# Water Supply Security and Willingness to Pay to Avoid Drought Restrictions*

DAVID HENSHER

*University of Sydney,
Sydney, Australia*

NINA SHORE

*NERA Economic Consulting,
London, UK*

KENNETH TRAIN

*University of California,
Berkeley, USA*

*This paper studies Canberra households' and businesses' willingness to pay (WTP) to avoid drought water restrictions, using stated choice experiments. We find that customers evidence a lack of WTP to avoid most types of drought-induced restrictions. Respondents appear unwilling to pay to avoid low-level restrictions at all and to avoid higher levels of restrictions that are not in place every day. Given the option of watering on alternative days, customers appear willing to adjust their watering schedules compared with paying higher water bills and appear willing to tolerate high-level restrictions for limited periods each year, compared with higher water bills.*

## I Introduction

Water supply systems are designed and maintained to deliver a specific level of supply security. Supply security can be defined, in simple terms, as the probability of running out of water at some defined future point in time. To manage this risk, water utilities regularly make trade-offs. They can choose, for example, to augment existing supply storages, to harvest and distribute alternative water sources (e.g. recycled water), to adopt demand-side measures (e.g. mandate the use of certain water-efficient appliances) or to impose explicit restrictions on water use. Each of these actions imposes a current cost on the community, in return for a future benefit in the form of a reduction in the probability of a (more significant) future restriction in water use. Historically, however, utilities have made this trade-off with little reference to their customers' preferences.

In many jurisdictions, the price of water and wastewater services is regulated under an incentive regulation regime. The intention of such a regime is to provide a financial incentive for businesses to reduce costs, with any cost savings being initially kept by the businesses and then, over time, passed onto customers in the form of lower prices. Ideally, the regulatory regime should provide a framework that will encourage businesses to provide an efficient mix of both quality of service and price to the customer. There are three ways in which service quality typically enters the regulatory framework: (i) via the *level of service quality that is assumed to underlie the revenue requirement* established for the regulated business at the time of each price review; (ii) via explicit *performance incentive schemes* that reward improvements in the *average* level of service quality over and above these targets and/or penalise a business's failure to meet the service targets embodied in the revenue requirements; and (iii) through establishing *guaranteed service levels* for specific aspects of service quality experienced by individual customers (or some larger subset of the total customer base).

A number of regulators in Australia are currently considering the development of an incentive scheme to be incorporated as part of the price control applying

to the utilities they regulate. Some are also considering the role and form of the minimum standards that should be applied to these utilities. A key part of many regulatory reviews is the determination of the amount of operating and maintenance expenditure and capital expenditure that should be reflected in the revenue requirement for the service provider. The desired level of service quality will be the key driver in determining the appropriate level of this expenditure. It is therefore important to be clear as to the level of service quality that is expected to be delivered for the revenue requirement set, that is, the service targets that are incorporated in the regulatory bargain. A growing gap in knowledge to support the difficulty for regulators and service providers in putting forward expenditure proposals is to know the extent to which customers are willing to pay higher prices to experience improvements in quality and which aspects of service quality customers would most like to see improved.

In this paper, we report the results of a study of Canberra households' and businesses' willingness to pay (WTP) to avoid drought water restrictions. Under the current regulatory regime, ACTEW's revenue stream is determined on a 4-year basis. To the extent that ACTEW/ActewAGL can reduce its costs to *below* the levels assumed when the revenue requirement was set, it is able to keep the additional profits made. While such arrangements are beneficial in terms of providing ActewAGL with an incentive to reduce costs, it is important to ensure that such cost reductions *are not made at the expense of service quality*. Ensuring the maintenance of service quality currently relies on various forms of scrutiny, and pressure being brought to bear by the Independent Competition and Regulatory Commission (ICRC) and other relevant agencies. However, such oversight of quality by the regulator can also result in intrusive and costly regulation. As a result, many jurisdictions are moving towards introducing incentive schemes for the maintenance of service quality.

A key input into the design of an effective performance incentive scheme is information on customers' WTP for service quality improvements. Information on customers' WTP allows the incentive scheme to focus on those aspects of service quality that are of key importance to consumers. By highlighting differences between customers in terms of their WTP (e.g. stemming from their current level of service or the ways in which they use water), it allows the incentive scheme to adequately reflect these differences. Customers' WTP also provides an upper bound on the financial quantum that should be associated with service improvements. The lower bound is represented by the incremental cost to the business of improving that aspect of service quality.

Our analysis is based on stated-choice experiments, similar to those used by Cai *et al.* (1998) and Goett *et al.* (2000), for electricity. Louviere *et al.* (2000) provide a description of stated-choice experiments in general and their applications in other areas. Briefly, in a choice experiment, a survey respondent is presented with two or more options for service levels and associated price and is asked to state which option he/she prefers. Different service levels and prices are specified in a repeated set of experiments, to provide the variation that is necessary for estimation. A series of experiments is presented to each surveyed customer, with the experiments varying over respondents. Respondents' choices reveal their WTP to avoid water restrictions. Statistical analysis of the responses, using discrete choice models, provides estimates of the WTP.

In the sections below, we provide an overview of previous studies that have also examined water restrictions, a justification for the stated choice approach over other available methods and then we describe the context to the present study, the sample, the choice experiments, the estimation procedure, the study results and policy implications.

## II  An Overview of Previous Studies

There are a range of studies that have examined the impact of, and residents' attitudes to, drought water restrictions using a range of valuation methods, including choice modeling studies, contingent valuation and the direct costs (or out-of-pocket expenses) attributable to drought-induced water shortages. The empirical results from the studies are somewhat mixed. This is not surprising given the range of survey design and methods adopted. Nevertheless, a number of general themes emerge. First, studies of out-of-pocket expenses tend to suggest drought-induced water shortage have low impact (except in very extreme situations). Second, previous studies using choice experiments have found that consumers reveal low willingness to pay to avoid water restrictions. Third, several contingent valuation studies suggest residents are willing to pay sizeable sums to avoid even minor restrictions (which researchers claim reflects a desire to avoid not only out-of-pocket expenses but also a loss of the range of amenities that plentiful water supplies facilitate (such as green lawns, swimming pools etc.)). We describe the previous studies below, grouped by method.

*(i) Out-of-Pocket Expenses*

Russell *et al*. (1970) examined the impact of a drought in 1960s New England and found that the observable losses to water users – that is, garden and lawn losses to residential customers, lost profits and additional drought-related expenditure by commercial and industrial customers and emergency expenditure by public authorities – were surprisingly small, between $5 and $13 per capita, in 1970 US dollars. Later studies by Dworkin (1973) and Kates (1979) on droughts throughout the United States found similar results, namely, that the out-of-pocket expenses associated with drought-induced shortages, as experienced by about 2.5 million urban residents per year in the United States, were modest, at between $3 and $5 per capita in 1973 US dollars. Nelson (1979) and Meral (1979) studied the 1976–1977 drought in Marin County in Northern California, and estimated quite large costs attributable to drought-induced water shortage, averaging in Meral's study $570 per single family dwelling in 1979 US dollars. It should be noted, however, that the Marin County drought was particularly severe. Normal water withdrawals were reduced by 25 per cent, and in 1977 the reduction was 64 per cent. Emergency measures were relatively drastic, involving the construction of a pipeline to tap into a remote water source. Interestingly, when the drought ended, the pipeline was removed, and citizens in the district voted against an initiative to permanently augment its water supply (Burgess *et al*., 1992).

*(ii) Contingent Valuation*

Howe and Smith (1994) conducted a contingent valuation study of residents in three towns in the United States: Boulder, Aurora and Longmont where it was proposed that residential outdoor water use would be restricted to three hours every third day for the months of July, August and September. They found, first, that between 41 and 58 per cent of respondents indicated that a decrease in supply reliability, even if accompanied by a change in the water bill, was undesirable. Second, of those willing to consider a change in supply reliability, respondents indicated that they would accept between $4.53 and $13.99/month (in 1994 US dollars), on average, for a decrease in supply security.

Griffin and Mjelde (2000) examined customers' preferences in seven Texan cities, using contingent valuation methods. Respondents were found to be willing to pay, on average, between $25.34 and $34.39 (in 1997 US Dollars) to avoid an occurrence of water restrictions. They also found, however, that respondents were willing to pay, on average, $9.76/month (or 25.6 per cent of their bill) to improve future supply security levels. The authors note that the results seem inconsistent, given the expected frequency of restrictions under current supply security levels.

Koss and Khawaja (2001) describe a contingent valuation study of householders' valuation of system security in 10 Californian water districts. Respondents indicated that they were willing to pay, on average, between $11.67 and $16.92/month to avoid restrictions (in 1993 US dollars), depending on the frequency and severity of the restrictions.

*(iii) Choice Modelling*

Gordon *et al*. (2001) present the results of a choice modelling study completed in the same area as the present study (Canberra, Australia). The aim of the study was to estimate residents' WTP to avoid environmental and urban damage caused by constructing a new water storage facility (or dam). The study, however, also investigated customers' WTP to avoid a status quo supply option, which involved a greater use of water restrictions. Results suggest that residents were willing to pay, on average, a very small amount ($10) to prevent a 10 per cent reduction in water use (in 1997 Australian dollars). On the issue of the impact on the urban environment, residents indicated that they were willing to pay $18 per annum to improve Canberra's general urban appearance, from 'brown' to 'some brown', although WTP for further improvements – from 'some brown' to 'green' – was found to be insignificant.

In 2002, Yorkshire Water, a water utility in the United Kingdom commissioned a choice modelling study with similar objectives to the present study, as described by Accent and CREAM (2002) and Scarpa *et al*. (2004). Four service levels were included in the experiments: existing service levels (where the expected frequency of having no water was once every 500 years); a decrement in service levels (once every 250 years) and two levels whereby service was improved (once every 750 and 1000 years, respectively). They found that residential customers were willing to pay only about £0.20 on average for a one-level improvement in reliability (e.g. to reduce the expected frequency of having no water from once every 500 years to once every 750 years). Business customers indicated that they were willing to pay about £1.74, on average, for a one-level improvement.

The studies summarised above show wide variations in WTP. The reasons are unclear, but are likely in part to be linked to the methods used and in part to the specific trade-offs being targeted in particular countries, which differ across the studies. One expects behaviourally different responses according to the historical context of water availability and expectations of shortages. As an application with limited evidence,

it is too early to suggest broad-based domains in which evidence might be expected to reside (in contrast, say to WTP for travel time savings in transportation contexts where a large body of evidence provides converging evidence).

### III Background to the Study

The study was conducted between October 2002 and April 2003 in Canberra, in Australia, on behalf of the region's water service provider, ActewAGL. ActewAGL is a joint venture company, controlled by a major private sector utility group and the local government. It provides water and wastewater services under a service contract, while the infrastructure assets it uses remain the property of ACTEW Corporation (which is wholly owned by the local government). ActewAGL is also a provider of gas and electricity services in Canberra.

Water prices in Canberra are regulated by an independent government authority, the Independent Competition and Regulatory Commission (ICRC). In addition to price regulation, the ICRC also oversees the quality, reliability and safety of services. The WTP study was originally commissioned by ACTEW and ActewAGL in response to a request by the ICRC for information on customers' valuation of service attributes, to assess whether the existing service levels provided by ActewAGL were appropriate. The entire study covered a range of service attributes for each of the utility services provided by ActewAGL, although only the results relating to water supply security are reported in this paper. Hensher *et al.* (2005) reports the study results for other attributes of the water and wastewater service.

The water supply system in Canberra is currently managed to deliver an unrestricted water supply 95 per cent of the time. From a customer's perspective, this means that water restrictions can be expected at most, once every 20 years. Water restrictions are triggered when water in storage reaches predefined levels. It is a staged process, comprising voluntary restrictions and then five stages of mandatory restrictions (constituting increasingly onerous restrictions). Indicative storage levels at which each stage of restrictions may be introduced are 55 per cent for Stage 1; 45 per cent for Stage 2; 40 per cent for Stage 3; 35 per cent for Stage 4 and 30 per cent for Stage 5. The stages are defined separately for business and residential customers (as described in Section V), and are implemented on an 'odds and evens' basis (i.e. every other day). In practice, the system has performed in excess of this minimum standard, with water restrictions rarely having been imposed, until recently.

Following a period of relatively severe drought over 2002, mandatory water restrictions were introduced in December 2002 (following on from voluntary restrictions in November 2002). Since that time, restrictions have remained in place.[1] It is estimated that an equivalent of 16 per cent of total water storage has been saved as a result of these restrictions, a significant portion of which was made during the Stage 3 water restrictions (ACTEW Corporation, 2004).

Continued drought conditions and other compounding problems relating to water supply have led ACTEW and the ACT government to give increasing consideration to water supply security over the past two years.[2] While a commitment has been made to decrease per capita water use by 12 per cent by 2013 and 25 per cent by 2023, proposals to expand Canberra's water storages and to make greater use of drought water restrictions are currently being evaluated (see http://www.actew.com.au/futurewateroptions/). Householders' and businesses' WTP to avoid restrictions has a distinct and important role to play in this decision.

### IV Preparatory Work, Design and Sample

Prior to designing the survey, we conducted a series of exploratory, qualitative group discussions. Three focus groups were undertaken with residential customers and five mini-groups were conducted each with five business customers, each exploring customers' perceptions and experiences of the water service. Information was used primarily to decide which service attributes to include in the choice experiments, as well as how to present and describe the attributes and their levels.

The sample for the main survey was segmented between residential and business customers. For the business segment, quotas by industry size and type were also set, based on Australian Bureau of Statistics profiles, given that the qualitative research had identified that these subgroups had different needs and expectations of their water service. The sample was then randomly generated using the electronic telephone book.

The survey was conducted in two parts – an initial recruitment interview and a choice experiment task. The recruitment questionnaire was designed to target

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[1]At the time of writing, restrictions were at Stage 3 and storage levels were about 50 per cent full.

[2]Whether to expand Canberra's water supply capacity has been the subject of public debate for the past decade or more. In 1994, following a community consultation process, a commitment was made not to build a new dam. However, this issue has resurfaced in the last few years with the recent drought and the need to investigate augmentation options.

individuals who would be responsible for dealing with utility-type decisions such as dealing with supply issues and ensuring that the bill gets paid. Other recruitment criteria were that: (i) participants were to be connected to the water service; (ii) participants were either to receive a bill directly from the water utility or a written notice from their landlord; (iii) participants had to be able to provide an estimate of their annual water service bill; and (iv) participants were not to be employed in the market research industry, advertising, media or public relations, or by a gas, electricity or water utility (in line with standard market research practice in Australia). Once the respondent was deemed to meet these criteria, the choice experiments, as described below, were mailed out to the respondent. The respondent was then contacted by phone, and the choice experiment interview was conducted.

A total of 240 residential respondents and 240 business respondents were recruited. Of the residential respondents, 211 completed the mailed-out choice experiments in a follow-up interview. To obtain the 240 recruited respondents, a total of 486 households were contacted. Of these, 179 refused to be interviewed and another 67 were excluded because they did not meet the criteria listed above. The relevant response rates are therefore: 47 per cent of all contacted households, including those that did not meet the eligibility criteria (211/486), 56 per cent of contacted households that met the criteria for eligibility (211/380, assuming that those households who refused to be interviewed had the same share that would meet the criteria as those who did not refuse) and 88 per cent of households who were mailed the choice experiments (211/240).

Within the business segment, 205 respondents completed the choice experiments. A total of 861 businesses were contacted, of which 211 refused to be interviewed, and another 410 were excluded because they did not meet the criteria listed above. The relevant response rates for the business segment are therefore: 24 per cent of all contacted businesses, including those that did not meet the eligibility criteria (205/861), 64 per cent of contacted businesses that met the criteria for eligibility (205/319, assuming that those businesses who refused to be interviewed had the same share that would meet the criteria as those who did not refuse) and 85 per cent of businesses who were mailed the choice experiments (205/240). Table 1 details the number of interviews that were achieved for each industry type and size.

### V Choice Experiments

A series of six choice experiments covering restrictions on the use of water were presented to respon-

TABLE 1
*Number of Commercial Respondents Recruited*

| Industry | Commercial water achieved |
|---|---|
| Organisation size | |
| < 5 employees | 160 |
| 5–19 employees | 61 |
| 20 + employees | 20 |
| Industry type | |
| Property & business services | 41 |
| Retail trade | 24 |
| Construction | 37 |
| Health & community | 29 |
| Personal & other | 21 |
| Accommodation | 15 |
| Wholesale trade | 7 |
| Finance | 7 |
| Cultural & recreation | 12 |
| Transport & storage | 7 |
| Education | 9 |
| Manufacturing | 21 |
| Government & defence | 5 |
| Agriculture & forrest | 4 |
| Communication | 1 |

dents. Each experiment listed two service options with their descriptions, and the respondent was asked which of the two service options he/she prefers. The range of attributes and levels that comprised each of the options in the choice experiment was as follows:

- The frequency with which drought water restrictions can be expected to occur, with four levels: 'once per year', 'once every 3 years', 'once every 10 years' and 'virtually none'.
- The duration that water restrictions can be expected to last, with four levels: 'all year', 'all summer', '1 month in summer' and 'no restrictions'.
- The types of days that water restrictions apply, with three levels: 'every day', 'on alternate days', and 'no restrictions'.
- The level of water restrictions, with six levels incorporating the five-stage restriction process adopted in the ACT.

For the residential segment, the six levels adopted were:

– Stage 5 – a ban on all outdoor water use (recycling water is permitted);
– Stage 4 – watering of lawns is not permitted. Handheld hoses and buckets can be used in the morning and evening;

– Stage 3 – use of sprinklers is not permitted. Hand-held hoses and buckets can be used in the morning and evening;
– Stage 2 – can use sprinklers for up to three hours in the morning and evening;
– Stage 1 – can use sprinklers morning and evening; and
– No restrictions.

For the commercial sector, the restrictions at each level contained greater detail, reflecting the greater variety of water use by businesses (e.g. public garden fountains, building washing). A copy of the detailed descriptions is available from the authors on request.

• Price, expressed as 'total water and sewerage bill for the year'. The bill was calculated in the experiments as a randomly chosen percentage of the customer's estimate of their actual annual bill. For example, a household or business whose bill in the previous year had been A\$800 would see a price of A\$880 if the random number 1.1 was drawn.

One other attribute – 'appearance of urban landscape including public lawns, parks and spaces' – was also included. This was intended to reflect the additional trade-off relating to the visual amenity of Canberra's urban landscape (e.g. increased use of water restrictions would spoil traditional European-style gardens and lawns or would necessitate increased planting of more water-tolerant native Australian plants). Two levels were adopted for this attribute: 'some brown lawns and no lush green lawns' and 'lush green lawns'.

Each respondent was presented with a series of six experiments. Examples of the experiments, as well as the protocol that was used when interviewing the respondents, are available from the authors on request.

The choice-experiment exercise was pretested twice, in which respondents were queried about their understanding of terminology, whether they felt they could meaningfully evaluate the service options, and their attitudes about the number and presentation of the choice experiments. Some changes in wording were made after the first pretest, and no changes were indicated in the second pretest. In similar experiments on gas service (not reported here, but conducted as part of the same study), respondents in the pretests reported that they found 15 experiments to be too many and that they lost interest by the end. No such complaints were voiced in the pretests of the water-restriction experiments.

The attribute levels that were included in the experiments for each respondent were determined by random selection among the levels listed above for each attribute, with equal probability of each level. When a pair was constructed that consisted of identical options or a dominant option (i.e. at least as desirable on all attributes as the other option and strictly better on at least one attribute), the pair was discarded and another one constructed. A different set of experiments was presented to each respondent. Variation in attributes over respondents is therefore utilised in addition to the variation for each respondent. Given the large number of possible combinations relative to the number of choice situations faced by each respondent, this variation over respondents is useful in estimation, in the same way that variation over observations in revealed-preference data is useful.

## VI Model

The respondent's choice between the two options in each experiment is modelled with a standard binary logit model (McFadden, 1974). The utility that respondent $n$ obtains from, or ascribes to, service option $i$ is $U_{ni} = \beta' X_{ni} + \varepsilon_{ni}$, where $X_{ni}$ is a vector of attributes of the option, $\beta$ is a vector of coefficients that reflect the relative importance of the attributes, and $\varepsilon_{ni}$ is a random term that is assumed to be distributed IID extreme value. The probability that the respondent chooses alternative $i$ when offered options $i$ or $j$ is $P_{ni} = \frac{e^{\beta' X_{ni}}}{e^{\beta' X_{ni}} + e^{\beta' X_{nj}}}$. The parameters are estimated by maximum likelihood. Mixed logit models, which are more general than standard logits (Train, 2003), were tested, but no significant improvement was obtained from the extra generality. Stated more precisely, the restrictions on the mixed logit models that result in a standard logit could not be rejected.[3]

## VII Estimation Results

### (i) Residential Segment

Table 2 gives estimation results for residential customers. The scenario of no restrictions is taken as the base against which other scenarios are compared; that is, the coefficient of each listed attribute gives the impact of that aspect of restrictions on utility relative to a scenario with no restrictions. The WTP to avoid an

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[3]Mixed logit allows each coefficient to have a mean and variance in the population, while standard logit contains fixed coefficients, which is equivalent to a mixed logit with zero variances. A test of logit against mixed logit is, therefore, a test of the significance of the variances of coefficients. As we discuss in the next section, few variables enter significantly, reflecting the fact that households are not willing to pay for most types of restrictions. Given that few fixed coefficients are significant, it is not surprising that the variances of coefficients are not significant.

TABLE 2
*Model of Residential Customers' Choice Among Water Restriction Scenarios*

| Variables | Estimates | *t*-stat |
|---|---|---|
| Price as share of current bill | −3.4539 | −7.85 |
| Frequency of restrictions that 'don't matter'[†] | −0.0298 | −0.27 |
| Frequency of restrictions that 'matter'[†] | −1.0798 | −3.15 |
| All year | −0.2667 | −2.73 |
| Every day | −0.0997 | −1.13 |
| Stage 3 | −0.3881 | −3.29 |
| Stage 4 | −0.4871 | −3.99 |
| Stage 5 | −1.1069 | −8.78 |

[†]Frequency is expressed on a per-year basis, such that, for example, 'once every 10 years' is expressed as 0.10 and 'once every year' is expressed as 1.0. Restrictions that 'matter' are defined as those that apply every day, last all year, and are Stage 3 or higher. Other restrictions are labeled as 'don't matter.'

undesirable attribute is calculated as the coefficient of that attribute divided by the price coefficient. Indicators are not included in the model for restrictions that last a month or all summer, apply every other day, are Stage 1 or 2, or result in brown lawns in public areas, because these were found not to be significantly different from no restrictions. This lack of significance is an important finding, in that it indicates that customers are not willing to pay to avoid most types of restrictions – in particular: restrictions that last only for the summer or less (as opposed to all year), still allow unrestricted water use on alternate days, or still allow sprinklers to be used in certain times. Similarly, customers evidence an unwillingness to pay to avoid brown lawns in public areas. In contrast, indicators are included in the model for restrictions lasting all year, every day and for Stage 3 or higher, each of which was found to be evaluated negatively.

In conformance with the indicator variables, the frequency of restrictions is differentiated into two variables: 'frequency of restrictions that matter', defined as those that apply every day, last all year and are Stage 3 or higher, and 'frequency of restrictions that don't matter', which are all other restrictions. This differentiation was determined after extensive testing of alternative definitions, that is, using a breakpoint of Stage 2 or higher instead of Stage 3, and so on. The names 'restrictions that matter' and 'don't matter' are given to reflect thet fact that the frequency of the former enters with a significant and relatively large, negative coefficient, indicating that these restrictions matter to households, while the frequency of the latter enters with an insignificant and relatively small coeffi-

cient, indicating that these restrictions do not matter to households. (When restrictions are not differentiated, their frequency obtains an estimated coefficient that is small in magnitude and highly insignificant. This non-differentiated result masks the fact that households do indeed care about severe restrictions, though not about most types of restrictions.) These results are consistent with the finding of the focus groups that customers are not willing to pay to avoid most types of restrictions, but are indeed willing to pay to avoid the most severe restrictions.

The point estimates imply that respondents evidence a WTP of 31.26 per cent of their water bill (i.e. −1.0798/−3.4539) of $765, or $239 on average, for a one-unit reduction in the frequency of restrictions 'that matter'. Note that since restrictions that matter last all year, frequency of 1 (once a year) means that restrictions apply continuously, all year, every year. Similarly, a frequency of 0 means that there is virtually no chance that restrictions will be imposed.[4] Reducing frequency from 1 to 0 represents a change from continuous restrictions to virtually no chance of restrictions. That is, $239 is the amount that householders are willing to pay, on average, to move from a situation with continuous restrictions at Stage 3 or above every day all year every year, to a situation with virtually no chance of restrictions.

The amount that customers are willing to pay to reduce the frequency of restrictions that matter from, say, once every 10 years to once every 20 years is $11.95 on average (one-twentieth of $239 – as the situation reflects a reduction in frequency of restrictions by one-twentieth). Similarly, the amount householders are willing to pay to reduce the frequency of restrictions that matter from once every 20 years to once every 30 years, say, is $3.98 on average (one-sixtieth of $239). Likewise, customers need to be compensated by $227 on average (95 per cent of $239) to accept an increase in the frequency of restrictions that matter from once every 20 years to once every year.

Several points are important to consider when interpreting the results of this analysis for the purpose

[4] 'Virtually no chance' was adopted in place of 'no chance' as it married better with the descriptions of other attributes in the choice experiments. If the frequency of restrictions was actually specified as 0 or 'no chance', then it would not make sense to also have the other attributes describing the nonexistent restrictions. That is, the choice experiments would not make sense if one variable specifies 'no chance of restrictions', while the other variables specify the type of restriction such as 'Stage 3', 'every day', etc. However, it does make sense to say that 'the chance of restrictions is virtually none' but if they happen to occur, then the restriction will be Stage 3, every day etc.

of planning and investment. First, the choice experiments include only three lengths for the restrictions: 1 month, all summer and all year. Interpolation of the results to other lengths is a matter of interpretation, beyond the actual data obtained in the study. For example, customers might be willing to pay to avoid Stage 3–5 restrictions that last, say, 10 months, but as that length is not examined in the study, no conclusions can be drawn with regard to this length (beyond the necessary implication that the WTP is no more than that for restrictions that last all year.) Second, in the experiments, the length of the restrictions is stated to the respondent, such that the respondent knows how long the restrictions would last when evaluating them. In practice, water restrictions have been, and probably will be in the future, imposed without a specified ending date. That is, the length of the restriction is not known beforehand, only after the restrictions have been lifted. It is possible that customers react differently to restrictions whose length is not known beforehand than to restrictions of a known length.

In calculating the WTP to have restrictions in place for a limited period or not at all, rather than all year, we have to account for the presence of two frequency variables: the frequency of restrictions that matter and the frequency of restrictions that do not matter. When the restrictions go from being 'all year' to less than all year, then the restrictions are no longer restrictions that matter. So the frequency of restrictions that matter goes to zero, and the frequency of restrictions that do not matter goes to whatever it had been for restrictions that matter. For example, suppose we start with a situation of restrictions that matter, which by definition are 'all year' and the frequency of such restrictions is 0.1 (one in 10 years). Now, we change the restrictions from being all year to their being only for 1 month. This means that the restrictions are no longer ones that matter. The WTP for this change is calculated as − [(coefficient of 'all year' dummy) + (coefficient of frequency of restrictions that matter−coefficient of frequency of restrictions that don't matter)∗frequency]/ price coefficient. Using the frequency of 0.1 and the coefficients in Table 2, the WTP is [0.2667 + (1.0798−0.0298)∗0.1]/3.4539 = 0.10762 or 10.76%. This implies that respondents evidence a WTP $82.3 on average, to have restrictions in place for a limited period or not at all rather than all year, given that the frequency of restrictions is once in every 10 years.

Second, we can estimate the amount customers are willing to pay, on average, to have restrictions apply on alternative days or not at all rather than every day. No statistical difference is found in respondents' choices between restrictions that apply every other day and

no restrictions at all. The ability to use water on the 'off' days make the every-other-day restrictions fairly benign. The estimates imply that respondents evidence a WTP of 5.93 per cent of their water bill, or $45.4 on average, to have restrictions in place on alternative days or not at all rather than every day, given that the frequency of restrictions is once in every 10 years.

Third, the amount customers are willing to pay to have Stage 1 or 2 restrictions (or no restrictions) rather than Stage 3 restrictions, for whatever frequency the restrictions occur can also be calculated. The Stage 4 and Stage 5 variables can be interpreted in a similar way. The estimates imply that respondents evidence a WTP of 14.3, 17 and 35 per cent of their water bill, to have Stage 1 or 2 restrictions rather than Stage 3, Stage 4 or Stage 5, respectively. The equivalent average dollar amounts are $109, $130, and $268, given that the frequency of restrictions is once in every 10 years.

As stated above, the variable relating to the appearance of urban landscape is omitted from the model, because it is not statistically significant. Respondents evidence no WTP to avoid brown lawns in public areas. Apparently, respondents feel that having brown lawns occasionally, in drought conditions, was acceptable.

The results for the residential segment are in line with the results obtained in the initial qualitative work conducted as part of the study. In the focus groups, residential participants indicated that they could live with regular restrictions provided the restrictions did not exceed level 3. Such restrictions were not perceived as lowering water supply service standards, but rather they were perceived as a 'sensible way of doing things'. Low-level water restrictions were perceived to reinforce nonwasteful behaviour, which ultimately benefited the customer by ensuring they did not use (and pay for) water unnecessarily. However, some participants in the focus groups foresaw that living with water restrictions would soon become a difficult chore. These participants often qualified the initial acceptance of water restrictions by stating that they would not want to endure restrictions for a long period of time (up to 8 weeks of restrictions was noted as the desired maximum restriction period by these participants). Water restrictions beyond low levels were therefore not generally accepted as a long term solution to Canberra's future water needs.

The results are also consistent with those from previous studies conducted in Canberra. In a recent project by the local government, a number of focus groups were held with the purpose of eliciting residents' preferences on future water supply options. Six focus groups specifically targeted demand

management options. Of these, one group concluded that permanent Stage 1 water restrictions 'made sense', while another concluded that water restrictions up to Stage 2 would have minimal effect but Stage 3 and above would 'affect Canberra's garden city image'. Results also appear consistent with Gordon *et al*. (2001), which, as noted in Section II, found that residents were willing to pay only very minor amounts to prevent a 10 per cent reduction in water use (equivalent to Stage 1 restrictions). On the issue of the urban environment, residents also indicated that they were unwilling to pay to avoid a change in Canberra's urban environment from 'green' to 'some brown lawns and no lush green lawns'.

Our study results, however, stand in stark contrast to the contingent valuation studies conducted in the United States. They are, however, consistent with the results of studies of out-of-pocket expenses associated with drought-induced water shortages.

Household characteristics are not entered into the model. The primary reasons to enter demographics are for the design of different levels of service for different demographic groups, to estimate equity impacts across demographic groups (such as income classes), and/or for forecasting the impact of changes in demographics. None of these tasks was a goal of the project. The water utility is not able to offer levels of restrictions and rates to different demographic groups, and the purpose of the study was to determine the current distribution of WTP to avoid restriction by the population of customers as a whole.

*(ii) Business Segment*

The model of business customers' choice among water restriction scenarios is given in Table 3. Importantly, commercial respondents evidence exactly the same pattern of WTP, and an unwillingness to pay, to avoid water restrictions as residential respondents. In particular, no significant difference is found in respondents' choices between a situation of no restrictions and restrictions that last 1 month or all summer, apply every other day or at Stage 1 or 2. Also, respondents evidence no WTP to avoid brown lawns in public areas during periods of drought.

The only restrictions that business respondents evidence a WTP to avoid are restrictions that last all year, are applied every day and are at Stage 3 or above. Respondents evidence that they are willing to pay 23 per cent of their current water bill to avoid these types of severe restrictions. Given the respondents' bills, this share translates into an average WTP of $1,104 and median WTP of $239. The share is smaller than for residential customers, but the median amount in

TABLE 3
*Model of Business Customers' Choice Among Water Restriction Scenarios*

| Variables | Estimates | *t*-stat |
|---|---|---|
| Price as share of current bill | −2.4839 | 9.01 |
| Frequency of restrictions that 'don't matter'[†] | −0.0661 | 0.40 |
| Frequency of restrictions that 'matter'[†] | −0.5763 | 1.37 |
| All year | −0.3326 | 3.33 |
| Every day | −0.0562 | 0.63 |
| Stage 3 | −0.2248 | 1.77 |
| Stage 4 | −0.3840 | 3.19 |
| Stage 5 | −0.7387 | 5.75 |

[†]Frequency is expressed on a per-year basis, such that, for example, 'once every 10 years' is expressed as 0.10 and 'once every year' is expressed as 1.0. Restrictions that 'matter' are defined as those that apply every day, last all year, and are Stage 3 or higher. Other restrictions are labeled as 'don't matter.'

*Note:* WTP figures expressed as share of bill.

dollars is nearly exactly the same as for residential customers.[5] This comparison suggests that residential and business customers are about equally concerned about water restrictions, something which ex ante we had not anticipated.

Again, the results for business customers are in line with those obtained from the initial qualitative research. In the focus groups, business participants generally noted that water restrictions did not impact on the core functions of their business and accordingly, from their business perspective, they were not concerned about the frequency, level or duration of water restrictions. The key exception was businesses involving irrigation (such as market gardeners, golf clubs and sport fields). Irrigators did express concern about water restrictions as they felt it would be impossible to meet the water reduction targets that form part of the water restrictions applicable to businesses. This was because they considered that their irrigation systems were already extremely efficient, and that there was little to no excess consumption that could be trimmed without having a significant impact on their business operation. These participants noted that they would contact their water supplier (e.g. to apply for an exemption or to discuss alternative water sources) in the event that water restrictions were put in place. Businesses involved in agriculture, forestry, fishing

[5]For residential customers, the mean and median bills are nearly the same, while for business customers, the mean is far higher than the median. A comparison of medians seems more appropriate when making statements about customers 'in general'.

and mining comprise about 1 per cent of the total business population in Canberra.

## VIII Conclusions

The primary finding of our analysis is that customers evidence a lack of WTP to avoid most types of drought-induced restrictions. Respondents appear unwilling to pay to avoid low-level restrictions at all (Stage 1 or 2 level restrictions). They also appear unwilling to pay to avoid higher levels of restrictions (Stage 3 or higher) that are not in place every day, and all year. Given the option of watering on alternative days, customers appear willing to adjust their watering schedules compared to paying higher water bills. Similarly, customers appear willing to tolerate high-level restrictions for limited periods each year (up to all summer), compared with paying higher water bills. These results stand in stark contrast to the results of past contingent valuation studies on the subject, but are in keeping with the only other choice-modelling study and studies of out-of-pocket expenses associated with drought-induced water shortages.

The outcomes of the qualitative research highlight two potential reasons for these results. First, any inconvenience associated with low-level restrictions may be offset by some welfare-enhancing novelty factor (e.g. a 'feel good' factor about using water responsibly). Second, customers may not be particularly inconvenienced by low-level restrictions – if restrictions are sufficiently flexible to allow customers to maintain their existing lifestyle (e.g. maintenance of a garden).

From a policy perspective, the results show that ACTEW would be justified in considering the implementation of permanent low-level restrictions, while noting this may not in itself provide a solution to current water security issues in the ACT. The ACT is currently experiencing the worst drought in its climatic records. This has resulted in water restrictions applying to Canberra residents for the first time in decades, prompting ACTEW and the ACT Government to investigate and assess future augmentation options. The findings of the WTP study will help ensure that the community's perspective on water security can be captured in this process. There is clear evidence to suggest from the study that a sustained period of high-level water restrictions imposes a relatively high cost on the ACT community that can be directly compared with the cost of augmentation solutions.

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