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ACCEPTANCE OF WATER RECYCLING IN AUSTRALIA: NATIONAL BASELINE DATA

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Abstract

Water recycling is recognised by policy makers and the water supply industry as being an important strategy in the management of urban water supplies. Following prolonged drought conditions, combined with predicted water demand, sewer mining has been given the official go-ahead in Sydney, indirect potable reuse is back on the planning agenda and various alternatives, including desalination, are either established, planned, or in the process of being implemented. With wide acknowledgement of the need for triple bottom line outcomes, the social aspect of water recycling needs to be considered along with the economic and environmental benefits. To what extent do Australians accept the introduction of water recycling as a water conservation strategy? Key results of a national survey (n=2504) are presented in this paper that confirm the historical preference for non potable (not for drinking) uses of reclaimed water. In addition, this research finds that householders are willing to use a range of alternative sources of water in the home and for purposes that will involve direct bodily contact.

Background

While there is no published literature in Australia on national findings relating to

public acceptance of recycled water, a few scholarly studies have demonstrated that various communities, in Sydney (Sydney Water 1996; Roseth 2000), Perth (ARCWIS 1999), and Adelaide's residential reuse sites (Marks 2003; McKay & Hurlimann 2003:48), are enthusiastic about non potable (not for drinking) uses of reclaimed water (water sourced from sewage effluent treated to a standard suitable for its end use). The same communities are more reluctant to recycle the water for potable uses. The percentages in Table 1 represent the proportion of each sample that support reclaimed water for a range of non potable and potable uses.

Of some interest is that one national telephone survey on public perceptions of health risks (Star, Langley & Taylor 2000; n=2008) included questions on "reuse of treated sewage on crops" and parklands. Despite the negative bias (omitting that the water is treated to suit its end use), around half the sample of Australians believed that the reuse for crop irrigation and parklands would involve low or minimal health risks (approximately 47 per cent for crops, and 53 per cent for parklands).

Another more recent telephone survey (UMR Research, n=600) on behalf of the Government of New South Wales reports that 29 per cent of Sydney residents were

very, or, mildly comfortable with "drinking recycled sewage, including toilet water, that is treated to drinking water quality" (Davies 2005). However when the process of indirect potable reuse was described, as involving the mixing of reclaimed water with rainwater in Warragamba Dam, "48 per cent supported the 'shandyng' option" (Davies 2005). A similar result was generated through a Clean Up Australia poll that reported Sydney people were "46.4 per cent in favour" of "pumping treated sewage into Warragamba Dam" (Clean Water Campaign 2005).

It has been argued that findings from general population surveys that focus on policy-type questions need to be differentiated from those that present more salient options. In the case of recycling water, the salience of a proposal means that its implementation is imminent (Bruvold 1988) or that bodily contact, personal use or ingestion is specified (Marks 2004:46). For example, recent work completed by CSIRO (Po *et al* 2005) in Melbourne and Perth queried respondents' intended action, rather than support for proposals. In relation to the Werribee Irrigation District's use of recycled water for crop irrigation, 35.0 per cent of respondents (n=400) indicated they would buy the vegetables without hesitation, and a further 55.5 per

Table 1. Acceptance of recycling reclaimed water (total percentages favour/agree).

	Sydney 1996 n=1000	Sydney 1999 n=1300	Perth 1999 n=666	New Haven 2000 n=20 ¹	Mawson L. 2001 n=20 ¹	Mawson L. 2002 n=136
Golf courses			95			
Recreational parks	94	97	89	100	100	
Household gardens	95	97	88	100 ²	95 ²	99
Car washing	96	96				
Home toilet flushing	96	96	95			
Vegetable crops	96	94		95	90	
Home laundry	77	75	51	50 ²	58 ²	49
Showering	55	52	31			
Cooking	33	34		45 ²	32 ²	
Drinking	27	26	16			0.7

Note: 1. Face to face interviews (qualitative research) with randomly selected householders.
2. Both types of applications included in the one statement.

cent were unsure (Po *et al* 2005:83). Most of the reasons (n=223) for being unsure related to the need for reassurances that the water would be treated properly or that safety would be guaranteed (2005:84). In Perth, respondents considered the planned Managed Aquifer Recharge (MAR) indirect potable reuse scheme and 31.3 per cent were unconditionally willing to drink the water (2005:52). Another 51.0 per cent had reservations, and 17.8 per cent indicated they would not drink the water. A total of 72.1 per cent of reasons (n=205) for being unsure related to respondents' concern about health risks (2005:53), as found in the Melbourne research.

As far as other alternative sources are concerned, the ARCWIS (1999) study mentioned earlier found that Perth residents preferred recycling water sourced from stormwater than reclaimed water. And in the ongoing recycled water vs. desalination debate, the aforementioned UMR Research study found that "65 per cent of people support desalination" (Davies 2005).

The risk literature, involving psychometric, social and cultural studies, confirms that risks are more acceptable if they are visible, voluntary, familiar, controllable, fair, forgettable, acute (as opposed to long term, chronic effects), immediate (rather than delayed) and natural (see for example Fischhoff *et al* 1978, Otway & von Winterfeldt 1982, Marris & Langford 1996). Risks that are most dreaded or unacceptable are new, higher technologies experienced involuntarily that have delayed consequences for masses of people (Fischhoff *et al* 1978:143; also Beck 1992, Giddens 1990). Current sociological thought on embodiment of risks is also relevant, as found in the growing literature on biotechnology, where acceptance is shaped by usefulness, moral and ethical considerations (e.g. Paula 2001). People (consumers) are particular about what they consume. To further complicate matters, risk perceptions of recycled water are likely

to be mediated by trust in the technology and those that control the ongoing management of the risks (Marks 2003, 2004; Po *et al* 2005; Hurlimann 2005).

Research Design and Methodology

The objectives of the survey were to establish national benchmark data on acceptability of a range of water recycling options and to explore the influence of context (prior experience, trust), values, beliefs and relevant demographics. The target population for the survey included householders who had experienced water restrictions over the previous summer period. Therefore, all capital cities except Darwin were included. The telephone survey was developed by the Flinders University researchers and administered through the University of Queensland Social Research Centre from November to December 2004 and completed in January 2005. The total finished sample was 2504, comprising approximately 357 respondents in each city, with an overall response rate of 29.6 per cent (that is, of 8,467 persons contacted, 2504 responded to the survey). This response was lower than expected, although it is comparable to that experienced for similar surveys (e.g. Po *et al* 2005). Representativeness of the sample to the seven target populations was assessed by comparison with relevant Census data (2001) revealing some biases on age, education and gender (our sample was older, more highly educated, with gender evenly distributed). Post hoc weights were then constructed to correct these biases. Sampling weights based on the relative sizes of cities were also calculated to permit estimation of representative national results. In addition, a follow-up survey of non respondents (total n=400) was conducted in September 2005. The results confirm that the initial non respondents do not vary greatly from respondents in the main sample. All results reported here are weighted using post hoc and sampling weights.

Due to the large sample size, all figures reported are representative of responses that would be found in the target population. That is, it can be claimed, at the 95 per cent confidence level, that average percentages in the population would vary only slightly from the sample percentages (within an interval ranging from plus or minus one to two per cent above and below the percentages shown).

This paper will detail the questions put to respondents and their responses to accepting alternative options to traditional mains water supply. Note that all 'don't know' responses were not offered, but volunteered. Reporting the results for each capital city is beyond the scope of this article and will be undertaken elsewhere. Space limitations also prohibit presentation and discussion of the influence of a range of factors as well as a more detailed analysis of the reasons given by respondents for their responses.

General Acceptance of Reclaimed Water

To gauge attitudes to the policy of introducing reclaimed water for non potable uses, respondents were presented with the following explanation and uses of recycled water. The results are recorded alongside each item in Table 2, and the level of support towards the applications is graphically illustrated in Figure 1.

Treated wastewater or sewage effluent is normally discharged to rivers or the ocean, but can be reclaimed for recycling. These uses for reclaimed water are not for drinking but the reclaimed wastewater is highly treated to suit the end use. Please indicate whether you strongly favour, favour, oppose, or strongly oppose these uses of reclaimed water [as listed in Table 2].

The questions were presented to respondents in the order they appear in Table 2. Figure 1 ranks the results which confirm that recycling reclaimed water for the irrigation of golf courses, parks, gardens and flushing of public toilets is strongly

Table 2. Acceptance of recycling reclaimed water (percentages, n=2504).

	Strongly favour	Favour	Total in favour	Don't know	Oppose	Strongly oppose
For flushing toilets in public buildings	56.5	37.7	94.1	1.4	3.6	0.9
Commercial laundries	32.4	43.6	76.0	3.7	18.6	1.7
For irrigating golf courses, parks & gardens	60.5	36.1	96.6	0.4	2.7	0.3
school yards and playing fields	45.0	41.6	86.6	1.7	10.8	0.9
dairy, beef and sheep pasture	34.9	40.2	75.1	3.2	19.4	2.3
vegetables and fruit crops	28.9	39.3	68.2	3.4	24.6	3.8
vineyards	29.6	44.3	74.0	3.5	19.7	2.9

Note: - Refusals and missing data not included (involving one respondent on four responses).

- At the 95% confidence level, population % would fall within $\pm 0.7\%$ through to $\pm 1.9\%$ of 'total in favour' figures.

favoured by over half the sample. Support for the remaining uses is also confirmed with the median falling within the 'favour' category. Less enthusiasm ('strongly favour') is indicated for irrigating school yards and playing fields, followed by personal contact through laundering of clothes and uses involving indirect ingestion.

Awareness of water recycling was explored with respondents being asked whether they had experienced any of these uses of reclaimed water. A total of 22.7 per cent had some experience, or said that they were aware of examples of water recycling, and 73.9 had no experience.

Willingness to Recycle Reclaimed Water

Recycling reclaimed water within households was queried as follows:

If reclaimed water became available to your household, how willing would you be to use it for [Table 3]: willing without hesitation, willing with some qualifications, or not willing?

The various uses were given in the order they appear in Table 3, from applications that may involve indirect contact, through to those that are more salient, that is, uses involving bodily contact or indirect ingestion. As predicted, closeness of contact governed willingness to recycle. Even so, there is little difference between levels of acceptance for those uses where contact can be avoided (toilet flushing and garden irrigation) and some others where contact is inevitable (hand watering and car washing). The medians for these first four uses fall within the highest level: 'willing without hesitation'. Obviously, there is some resistance to using reclaimed water in the laundry, with more than a quarter of the sample indicating they are not willing to do so. While a detailed analysis of reasons relating to hesitation on laundry use cannot be undertaken here, the overarching theme for concerns with respect to one or more of the applications listed in Table 3 is concern for health risks (articulated as chemicals, water quality, safety, health risks, etc).

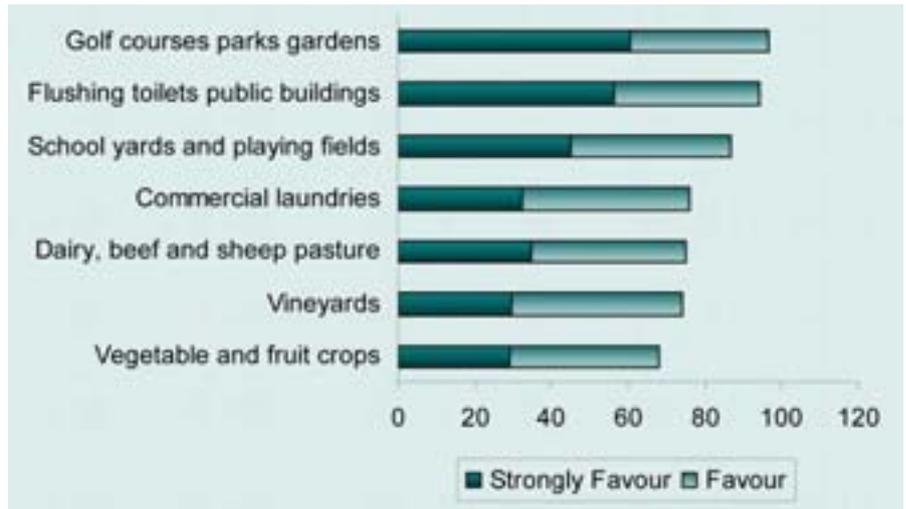


Figure 1. Percentage 'strongly favour/favour' recycling reclaimed water (n=2504).

Box 1. Questions on salient options.

There are at least six ways of recycling different sources of water in the home that are currently being considered.

1. Individual greywater units can treat used water from the laundry and shower for household garden watering and toilet flushing. How willing would you be to have this type of unit installed?
2. Reclaimed water – that is highly treated wastewater - could be recycled for outdoor uses only, such as watering your garden. It would be distributed from a municipal treatment plant through purple pipes. How willing would you be to connect to this service?
3. Reclaimed water could be recycled for toilet flushing as well as for watering your garden, while treated rainwater from roofs could be used for other uses. If you were in the market for a new home, how willing would you be to buy into this type of housing development if other features met your needs?
4. Stormwater, that is, water drained from streets and other areas, can be treated for recycling. How willing would you be to use it for toilet flushing and garden watering?
5. Stormwater can also be treated to a high, drinking water quality. How willing would you be to use it for all your water needs in your household, including drinking?
6. Finally, seawater can be used. Desalination removes the salt and has been an expensive option that uses a lot of energy, but is becoming more economical. If desalinated water became available, how willing would you be to use it in the same way as you use the current mains water?

Six water recycling options

To increase the salience of water recycling six scenarios were put before respondents (Box 1). These centred on the use of different sources of water that included reclaimed water, greywater, rainwater, stormwater and desalinated seawater. Rather than providing detail that would be unmanageable within the allotted time and could tax respondents' patience, the

different options were summarised to include distinguishing features of those that are either established or under consideration in different parts of Australia. Results of this line of questioning on willingness are as listed in Table 4, in the order given to respondents.

City householders are willing to recycle all these sources of water with preference given (over 60% 'willing without hesitation', Table 4) for non potable uses of reclaimed

Table 3. Willingness to recycle reclaimed water for the household (percentages, n=2504).

	Willing without hesitation	Willing with some qualifications	Total willing	Don't know	Not willing
Toilet flushing	77.6	18.8	96.5	1.0	2.6
Garden irrigation	80.8	15.1	95.9	0.8	3.2
Hand watering	80.1	15.1	95.1	0.5	4.4
Car washing	77.2	14.1	91.3	1.3	7.4
Washing machine	38.7	34.6	73.3	0.8	26.0
Hand washing	34.7	32.6	67.4	1.1	31.5

Note: - Refusals and missing data not included (involving from three to six respondents of the total sample).
 - At 95% confidence level, population percentages would fall within $\pm 0.7\%$ through to $\pm 1.9\%$ of 'total willing'.

Table 4. Willingness to use water through salient options (percentages, n=2504)

	Willing without hesitation	Willing with some qualifications	Total willing	Don't know	Not willing
Grey water installed for garden and toilet flushing	59.9	34.2	94.1	0.7	5.1
Reclaimed water for garden	63.3	30.2	93.6	1.5	5.0
Reclaimed water for garden, toilet and rainwater for all other uses	75.8	19.7	95.5	1.4	3.1
Stormwater for garden and toilet	83.9	12.4	96.3	0.4	3.3
Stormwater for all uses including drinking	25.5	48.1	73.6	1.1	25.2
Desalinated seawater for all uses	51.4	39.7	91.1	0.7	8.1

Note: - Refusals and missing data not included (involving from two to seven respondents of the total sample).

- The medians fall within the 'willing without hesitation' category except for potable uses of stormwater where the median is within 'willing with some qualifications'.

- At the 95% confidence level, percentages for the population would fall within $\pm 0.8\%$ to $\pm 1.9\%$ of 'total willing'.

water and stormwater. Taken together with 'some qualifications', over 90 per cent of respondents would be willing to undertake recycling on their property for toilet flushing and garden watering, or accept the desalination alternative. The ranking of the high positive response is depicted in Figure 2 which illustrates highest acceptance (willingness without hesitation) of non potable uses of stormwater while willingness to use stormwater for all household needs including drinking is ranked well below all other options. Following the questions on stormwater (Box 1, questions 4 and 5), respondents were asked for their level of confidence in specific potable uses, and the results are presented in the next section.

Potable Reuse

Potable reuse involving reclaimed water was treated as a separate question from the six scenarios to make respondents more aware of what was being proposed. When finalising the wording to these questions, the advice of proponents of potable reuse was sought and some were concerned that the descriptions, that include the word 'sewage', would "put people off" or, worse, "would cause a stir". However, the aim of the exercise was to ensure transparency in communicating the concept, to assist people in making an informed choice, and to ensure that there would be no surprises for them in the future when indirect potable reuse might be considered for implementation in their city. The wording of the introductory statement is as follows:

Reclaimed water – that is, water reclaimed from wastewater or sewage effluent - can also be treated to drinking water quality. It can then be mixed with traditional sources, such as water collected in reservoirs, and then treated and piped in the usual way to the whole city or town.

Have you heard of this before?

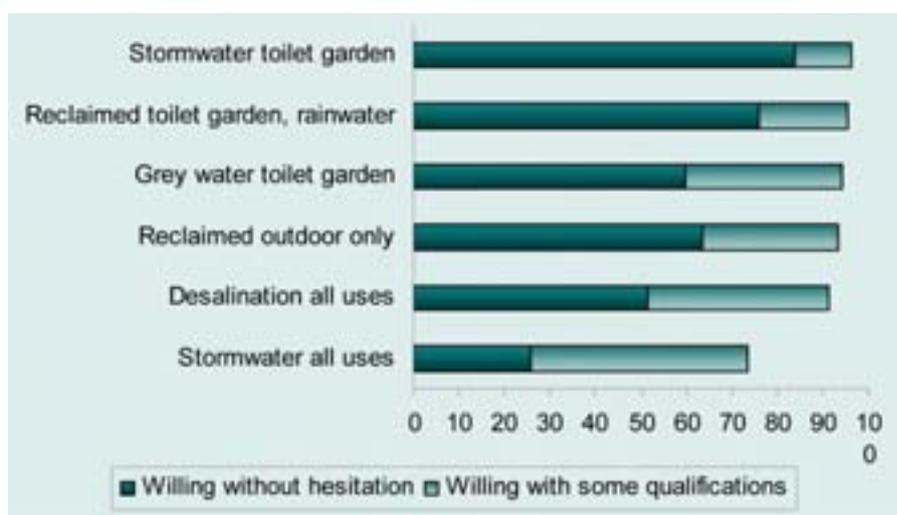


Figure 2. Willingness to use water through salient options (percentages, n=2504).

A total of 35.0 per cent of respondents had heard of the 'indirect potable reuse' concept, with 64.3 per cent saying they had not heard of this form of recycling reclaimed water (17 were unsure, 0.7 per cent). Respondents were then asked if they would be willing to use the water:

How willing would you be to use water mixed with reclaimed water, treated to drinking water quality, for all your household needs?

As with previous questions, there were few missing data (1 refusal, 4 missing data). A total of 22.2 per cent were willing to use the water without hesitation, 50.5 per cent were willing with some qualifications, 26.0 per cent are not willing and only 1.3 per cent expressed uncertainty (unsure/don't know). The median falls within the category 'willing with some qualifications' and a total of 72.7 per cent are willing to recycle the water in this way, albeit with some qualifications.

To build salience of the issue, respondents were then asked how much confidence they would have in using it for showering, cooking and drinking. The same question

was asked of them earlier in relation to using drinking water quality stormwater. Both results, reflecting trust in potable reuse, are compared in Table 5, Figure 3.

This exercise provided respondents with the opportunity to give closer consideration to potable reuse and, not surprisingly, overall, the result is more conservative than the 'willingness to use' questions. The median result lies within 'moderate confidence' for all but drinking where it rests within 'not much confidence'. However, respondents are more 'confident' on the more salient options of showering with stormwater or reclaimed water (Table 5: Total confident) than they are 'willing to use' either water source for all household needs (a more general, less salient measure), being 73.6 per cent (stormwater, Table 4) and 72.7 per cent (reclaimed water) respectively.

Although a detailed analysis of qualified responses cannot be included here, the main comments given by respondents at the end of this section can be summarised as concerns about health risks and the need to have more information made available.

Table 5. Confidence in potable uses of stormwater, or reclaimed water through indirect potable reuse (percentages, n=2504).

	n=	Great confidence	Moderate confidence	Total confident	Don't know	Not much confidence	No confidence
Drinking water quality stormwater							
showering	2498	42.0	39.6	81.6	0.5	11.8	6.2
cooking	2499	25.1	31.0	56.1	0.7	18.8	24.4
drinking	2496	19.4	26.8	46.2	0.5	19.6	33.6
Water mixed with reclaimed water treated to drinking water quality							
showering	2498	36.5	39.3	75.8	0.5	13.0	10.7
cooking	2500	21.1	33.0	54.1	0.4	17.2	28.3
drinking	2498	14.7	26.9	41.5	0.7	20.0	37.8

Note: - Refusals and missing data not included (four to eight).
 - The medians fall within the 'total positive' category except for drinking where they rest in 'not much confidence'.
 - At the 95% confidence level, percentages for the population would fall within $\pm 1.6\%$ to $\pm 2\%$ of 'total positive'.

In addition to the earlier question on prior awareness, respondents were given a description of 'unplanned indirect potable reuse'. This was included to build knowledge while gauging public awareness of this aspect of the water cycle that is so familiar to water engineers. Interviewers were instructed to read the following explanation very slowly:

One way of thinking about recycling water is that it already occurs wherever water supply for drinking is withdrawn downstream of other cities and towns that discharge sewage effluent into rivers; for example, the Thames River and the Murray River.

Have you ever thought about water supply in this way?

Some 67.1 per cent had not heard of the concept while almost a third had (32.2 per

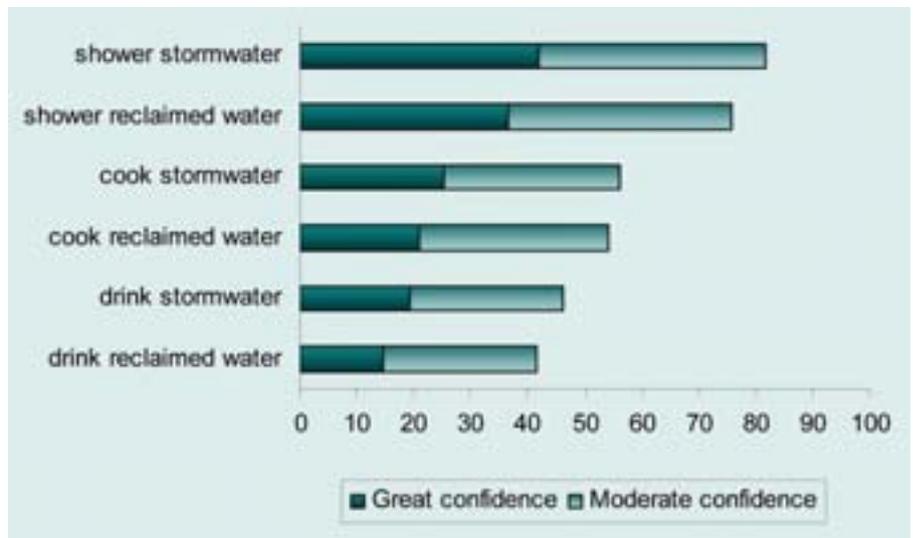


Figure 3. Confidence in stormwater and indirect potable reuse (percentages, n=2504).

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cent); again, only 0.7 per cent were unsure whether they had or had not.

Willingness to Pay

Respondents were asked to consider paying a realistic price for water in the event that recycled water had to be implemented in order to supplement the water supply. Note that this question came at the end of all questions on water recycling and refers to scenarios that include the reticulation of either reclaimed water or stormwater, while not specifically nominating non potable or potable uses. The aim was to test resistance to these sources of water, while introducing the concept of more realistic pricing of recycled water.

If we had to increase water supplies, and there were two options -

one - that you pay double the price you pay now for water so that additional water can be captured through new reservoirs, or from rivers, etc.; or,

two - that you use some form of recycled wastewater or stormwater and pay the same price for that as you pay now for water -

which would you support: pay double what you pay now, or recycle?

A total of 79.1 per cent chose recycling water sourced from wastewater or stormwater charged at the same rate that they now pay for mains water. Another 11.5 per cent would prefer to pay double that price in order not to recycle water, and 6.6 per cent chose neither option, wanting some alternative such as more water conservation (total 'don't know': 2.7 per cent, with only four refusals).

Discussion

The general acceptance 'policy' questions on recycling reclaimed water yield high levels of support (Table 2). Acceptance grades from least likelihood of direct contact - being the irrigation of golf courses, parks and gardens - through to those involving contact with the body via clothing (commercial laundries), or through indirect ingestion (meat, vegetables, fruit, wine). Looking at the results for the more salient proposition of willingness to recycle reclaimed water for non potable uses (Table 3), the pattern of ranking reveals that people are prepared to handle the water for hand watering and car washing (bodily contact) but are less willing to use it for laundering clothes, where the level of acceptance is similar to that for commercial

laundries. In part, these results confirm previous findings, particularly the comparable results for Sydney (Table 1): golf courses, recreational parks, home toilet flushing and laundry. However, national support for the irrigation of vegetable crops is well short of that previously reported for Sydney and Adelaide. This may reflect general health risk concerns as found previously by Star *et al* (2000) and Po *et al* (2005) combined with a lack of familiarity with working examples of water recycling.

Reclaimed water is rated highly against other alternative sources when willingness to recycle water in the household is further explored (Table 4). For these salient options, the median for all non potable uses falls within 'willing without hesitation', although enthusiasm is dampened somewhat for existing properties to connect to a reclaimed water service for outdoor uses, and for the installation of greywater units. Rainwater is the preferred drinking source, and desalination is favoured over stormwater for all household uses.

When the idea of potable reuse is explored, it is confirmed that: (a) on the face of it, stormwater is preferred over reclaimed water (Table 5), but not to the extent found in the ARCWIS (1999) Perth study (the difference is negligible: from 2 to 6 per cent); and (b) people have significantly less confidence in ingesting the water compared to using it for showering. Both willingness and confidence in potable uses of reclaimed water, however, are much higher than that indicated in previous surveys (Table 1). These national survey results are more in line with those produced by the latest Sydney and Perth measures of acceptance: in all three cases, respondents were given a description of indirect potable reuse systems.

A final assessment of people's willingness to recycle water is provided in the 'willingness to pay' question. If the choice had to be made to combat depleting water resources, 79 per cent would not only use recycled water but would be prepared to pay the same price as they currently pay for mains water. On the other hand, in relation to current prices of mains water, 12 per cent opted to pay double the price than use recycled water.

The results on prior experience or awareness are of interest in assessing the level of background familiarity people have with this new technology. Only around a third or less of the national sample have had exposure to the idea of recycling water. A total of 74 per cent have had no experience with non potable reuse, 64 per cent have not heard of blending drinking water quality reclaimed water with current

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water supplies before it is treated and reticulated (indirect potable reuse), and 67 per cent have never contemplated that their water supplies may be supplemented by upstream environmental discharges of sewage effluent (unplanned potable reuse).

Conclusions

In the absence of comprehensive findings on perceptions of water recycling across Australia, these results provide national baseline data to outline potential public acceptance of alternatives to traditional water supplies. The study confirms the pattern of acceptance previously reported for Sydney, Perth and two sites in Adelaide: acceptance is ranked roughly in accordance with the degree of bodily contact. However, the current data clarifies this ordering in that the nature of the contact is important: there is a strong willingness to handle reclaimed water for car washing and hand watering; a decline in willingness when its use becomes personalised, in washing clothes and the body; and less confidence for uses that involve ingestion. The salience of the proposal helps explain this ordering. This study also provides evidence that Australians are willing to use a range of alternative sources of water and that, despite the lack of familiarity with the concept, and given a frank description of indirect potable reuse, they are more prepared to consider potable reuse than some communities have in the past. Further deliberations such as the role of prior experience and awareness, risk perceptions and trust, will be considered in subsequent reports on these national findings that will model a range of factors that influence levels of acceptance.

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