By Robert S. Raucher & Janet E. Clements

Extracting freshwater from traditional sources, such as rivers and aquifers, is becoming more difficult due to tightening physical and institutional limits. Meanwhile, demand for clean water continues to grow. Faced with these issues, more water managers are considering adding or expanding water reuse and/or desalination options as part of their long-term supply portfolios. New water resource options, however, typically are more expensive than traditional water supplies, which can make reuse and desalination difficult to justify to governing boards, customers, economic regulators and potential funding agencies.

Although reuse and desalination may seem relatively expensive, they provide a range of important values not generated by most traditional supply options. Both reuse and desalination offer reliable and locally controlled yields when drought, climate change or other factors (e.g., court orders curtailing freshwater extractions) limit traditional sources. Utility managers recognize that yield reliability and local control are likely to be highly valued by their communities; however, the absence of suitable customer valuation data makes these benefits difficult to quantify. This impedes the implementation of reuse and desalination and adds a challenge to securing state and federal funding.

The WateReuse Research Foundation retained Stratus Consulting Inc. to develop empirically robust estimates of how much residential customers valued additional water supply reliability. In this context, the value of added water supply reliability reflects household willingness to pay to reduce the frequency and severity of future water shortages and associated water use restrictions. Such willingness to pay values may be considered part of the total economic value of providing drought-resistant water yield reliability, associated with, for example, reuse and desalination projects. Another important research objective was to evaluate customer preferences for the types of water supply options (including reuse and desalination) that water utilities should pursue in the future to increase supply reliability.

This article provides a summary of the relevant findings from the stated preference survey implemented in this research. It presents customer willingness to pay values for the importance of increasing water supplies within their areas. It also discusses the types of water supply projects that customers think their utilities should pursue to enhance their supply reliability. Full details can be found in the WateReuse Research Foundation report for Project WRF-08-09.

Methodology
A series of stated preference surveys of residential customers in five U.S. water utility service areas were developed and implemented: Austin Water (Texas); Long Beach Water Department (LBWD, California); San Francisco Public Utilities Commission (SFPPC); Orlando Utilities Commission (OUC, Florida); and a fifth, anonymous utility. Researchers developed initial survey questions and designs, and used a series of focus groups and expert advice to fine-tune the survey wording and design to ensure respondents properly understood the issues and provided objective responses. The final survey was distributed to water agency customers using Knowledge Network’s Internet-based approach, with an average sample of more than 400 completed surveys from each of the five sampled service areas, for a total national sample size of more than 2,100 households.

In the survey, researchers applied a “choice experiment” to elicit values for water supply reliability based on residential customer willingness to pay to avoid impacts associated with water supply shortfalls. Respondents were presented with information regarding two levels of water use restrictions. The water use restrictions vary slightly by water utility service area, based on each utility’s actual water restriction programs.

In general, a Level 1 restriction was presented as limiting outdoor watering to specific days (e.g., two days per week), times of day (e.g., after dusk), and duration. In more severe water shortage circumstances, Level 2 restrictions would be implemented, which might preclude all turf and garden watering, but might allow limited handheld hose watering of trees and shrubs.

Respondents were presented with three sets of choice questions in order to evaluate their preferences for a range of possible programs to reduce (to varying degrees) the frequency and/or severity of water use restrictions over the next 20 years. Each choice set allowed respondents to choose the program called, “No Additional Actions.” The experimental design for this study comprised 24 programs with varying levels of use restrictions. For each choice set, two of the programs were randomly selected.

Customer Values for Added Water Supply Reliability
A household’s willingness to pay to reduce future water use restrictions depends on a number of characteristics. Researchers applied a conditional logit model to conduct a statistical analysis of the data, in order to infer willingness to pay to avoid different water shortage scenarios. In general, researchers found that in many instances, Level 1 restrictions were viewed as short-term inconveniences, and households did not have a significant willingness to pay to avoid such situations. However, the mean per-household willingness to pay for reducing Level 2 restrictions by one summer out of the next 20 was positive and statistically significant from zero in all cities. These results implied a positive willingness to pay by respondents for increasing water reliability to avoid Level 2 restrictions.

To interpret these results for specific water supply enhancement programs, one needs to add the mean values based on the number and type of restrictions the program is expected to eliminate. For example, in the Long Beach survey, the next 20 years were portrayed as yielding an anticipated seven years with no restrictions, 10 years with Level 1 restrictions and three years with Level 2 restrictions. If a supply

Figure 1. Options & Respondents, by City

Figure 2. Example Choice Set
A study was conducted to evaluate customer preferences for water supply enhancement options. In each city, nine or ten choices were presented, with some variation to reflect local circumstances. Options typically included:

- Reusing more water for outdoor irrigation and industrial applications;
- Adding indirect potable reuse by replenishing local groundwater reservoir supplies;
- Transferring more water from agricultural uses;
- Increasing the price of water to motivate customers to use less;
- Requiring low water use landscaping in new homes and redevelopment;
- Promoting voluntary water conservation through education and incentives (e.g., rebates);
- Importing additional surface water from outside of the region or river basin;
- Adding desalination facilities to convert coastal or brackish waters into drinking water;
- Expanding or adding new surface storage reservoirs.

Water reuse and conservation were consistently among the most preferred options. Figure 1 shows the percentage of respondents who ranked a given option as one of their top three choices. Across all locations, the top three most preferred water supply options included expanding the use of recycled water for outdoor irrigation and industrial purposes, promoting additional voluntary conservation measures through education and incentives and requiring low-water-use landscaping for new development and redevelopment projects.

The study also asked respondents to choose their least-preferred option. Three options consistently were ranked among the least preferred: increasing the price of water, importing surface water from outside the region and transferring more water from agricultural uses to urban areas. In general, this reflects a preference to solve water supply problems with locally available resources, and to avoid price-based rationing.

**Summary**

Estimates of the economic value of drought-resistant water yield indicate a sizable willingness to pay by households to avoid severe water use restrictions. In most cities, customers are willing to accept some level of water use restrictions. However, customers are willing to pay to avoid more severe restrictions. Annual willingness to pay values to avoid these more severe restrictions ranged from $20 (Orlando) to about $37 (San Francisco) per household per year, for each anticipated future year of restrictions avoided.

Customer preferences for different types of water supply options also were evaluated. Results of the survey indicated that the most preferred water supply options typically included expanding the use of recycled water for nonpotable purposes, promoting additional voluntary conservation measures and requiring low-water-use landscaping for new development. Indirect potable water reuse also was one of the more preferable options. Least preferred options were increased water importation and transfers, and using price as a rationing mechanism.

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