responses and identify geographic areas where certain opinions, knowledge gaps, and misconceptions related to water resources and reuse exist—in short, we mapped the results of our survey. Details of this approach are described by Cruz et al. (2020) and are briefly described here.

The survey data were linked with the ABCWUA customer database, which included anonymized customer addresses, and were imported into GIS software. Next, we used a statistical test (Getis-Ord Gi*) to identify geographic areas (census tracts) that were hotspots for certain types of responses. To demonstrate the approach, we performed hotspot analyses for several of our survey questions that we thought could be well addressed through targeted outreach. For example, Figure 7 shows the results of the hotspot analysis for "No" and "I don't know" responses to our survey question about whether respondents were aware of water scarcity. A clear pattern

GIS Hotspot Analysis for Water Scarcity Awareness in Albuquerque



Adapted from Cruz et al. 2020

GIS—geographic information system

The map shows patterns of "No" and "I Don't Know" responses from the survey.

Figure 7

of "No" and "I don't know" responses is clustered within the southwest quadrant of the city—data that could be used to inform outreach and education specific to those customers.

Mapping survey data using GIS to visualize patterns in misconceptions and/or distrust could help utilities develop targeted plans for customer outreach and education, and allow for more efficient use of resources. Further, by examining the results of GIS analyses alongside the knowledge of water utility staff and water managers (e.g., knowledge of water-service-related problems, cultural differences, and/or institutional barriers), additional explanations could be provided for patterns in response to certain survey questions.

Moving Forward With Potable Reuse

Community surveys are important in gaining a baseline understanding of public knowledge and perceptions around water-related issues; they can serve as useful planning tools for water resource professionals. Our

survey improved our understanding of how water users in the Albuquerque area perceive water issues, including two potable reuse scenarios. Generally, our results suggest that Albuquerque-area water users are fairly accepting of potable reuse, but questions still remain, and trust in certain entities was lacking among the majority of those surveyed. It seems that more public education and outreach are needed on a variety of water topics, both basic and advanced.

This baseline understanding is key to designing effective educational programming that can help the public develop informed opinions about water resources. Beyond education, genuine public engagement in formulating solutions to water scarcity is needed. Survey results and GIS mapping can be used to prioritize and tailor relationship-building and educational programming needed in specific parts of the community. We hope these results are useful to water utilities that are considering public outreach related to reuse projects, the feasibility of reuse in their communities, and/or conducting their own public acceptance surveys.

Acknowledgment

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AWWA Resources

- **Introduction to the Topical Collection on Potable Reuse. Howe KJ. 2020. *AWWA Water Science.* 2:6:e1212. https://doi.org/10.1002/aws2.1212**
- **Potable Water Reuse in Small Inland Communities: Oasis or Mirage? Scruggs CE, Lawler DF, Tchobanoglous G, et al. 2020. *Journal AWWA.* 112:4:10. https://doi.org/10.1002/awwa.1476**
- **Widespread Potable Reuse Requires Thorough Understanding of Water Quality and Public Health Challenges. Salveson A, Soller J. 2019. *Journal AWWA.* 111:7:78. https://doi.org/10.1002/awwa.1328**

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