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REVIEW OF WATER RESTRICTIONS

VOLUME 2 - APPENDICES

Institute for Sustainable Futures

UNIVERSITY OF TECHNOLOGY SYDNEY

REVIEW OF WATER RESTRICTIONS

Volume 2 – Appendices

Final Report

For the National Water Commission

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Currency of this report

The research presented in this report was **completed during December 2006 to August 2007**. The research, including perspectives and evidence collected from personal communications, is current only for that period.

Since August 2007, there have been changes to drought situations, restrictions policies, and urban water systems and planning.

Changes which have occurred since August 2007, including further evidence or studies into the costs and benefits of restrictions, are not reflected in this report.

Acknowledgements

The authors would like to extend thanks to the many individuals and organisations across Australia who contributed their time and resources to provide detailed information for this project. Their contributions made this review possible. These organisations contacted include water retailers, government agencies, local councils and local council organisations, businesses and industry associations, and community and consumer representatives.

We would also like to thank our many colleagues for their input, advice, ideas and support throughout this study.

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Appendix A: Organisations interviewed for this review

Comprehensive public consultation was **not** part of the terms of reference for this review.

The organisations listed below represent key stakeholder interests. As there was limited secondary information about the impacts of restrictions on the community, these organisations were interviewed. The number and scope of organisations contacted was limited by the time available for this review. Where possible, organisations which represented interests in case study locations were contacted.

State	Metro Water Area*	Water providers and other organisations contacted
South Australia	Adelaide	SA Water
	Eyre Peninsula	SA Water
Victoria	Melbourne	Department of Sustainability and the Environment (DSE), Melbourne Water, Drought Coordinating Committee (includes Melbourne Water, DSE, Yarra Valley Water, City West Water, South East Water, Western Water).
	Ballarat	Central Highlands Water
	Bendigo	Coliban Water
	Geelong	Barwon Water
New South Wales	Sydney	Sydney Water, Metropolitan Water Directorate
	Hunter	Hunter Valley Water
	Gosford-Wyong	Gosford-Wyong Water
Queensland	Brisbane/SEQ	Brisbane City Council, Queensland Water Commission, SEQ Water
ACT	ACT	ACTEW, ACTEWAGL
Western Australia	Perth	WA Water Corporation
Tasmania	Hobart	Hobart Water
	Launceston	Esk Water

*Specified in Terms of Reference

	Organisations
Industry organisations	Swimming Pool & Spa Associations from various states Australian Car Wash Association Irrigation Association of Australia Parks and Leisure Australia Turf Producers' Australia Ltd. Turf Producers Australia Ltd – Victoria Nursery and Garden Industry Australia (NGIA)
Community/consumer organisations	St Vincent de Paul Society Victoria Inc., VIC Consumer Utilities Advocacy Centre (CUAC), VIC Consumer Action Law Centre, VIC Public Interest Advocacy Centre, NSW ACT Council of Social Service WA Council of Social Service
Local government associations (and related)	Western Australia Local Government Association Municipal Association of Victoria (MAV) NSW Local Government and Shires Association International Council of Local Environment Initiatives
Other	CSIRO Water Services Association of Australia (WSAA)

Appendix B: Websites describing restrictions rules

State	Metro Water Area*	Websites holding restrictions rules and regimes
South Australia	Adelaide	http://www.sawater.com.au/SAWater/Environment/WaterRestrictionsConservationMeasures/In+Detail.htm http://www.sawater.com.au/SAWater/Environment/WaterRestrictionsConservationMeasures/level3_indetail.htm http://www.sawater.com.au/SAWater/WhatsNew/Level2_enhanced.htm http://www.sawater.com.au/SAWater/Environment/WaterRestrictionsConservationMeasures/Level2_indetail.htm
	Eyre Peninsula	http://www.sawater.com.au/NR/rdonlyres/9905CEEE-3EA2-4972-A600-5E3E9EACA260/0/WCM_Eyre_Peninsula.pdf
Victoria	Melbourne	http://www.melbournewater.com.au/content/water/water_storages/water_storages.asp#2 http://www.citywestwater.com.au/residential/water_restrictions.htm http://www.yvw.com.au/yvw/Home/Stage2WaterRestrictions/ http://www.southeastwater.com.au/sewl/index.asp?link_id=27.1593
	Ballarat	http://www.chw.net.au/STAGE4/ballarat.html
	Bendigo	http://www.coliban.com.au/restrictions.htm
	Geelong	http://www.barwonwater.vic.gov.au/index.cfm?h2o=customer.rest.gwr4 http://www.barwonwater.vic.gov.au/index.cfm?h2o=customer.rest.abwr
New South Wales	Sydney	http://www.sydneywater.com.au/SavingWater/WaterRestrictions/
	Hunter	http://www.hunterwater.com.au/
	Gosford-Wyong	http://www.gwcwater.nsw.gov.au/main/
Queensland	Brisbane/SEQ	http://www.qwc.qld.gov.au/Water+restrictions
Australian Capital Territory	ACT	http://www.actew.com.au/conservation/measures.aspx
Western Australia	Perth	http://www.watercorporation.com.au/R/restrictions_rules.cfm?uid=7270-8873-6468-1099
Tasmania	Hobart	*No current restrictions*
	Launceston	http://www.launceston.tas.gov.au/subsector.php?id=3382
Northern Territory	Darwin	*No current restrictions*

* As specified in terms of reference

These sites were accessed prior to 1 April 2007 and may have changed.

Appendix C: Legislation underpinning restrictions

New South Wales

A range of acts and regulations underpin the water restrictions in the metropolitan areas supplied by Sydney Water, Hunter Water and Gosford/Wyong Councils' Water Authority.

Under clause 15 of *Sydney Water Regulation 2000*, during drought the Minister for Water Utitilies may, by notice, restrict or regulate the purposes, times, quantities and means or methods of water use. The Minister may also, by notice, impose restrictions in the Hunter region under the *Hunter Water (General) Regulation 2005*. Gosford-Wyong Water Supply Authority is empowered to impose restrictions during drought under the *Water Management (Water supply Authorities) Regulation 2004.*

Victoria

In Victoria, Schedules of Restrictions (containing trigger levels, rules and stages) are documented in Drought Response Plans (DRPs).

In accordance with section 78B of the Water Industry Act 1994, metropolitan water businesses are required to prepare DRPs taking into account the written guidelines issued by the Minister for Water – "Guidelines for Developing and Implementing a Drought Response Plan" (1998). These guidelines also recommend period review and revision of restrictions, including after drought. The Schedule of Restrictions, as a part of a metropolitan water business DRP, must be approved by the Minister for Water.

Although there is no comparable legal requirement in the Water Act 1989 (under which regional businesses operate), the Minister has asked regional businesses to prepare DRPs in accordance with the same guidelines which apply to (Vic Uniform Guidelines). The Schedule of Restrictions, as part of a regional water business DRP can only be given legal effect by the relevant Water Authority by establishing a By-law, which must subsequently be approved by the Minister.

In Victoria, a 4-stage "Victorian Uniform Drought Water Restriction Guidelines for Drought Response" contain a Schedule of Restrictions which is intended to be the model for all future Schedules of Restrictions. This schedule was developed by a working group including representatives from the Department of Sustainability and Environment and Victorian water businesses (including bulk supplier Melbourne Water). This uniform schedule was developed as an initiative of the 2004 White Paper on Water, and has since been adopted (with some minor variations to allow for local conditions) by all water authorities across the State.

Queensland

In Queensland, responsibility to set and enforce water restrictions lies with the Queensland Water Commission (QWC), which was established in March 2006 as a statutory authority to implement the recommendations of the South East Queensland Regional Water Supply Strategy.

The QWC is governed by a legislative framework under Chapter 2A of the Water Act 2000. Under section 360ZD of the Water Act 2000, if the QWC considers it necessary because of a significant threat to sustainable and secure water supply, the QWC may impose restrictions on volumes of water, hours or water use, or the way in which water is used. The restriction takes effect one day after the Minister publishes a notice under section 22 of the Act, or makes a regulation under section 23 of the act. Section 360SE of the Water Act 2000 requires the QWC to consult with water service providers for water supply works in the region before it gives notice of a restriction.

South Australia

In south Australia, under section 33a of the Waterworks Act 1932, the SA Water Corporation may, with approval of the Minister by notice published in the Gazetter, prohibit, restrict or regulate the purposes for which water can be used, the manner or means by which water many be used, and the times at which water may be used.

Western Australia

In Western Australia, a seven-stage schedule of restrictions rules are contained within the the Water Agencies (Water Restrictions) By-laws 1998, which was made by the Minister under the Water Agencies (Powers) Act 1984. The water restrictions rules were designed by the WA Water Corporation.

Australian Capital Territory

In the ACT, under the Utilities (Water Conservation) Regulation 2006, the Minister may approve a scheme developed by ACTEW Corporation for temporary restrictions on the use of the water that ACTEW Corporation supplies. The Minister's approval depends on satisfaction that the restrictions are necessary and desirable, that approved water conservation measures are not likely to ensure an efficient, reliable and sustainable supply of water, that the scheme adequately protects the interest of consumers, and that the utility developed the scheme in consultation with the environment protection authority.

Appendix D: Recent restrictions stages in metropolitan locations across Australia

State	Metro Water Area*	Recent restrictions (date of introduction)+	
South Australia	Adelaide	Stage 2	23-Oct-06
		Stage 3	1-Jan-07
	Eyre Peninsula	Stage 3	1-Dec-02
Victoria	Melbourne	Stage 1	1-Nov-02
		Stage 2	1-Aug-03
		PWSR	1-Mar-05
		Stage 1	1-Sep-06
		Stage 2	1-Nov-06
		Stage 3	1-Jan-07
		Stage 3A	1-Apr-07
	Ballarat	Stage 1	Aug-Nov-00
		Stage 2	Nov-02
		Stage 3	Sep-03
		stage 2	22-Mar-05
		Stage 3	1-Sep-06
		Stage 4	1-Nov-06
	Bendigo	Stage 1	9-Nov-02
		Stage 1A	18-Nov-02
		Stage 2	1-Jan-03
		Stage 3	31-Mar-03
		Stage 4	1-Jun-04
		Stage 3	20-Nov-04
		Stage 4A	1-Nov-05
		Stage 4	1-Sep-06
	Geelong	Stage 1	Feb-98
		Stage 2	Dec-99
		Stage 1	Dec-00
		PWSM	1-Dec-05
		Stage 1	1-Jul-06
		Stage 2	16-Sep-06
		Stage 3	1-Nov-06
		Stage 4	9-Dec-06

State	Metro Water Area*	Recent restrictions (date of introduction)+	
New South Wales	Sydney	Level 1	1-Oct-03
		Level 2	1-Jun-04
		Level 3	1-Jun-05
	Hunter	*No current restrictions*	
	Gosford-Wyong	Stage 1	1-Feb-02
		Stage 2a	1-Aug-04
		Stage 2b	4-Dec-05
		Stage 3	3-Jun-06
		Stage 4	1-Oct-06
Queensland	Brisbane/SEQ	Level 1 (vol)	13-May-05
		Level 2	3-Oct-05
		Level 3	13-Jun-06
		Level 4	1-Nov-06
		Level 5	10-Apr-07
Australian Capital Territory		Stage 1	16-Dec-02
		Stage 2	1-May-03
		Stage 3	1-Oct-03
		Stage 2	1-Mar-04
		Stage 3	1-Sep-04
		Stage 2	1-Mar-05
		Stage 1 - trial of permanent	
		Stage 1 - PWCM	
		Stage 2	1-Nov-06
		Stage 3	16-Dec-06
Western Australia	Perth	Stage 1	1-Nov-94
		Stage 4	8-Sep-01
Tasmania	Hobart	Stage 1 see notes in appendix	
	Launceston	*No current restrictions*	
Northern Territory	Darwin	*No current restrictions*	

*As specified in the terms of reference

+ Note that restrictions rules may have changed during the periods specified above.

Appendix E: Consumer attitudes surveys reviewed

Survey – study citation	Study location(s)	Survey date(s)
Newton Wayman Chong (2005) Water Restrictions Survey - Part B: Non-Residential Study - A Research Report - Prepared For: Drought Co-ordinators Committee, Melbourne. (Wave 3 – non-res) December 2005	Victoria, Metro Melbourne	*Not stated*
Newton Wayman Chong (2005) "Water Restrictions Survey – Attitudes and Behaviours of Consumers – Wave 3 Survey – Part A: Residential Study" (The Drought Response Report). A Research Report - Prepared For: Drought Response Committee May 2005	Victoria	February 2005
Newton Wayman Chong (2003) Stage One Water Restrictions - Attitudes & Behaviour Of Consumers - A Research Report - Prepared For South East Water (Wave 1) (On Behalf Of Water Industry) April 2003	Victoria	March 2002
Newton Wayman Chong (2001) Customer Value Study - Quantitative Research Stage - A Research Report Prepared For System Security Standards Study Group November 2001	Melbourne and Geelong	*Not stated*
Taverner Research (2005). Survey of Household Water Attitudes, prepared for the Independent Pricing and Regulatory Tribunal of New South Wales, Sydney.	Sydney and NSW Central Coast (Households in the Sydney Water, Hunter Water and Gosford-Wyong Water Areas)	January 2005
Roseth, N. (2006) Community Views on Water Shortages and Conservation. CRC Water Quality and Treatment.	Adelaide, Darwin, Melbourne, Perth, Sydney	14 October to 27 November 2005
Independent Pricing and Regulatory Tribunal of new South Wales (2004). Residential water use in Sydney, the Blue Mountains and Illawarra – Results from the 2003 Household survey.	Blue Mountains and Illawarra Sydney	2003
Department of Water (WA) (2002). WA Water Symposium, Summary of Outcomes volume 1. Available at http://dows.lincdigital.com.au/WaterSymposium.asp (accessed 13 February 2007).	Perth	7-9 October 2002 Deliberative Forum
DSE, Responses to Drought Response Plan *(MWC comment: "Retail Water Authorities involvement?")*	Victoria	2002 Not a formal survey, attitudes surmised from response to consultation

Appendix F: Review of currently available quantitative studies on the costs of water restrictions

Hensher, Shore and Train (2006)

HST studied Canberra households' willingness to pay (WTP) to avoid different levels of water restrictions, using stated choice experiments. The choice experiments were designed to present different levels of water restrictions and various attributes that may be associated with the service options, including the water price, and the severity, frequency and length of restrictions.

In the survey conducted by NERA/AC Nielsen, 211 respondents indicated their choice of service options when presented with their descriptions in a series of six experiments. A standard binary logit form is used for choice modelling where the probability of the respondent's choice between the two options is expressed as a function of the attributes associated with the options. Estimates of willingness to pay/accept have been derived as follows.

- Canberra householders are willing to pay $239 per household, on average, to move from a situation with continuous restrictions at Stage 3 or above, all year every year, to a situation with virtually no chance of restrictions. Note that at the time of the study, stage 1 restrictions were in place.
- The amount that households are willing to pay to reduce the frequency of restrictions that matters (ie, stage 3 and above every day) from, say, once every 10 years to once every 20 years is $11.95 on average
- 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.
- Customers need to be compensated by $227 on average to accept an increase in the frequency of restrictions that matter from once every 20 years to once every year.

The analysis also revealed that households were not willing to pay to avoid Stage 1 or 2 restrictions (equivalent to the current permanent water conservation measures – PWCM and Stage 1) nor were they willing to pay to avoid "browness" of public spaces under restrictions.

At the time of this report, the above estimates are the most up to date and relevant measures of willingness to pay to avoid water restrictions in the Australian context. As with all stated preference experiments, the applicability of WTP estimates in supply/demand planning should be viewed with the following qualifications:

- When the experiment was conducted in 2003, Canberra households were facing level 1 water restrictions and had never experienced water restrictions at level 3 or higher;
- The 95 percent confidence interval for the WTP estimate of $239 is from $90 to $420, a large range which reflect the sample size of 211;

- Whether stated preference reflects true behaviour, i.e. whether the respondents would have the same response to the experimental service options in real-life situations. (Discussed further in main report).

Centre for International Economics (2005)

To estimate the cost of restrictions on households in the study 'Economic benefit cost analysis of new water supply options' for the ACT (CIE 2005), CIE reviewed various estimates of willingness to pay to avoid restrictions (WTP) including those from the NERA/AC Nielsen study (REF) and those which they derive from ACTEW's Future Water Options values meetings held in October 2004. CIE (2005) describe their approach as one which uses the WTP estimates from the former studies to calibrate a "demand curve" for water, then calculating the cost of water restrictions using this demand curve, i.e. the loss of consumer surplus resulting from the restriction on quantity consumed. In Table 1, the estimates of costs of water restrictions for various restriction levels, to a baseline of no restrictions, is presented. WTP estimates based on 2003 prices and incomes were indexed to 2005 figures. As described below, these estimates are significantly greater than those estimated by Hensher (2006), due to somewhat arbitrary selection of "upper bounds" to calibrate results.

Table 1 CIE estimates of restrictions costs based on WTP (2005 $)

Restriction level	Low estimate ($)	High estimate ($)
Stage 1	18	24
Stage 2	80	118
Stage 3	198	360
Stage 4	224	411
Stage 5	396	769
Average for stage 3 and above	273	513

The above estimates of water restriction costs (or rather the value of the benefit of avoided restrictions) are higher than those presented in the study by Hensher (2006), despite their use of the same choice experiment results to calibrate results.

There are a number of possible reasons why the CIE study overestimates the welfare loss to households (i.e .overestimates the benefit gain from avoided restrictions), including:

- Point choice elasticity of -0.39; the authors note that, during drought conditions, elasticity may be much greater.
- The use of the upper estimate from the NERA/AC Nielsen survey to calibrate the demand curve and report final aggregated costs. There is no basis for choosing the upper bound 95% confidence interval to calibrate results. CIE (2005) also refer to an ACT Future Water Options values meeting (of 60 to 80 people) to justify the choice of upper-bound costs, however in this meeting, participants were asked questions about the frequency of restrictions. CIE (2005) then assume a linear functional relationship to

"transform" these responses (about frequency) into welfare losses over a year, continuous as such:

- A WTP of $40 to reduce one year in six to one year in twelve is equivalent to the cost of restrictions of $480/year (using the formula 41/(1/6-1/12)).
- There is no theoretical or statistical justification behind this calibration, and is likely to result in erroneous results.

There are also a number of reasons why CIE (2005) analysis could represent an overestimate of costs – including:

- Recreation – CIE (2005) notes that much sporting time is undertaken by children and should not be valued at the full average wage rate. Furthermore, this study makes the arbitrary assumption that recreation time should be valued at the average wage rate, and also makes arbitrary assumptions about the "percentage of recreation time needed to be reallocated" under each stage of restrictions – implicitly to finding other recreation activities, although this study does not explain clearly. CIE (2005) also fails to justify their assumed costs for restoration. Therefore the costs of Stage 3 - $8m, Stage 4 - $13.7m, Stage 5 - $20.8 m, could be overstated.

- Tourism – Again, CIE (2005) does not provide analysis to determine the relationship, if any between water restrictions, and their impacts, and tourism activity – visitor numbers or expenditure. Indeed, the study notes that most tourism is related to places of national interest which are not likely to be affected by restrictions (e.g. the National Gallery). Furthermore, the suggestion that garden events such as Floriade would be lost does not take into account exemptions that are likely to apply for such events (as they would for botanic gardens, etc). The use of economy-wide I-O analysis also could magnify the original estimates. Therefore the $31m lost for stage 5 is likely to be overstated. There are also criticisms of IO analysis to be arbitrarily assuming the 'multiplier' effect. It is a useful method for indicating the regional impacts of changes in demand and supply, but not for estimating impacts of changes in resource supply.

- Reduced ACTEW profits and loss of revenue from abstraction charge – these are not an economic cost but transfers and hence should not be included in total costs.

- Commercial and industrial costs – again the analysis is not clearly explained, and is based on reduced water availability – however, there is no evidence provided by CIE (2005) about what assumed reductions in water use have been modelled. Indeed, significant evidence (see main report) suggests that costs to industry are not based on reductions in water use (by the industry's customers), but on restrictions on their customers. Restrictions currently in place in ACT do not imposed "caps" on water use to industrial or commercial users.

Brennan, Tapsuwan and Ingram (2006)

BTI estimates the impact of outdoor water restrictions on consumer welfare in Perth by formulating a conceptual consumer model for the choice between lawn quality and leisure. Water restrictions are considered a restriction on technology, rather than on absolute quantity of water. Without the use of sprinklers, householders can choose to do nothing and accept lower lawn quality or to use hand-held hoses to maintain a higher level of 'greenness'. The cost of restrictions is derived by calculating the value of the lost leisure time (measured by wage rates) for several representative groups with different incomes and preferences for greenness. The model was calibrated using empirical data on the relationship between water use and lawn quality and other characteristics of the 'cost function' for lawn quality.

At the baseline price for water of $0.91 per kL, the conceptual model estimated:

- For 'high greenness preference' consumers, the price elasticity of demand for water between successive price changes to range from -1.05 in low income consumers, to -0.37 for high income consumers.
- A sprinkler ban will cause low, middle, and high income households to experience a total welfare loss of $3,418, $7,964 and $16,057 under high greenness preferences, and $510, $1,761 and $3,390, under low greenness preferences.

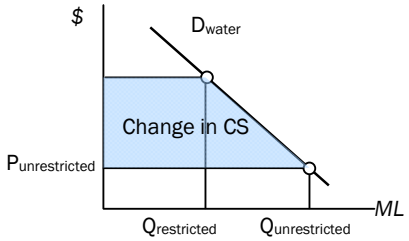
This approach (lawn production cost) does not directly incorporate information on consumer preference with respect to water restrictions – as would studies eliciting willingness to pay. Furthermore, caution should be exercised when using these results, whether in Perth or other areas for the following reasons:

- This study, like CIE (2005), also makes the assumption of a linear relationship between "expected welfare loss" and probability of a sprinkler ban.
- The analysis focuses solely on the impact of sprinkler restrictions on watering of gardens and lawn and not other outdoor use of water such as car washing, pool filling etc
- The model examined the choice between watering methods (sprinkler versus hand hose) in the short run whereas in the long run, consumers may consider other technologies (rainwater tank, recycling) and changes to low water use gardens and lawn area.
- Estimates of welfare loss for high levels of lawn quality are likely to be overstated because they are solely based on the costs of factor inputs. As production cost estimates, they represent the upper limits to the welfare loss faced by consumers and not the actual value they attach to greenness i.e. only when the former is exceeded by the latter, that consumers opt for hand held watering. For instance, because of the inconvenience and/or high imputed costs of achieving high levels of greenness during periods of water restrictions, consumers may be more prepared to accept lower levels of greenness. As the estimated marginal cost of lawn quality in the study is very low up until about 90% greenness, consumers' acceptance of lower quality levels also means that their welfare loss is well below the model estimates derived for high preference of greenness.
- Estimates for the high income groups may be overstated as these consumers can pay workers to care for their lawn at a lower wage rate.

Appendix G: Basic consumer surplus analysis method used to determine costs of restrictions to households in case studies

As noted in volume 1 (main report), a basic consumer surplus method was used to estimate illustrative costs (welfare loss) of restrictions to households. The reason for using this very simplified method was to illustrate a consistent method across all three case studies.

Essentially, these estimates assume that the cost of restrictions is equivalent to the change in consumer surplus derived from estimating the demand for water. A linear demand curve was estimated rather than constant elasticity (for the ranges estimated, this assumption about functional form has negligible impact on magnitude of estimates).



The change in consumer surplus can be estimated as:

$$\left(\frac{Q_{restricted}+Q_{unrestricted}}{2}\right)*P*\frac{\left(\frac{Q_{unrestricted}-Q_{restricted}}{Q_{unrestricted}}\right)}{\eta}$$

where η is the price elasticity of demand.

As also noted in chapter 5 of volume 1, there are a number of assumptions with any estimation – including this simplified method, or more "complicated" models – which have implications for results (see below).

Basic consumer surplus method – some assumptions and their implications for cost estimates

Price elasticity of demand	Price elasticities during drought conditions or for outside water use are largely unknown. Depending on choice of elasticity, could over- or under-estimate costs to households.
Price of water	Top tier prices of water $/kL have been used. However not all households would pay this top marginal rate (either with or without restrictions). This assumption results in an over-estimation of costs to households.
Total or outdoor water use	Water restrictions almost exclusively target outdoor water use (water management plan offsets are an exception). Therefore estimating welfare loss from reductions in total water use is likely to over-estimate costs to households. However, estimating welfare loss from reduction in outdoor water use only is likely to under-estimate costs to households, because of attributing all reductions in water during restrictions to outdoor use. Both methods have been used in this study.
Assumption that actual restrictions are equivalent to quantity restrictions, and	Water restrictions target types, method and timing of water use, but not the total water of volume used. This method assumes that the loss of welfare under restrictions is equivalent to that under rationing, which could result in costs being

that welfare losses are independent of frequency and duration	underestimated (for more severe restrictions) or overestimated (for less severe restrictions). This method also does not account for the effect of frequency and duration of restrictions, which could also result in over- or under-estimate of costs.
Aggregation	This method aggregates water use over time and across households, which could result in over- or under-estimation of costs.
Accuracy of water use data	In many locations, savings are calculated based on reported volumes of bulk water supply, and were adjusted for actual residential use, and outdoor use (where applicable). Attributing all savings under restrictions to the household sector is likely to have resulted in an over-estimate of welfare costs.

For the case studies, to illustrate the sensitivity of the estimations to some of these assumptions, the following ranges were used:

- Modelling total residential water use (higher estimate of consumer welfare loss) or outdoor residential water use only (lower estimate of consumer welfare loss).
- Price elasticities of demand between -0.3 (greater estimate of consumer welfare loss) and --1.7 (lesser estimate of consumer welfares loss). This range of estimates appears greater than those commonly used – indeed in many Australian studies elasticity estimates of between -0.25 and -0.35 are employed. Whilst there is some evidence that the average (eg. over time) price responsiveness of demand is in this range, it is likely (although fewer studies exist) that demand for outdoor water use, which is generally regarded as more "discretionary", and during drought periods, is significantly more elastic. Indeed, a meta-anlysis of residential water demand periods (not specifically during drought periods)1 has indicated that outdoor elasticities in the range -0.7 to -1.6.

The following parameter values were fixed in the estimations:

- Prices – the top-tiered prices were used, although some consumers will not pay this rate. This is Sydney $1.17/kL, Perth $1.12/kL, ACT $1.11/kL (higher estimate of consumer welfare loss).
- Indoor use – this was estimated to be constant at 160L/p/day throughout, in all cities. This figure was derived from a domestic water use study conducted in Perth from 1998-20012 and data from end-use model used in the review of the Metropolitan Water Plan 20043, commissioned by the NSW Cabinet Office.
- Non-residential use – Total supply/consumption volumes were adjusted using non-residential supply figures from WSAA Facts (2005).

[1] Mayer et al (2004). National Multiple Family Submetering and Allocation Billing Program Study Final Report. http://www.aquacraft.com/Projects/submeter.htm (accessed 30 April 2007).
[2] Loh, M., and Coghlan, P. (2003). Domestic Water Use Study in Perth, Western Australia 1998-2001. Water Corporation (WA).
[3] White, S. et al (2006). Review of the Metropolitan Water Plan: Final Report. Institute for Sustainable Futures UTS, ACIL Tasman Pty Ltd, and SMEC.

Appendix H: Least cost planning and levelised costs

Least cost planning

Least cost planning (LCP) (also known as integrated resource planning - IRP) is an economic assessment method applied widely to utility planning (energy and water) to determine the most cost effective program for implementation. Options for water service provision include the augmentation of water supply and water efficiency programs. The LCP principle examines the ability of water utilities to influence future demand in recognition of scarce resources and often highlights that source development through supply augmentation alone may not be the most cost effective solution because of constraints such as reliability, risk, and environmental impact4. By focussing on the services that water provides (sanitation, showers, landscape), rather than the product provided, efficiency outcomes often mean that demand is satisfied with lower resource use, leading to a welfare improvement through greater producer and consumer surplus.

In the US, the National Association of Regulatory Utility Commissioners5 recognises LCP as a method that:

> ... will ensure reliable service for the customers, economic stability and a reasonable return on investment for the utility, environmental protection, equity among ratepayers, and the lowest costs to the utility and the consumer.

LCP has evolved based upon methods used in the energy economics field where the cost of conserving energy without altering the level of service experienced by the end user was investigated6. LCP identifies the optimal mix of supply-side and demand-side management practices while balancing system reliability and affordability, thereby producing planning alternatives with the lowest costs to the utility and customers7. It is for these reasons that LCP is widely recommended as a framework for determining the potential for water efficiency and other conservation measures to delay or avoid the need for expensive augmentation of bulk supply8.

Levelised cost

The costing methods used in LCP are known as "levelised cost." Levelised cost is viewed as an accepted method for economic evaluation because it includes all costs and benefits of an option, including environmental and social costs and the level of customer satisfaction, assessed from the combined perspective of the utility, customers and community. This method is known as levelised cost because it provides an equivalent metric enabling both demand and supply side options to be compared in terms of unit cost ($/ML). The levelised

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[4] CUWCC – California Urban Water Conservation Council (2003). Calculating Avoided Costs Attributabl to Urban Water Use Efficiency Measures: A Literature Review, in Feldman M, W Maddaus and J Loomis (eds) Report to the California Urban Water Conservation Council.

[5] NARUC (1998) . Least Cost Utility Planning, vol. 1, National Association of Regulatory Utility Commissioners, October 1988, p. 1, p. A10.

[6] Beecher J (1996). 'Integrated Resource Planning for Water Utilities'. Water Resources Update, No. 104, Summer.

[7] NARUC (1998) and CUWAC (2003).

[8] IPART – Independent pricing and Regulatory Tribunal of NSW (1996). 'Water Demand Management: a Framework for Option Assessment'. White S (ed), Report of Water Demand Management Forum, March.

cost is a net cost of the present value sum of the capital, operating, and avoidable costs (or benefits). It is defined here as9:

$$L = \frac{PV(costs\ to\ WSP) + PV(costs\ to\ customers)}{PV(water\ saved\ or\ supplied)}$$

where:

- L = levelised cost in $/kL.
- WSP = water service provider.
- PV(costs) = present value of costs ($) over a given period and at a given real discount rate.
- PV(water saved or supplied) = present value of the water actually supplied by a source or saved by a demand side or water efficiency option over the same period and using the same discount rate (kL).

The values included in the levelised cost are determined by the type of 'cost test' employed. The 'cost tests' include:

- Utility cost (i.e. the cost borne by the utility).
- Customer cost (i.e. the cost borne by the customer).
- Total resource cost (i.e. the cost of each option borne by the utility, customers and government – comprising of capital and operating costs).
- Societal cost (i.e. the cost of each option imposed directly on the community).

The total resource cost and societal cost tests are employed to evaluate the cost effectiveness of a supply or demand side option from a whole of community perspective. The total resource cost and societal cost differ in that the societal cost includes externalities.

The use of economic values rather than market prices reflects the occasional failure of market prices to adequately reflect scarcity value. This is particularly the case where there is imperfect competition, government intervention in the market, and the absence of a market10 – three scenarios commonplace in water service provision. Adjustment of market prices in these situations will more adequately reflect the marginal social costs and benefits and consequently social welfare. In an ideal world, the societal cost would always be employed to include the economic value of externalities. As valuations are not always possible, the total resource cost method is the next best, and commonly used, alternative.

Applied to water service provision options, the levelised cost is the net present value of the costs borne and avoided by the utility, customers and government. This analysis allows simple comparison of options based upon the unit cost of alternatives, for example, in dollars spent to obtain an additional kL of physical water supply. Since each water efficiency

[9] White S and C Howe (1998). 'Water efficiency and reuse: A least cost planning approach'. Proceedings of the 6th NSW Recycled Water Seminar, November.

[10] Hanley N and C Spash (1993). Cost-benefit analysis and the environment. Edward Elgar.

option is an alternative to new or expanded water supply, water efficiency options are considered cost effective when their unit cost is less than the unit cost of the lowest-cost option for new or expanded water supply. Because the utility can select the lower cost efficiency options in a water provision program, it satisfies consumer needs at a reduced water bill, thereby increasing consumer surplus.

The total resource cost and societal cost aim to reflect the costs and benefits imposed directly on the community, thereby indicating cost effectiveness from the societal perspective. These benefits and costs include avoided benefits and costs from delaying alternative projects. For example, in the case of options which provide savings in hot water use, such as labelling or standards for showerheads, the benefit of avoiding greenhouse gas emissions should be included in the NPV of that option. This benefit represents an avoided cost. In the case of showerhead standards the avoided cost of greenhouse gas emissions is such that the option has a negative societal 'cost'. This means that the option has a net benefit even before the water conservation potential is considered.

In summary, the financial cost tests in LCP – from utility and customer perspectives – are used to analyse cash flow and to decide on the most suitable format to roll out programs and apportion costs fairly among stakeholders. The results of this form of economic assessment are used to address equity considerations between customer groups and ensure the financial viability of the water service provider.

Appendix I: Summary of water restrictions across Australia

In this appendix, the restrictions rules which applied across metropolitan water areas at the time of this report are described. The relevant restrictions frameworks (regimes) are also described, noting different trigger levels and target water use savings for different restrictions stages, as well as system supply objectives where available (security and reliability). The material presented below is from interviews with utilities, various websites describing restrictions, 2004-05 figures from WSAA Facts (2005), and other sources as noted. Where sources are not noted, the information was obtained from pers. comm.s with utilities.

Note that information presented in this Appendix is a sample of some of the information obtained, and is not intended to be comprehensive across locations.

South Australia

Adelaide

SA Water introduced water restrictions in Adelaide for the first time in July 2003, at level 2 for almost four months. Permanent water conservation measures (restricting sprinkler use to mornings and evenings) were introduced on 2 October 2003. In October 2006, level 2 restrictions were re-introduced, and increased to level 3 on 1 January 2007. It was announced in June 2007 that a further ban on domestic outdoor watering will be in place for the months of July and August, due to record low flows. These restrictions applied to all SA Water customers supplied with River Murray water – the greater Adelaide area comprising Northern Adelaide & Barossa, Torrens, Patwalonga and Onkaparinga.

Other measures adopted have included the increase of emergency storage levels at Mt Lofty, and the purchase or lease of additional temporary or permanent water licenses to increase SA Water's River Murray allocation.

At 8 Jan 2006, SA Water has 20 dedicated water conservation officers and more than 40 'authorised' officers undertaking monitoring and enforcement. Since level 2 restrictions were introduced in late 2006, SA Water has issued 2022 friendly reminders, 474 warning notices and 3 expiation notices ($315).11

Due to the mixed nature of water supply sources, the restrictions framework for Adelaide does not prescribe established "trigger levels" based on amount of water in storage.

SA Government aims to reduce annual mains water demand so that by 2025 consumption would be lower than what it would otherwise have been by about 35 GL (target savings 30 GL households, commercial/industrial 2GL, community 3GL).12

[11] SA Water, pers. comm., January 2007.
[12] SA Water (2005). *Waterproofing Adelaide Strategy 2055*.

Current Restrictions – Adelaide			
Current level	Level 3 since 1 January 2007	**Population**	1,100,000 (2003/04)[13]
Recent levels	Level 2 since October 2006	**Connections**	406 099 residential 13 499 non-residential[14]

Brief summary of key rules

- Sprinkler systems may be used to water domestic gardens and lawns once a week for three hours in the morning (5-8am) or evening (8-11pm) on Saturdays (evens) or Sundays (odds). Trigger hoses and drip systems can be used 8pm-8am. Buckets and cans may be used anytime. These rules apply except for the months of July and August (2007), during which a ban on the use of household sprinklers, hoses and irrigation systems apply. Sports grounds and recreational facilities face similar restrictions as domestic gardens.
- Existing pools and spas must not be refilled from empty. New pools or spas require pool cover and permit to fill. Vehicles may be washed using bucket or commercial car wash.
- Nurseries and garden centres may use sprinkler systems 8pm-8am, or trigger hoses, cans, buckets and drip systems anytime.

Penalties

$315 expiation notice if non-compliance continues after warning notice. Serious and ongoing breaches could result in court action and fines of up to $5000 for individuals or $10 000 for businesses.

Restrictions framework – Adelaide			
System objectives "Difficult to quantify overall [security] standard of yield due to mixed nature of sources of water… [security] standards equate to approximately four weeks of demand held in storage."		**Storage capacity**	197GL (10 reservoirs)[15]
		Annual demand	310GL average year, 326 GL dry year, unrestricted [16]
		Annual supply sources (Average)	• 137GL (Adl Hills catchments) • 88GL (R. Murray) • 9GL (metro GW) • 5GL (stormwater and recycled water) • 1GL (rainwater tanks)[17]
Restrictions level	Illustrative example of rules on outside watering	**Trigger - storage level**	**Target water use savings** *On total (annual) demand*
PWCM	Sprinklers 5pm-10am.	Due to the mixed nature of Adelaide's water supply, trigger levels based on storages have not been established.	3.5%
Stage 2	Sprinklers evens/odds (3 days per week) 8pm to 8am.		11%
Stage 3	Sprinklers once a week for 3 hours 5-8am or 8-11pm.		18%
Stage 4	Stage 4 and 5 rules will be developed as needed according to the desired water savings at the time. Pers comm		22%
Stage 5			27%

[13] SA Waters, pers. comm., January 2007.
[14] SA Waters, pers. comm., January 2007.
[15] SA Water website. Viewed March 2007 < http://www.sawater.com.au/sawater/>
[16] SA Water (2005). *Waterproofing Adelaide Strategy 2055.*
[17] SA Water (2005). *Waterproofing Adelaide Strategy 2055.*

Eyre Peninsula

Eyre Peninsula, which is not supplied by River Murray water, has been under customised stage 3 restrictions since 1 December 2002 which continues to apply at the time of this report.

SA Water (pers. comm. January 2007) reported that there has been limited enforcement of the Eyre Peninsula restrictions, with dedicated compliance officers making only a few targeted visits. After the River Murray connection to the Eyre region is completed (commissioned in 2007), it is expected that they will fall under the restrictions framework applicable in the rest of the SA Water region.

Current Restrictions – Eyre Peninsula			
Current level	Restrictions introduced for the first time in December 2002, at level 3.	**Population** **Connections**	35 000[18] 11,500 residential 1,600 non-residential 5,000 country lands
Brief summary of key rules • Sprinkler systems for domestic gardens, irrigation purposes, public gardens or sporting grounds may only be used 6pm-8am (8pm-8am during daylight saving). Hand-held hoses, buckets and watering cans may be used at any time. Empty new or existing pools, spas of ponds require approval for filling. Vehicles may only be cleaned using automatic washing systems that recycle water, commercial car washing facilities using trigger hoses, or on domestic premises using trigger hoses, buckets or watering cans. • Restrictions on washing of food transport or motor vehicle dealer vehicles to trigger hoses, buckets or means that recycle water. • Farm dams or tanks require approval for filled or topping up except for fire fighting, domestic purposes or stock watering.			

[18] SA Water pers. comm, January 2007.

Victoria

In Victoria, a statewide drought response planning is coordinated through the Department of Sustainability and the Environment. Each metropolitan and non-metropolitan urban water authorities is required to prepare a Drought Response Plan according to the guidelines provided for under The Water Industry Act 1994. The Guidelines outline actions which should occur in pre-drought, drought and post-drought phases – including:

- Reviewing past experience during drought - including the impacts on consumers, the authority itself, environment and water quality
- Identify and evaluate demand reduction and supply enhancement measures, including evaluation of the financial, social and environmental impacts.19

There are four stages of urban water restrictions applicable across the whole of Victoria.

The Victorian Government has set short-term water conservation targets for the Central Region (includes Melbourne, Geelong and Ballarat). Reductions from 1990 average per capita drinking water consumption 25% by 2015, 30% by 2030; at least 1% annual reduction in current water consumption in the non-residential sector.20

Melbourne

Melbourne comprises the Port Phillip and Westernport regions (7665 square kilometres).

Current Restrictions – Melbourne			
Current level	Stage 3a	**Population**	3,600,000
Recent levels	Permanent water savings rules were introduced on 1 March 2005, stage 1 water restrictions on1 September 2006 and stage 2 water restrictions on 1 November 2006, Stage 3 water restrictions on 01 January 2007, Stage 3A water restrictions on 1 April 2007	**Connections** (2004-05)	1,404,000 residential 129,000 non-residential[21]
Brief summary of key rules • Lawns may not be watered at anytime. Sprinklers must not be used. Dripper systems and trigger hoses may be used for garden two days per week with restricted hours. New pools must not be filled. Households may use bucket filled directly from tap for safety and corrosion, spot-cleaning vehicles, or commercial car washes which use less than 70L per car allowed. • Sportsgrounds and public gardens may water under restricted hours, or under approved Water Conservation Plan. • Commercial nurseries, garden centres and market gardens may use watering systems up to 3 hours/day with approval. Trigger hoses, buckets and cans filled from tap may be used anytime. • Following a warning notice, if restrictions are still breached, customers may have water supply restricted.			

[19] Department of Natural Resources and Environment (1998). *Ministerial Guidelines for Developing and Implementing a Drought Response Plan.*
[20] Victorian Government (2005). *Our Water Our Future*.
[21] The Australian Urban Water Industry (2005).*WSAA facts 2005*.

Restrictions framework – Melbourne			
System objectives – The probability of water restrictions being imposed is never greater than 5%. – Water restrictions are never imposed for more than 12 continuous months – Water restrictions never exceed Stage 3.		**Storage capacity**	1773 GL[22]
		Annual demand	484 GL/annum (unrestricted)[23]
		Annual inflows	555 GL/annum (long-term average) 395 GL/annum (low inflows)[24]
Restrictions level	Simplified example of rules on outside watering	**Trigger - storage level (depends on month)**	**Target water use savings (annual)**
Stage 1	Watering systems evens/odds restricted hours. Trigger hoses anytime.	795GL Jun to 955GL Nov	2.5%
Stage 2	Lawns cannot be watered. Gardens as for stage 1.	703GL Jun to 810 GL Nov	8%
Stage 3	Lawns cannot be watered. Sprinklers not allowed. Drippers and trigger hoses 2 days per week restricted hours for gardens.	611GL Jun to 665GL Nov	12%
Stage 4	No watering.	520 GL	17.5%

Bendigo

Bendigo urban supply system is part of the Coliban System (Campaspe Catchment) which also supplies Castlemaine, Kyneton, Heathcoate, and rural areas. Coliban Water is entitled to divert 45 654 ML/year as part of long-term average (the Campaspe River is a tributary of the River Murray).

Coliban held a series of workshops in August/September 2004 (200 people attending 7 workshops) to raise public awareness of water planning options. At these workshops, participants were in favour of the community adopting water restrictions during times of drought, and also generally supported permanent water conservation measures. 25

Coliban employed three teams of two officers to undertake enforcement (Coliban Water pers. comm. December 2006).

[22] Melbourne Water website. Viewed March 2007. <http://conservewater.melbournewater.com.au/content/storage.asp>
[23] Department of Sustainability and Environment (2006). *Central Region Sustainable Water Strategy 2055*.
[24] Department of Sustainability and Environment (2006). *Central Region Sustainable Water Strategy 2055*.
[25] Coliban Water (2006). *Waterplan 2055.*

Current Restrictions – Bendigo			
Current level	Stage 4 since 1 July 2006.	**Population** (2004-05)	74,000[26]
Recent levels	Mandatory restrictions since November 2002, stage 3 or higher since April 2003.	**Connections** (2004-05)	37,163 (total)[27]

Brief summary of key rules

- No outside watering of household gardens or lawns, sportsgrounds or public lawns.
- New pools cannot be filled.
- Vehicle cleaning may only occur with bucket for windows, mirrors, lights and spot-cleaning corrosive substances (households, motor vehicle dealers, or commercial car washes).
- Commercial nurseries, gardens and market gardens can apply for approval to use watering systems for 2 hours a day, or use trigger hoses, buckets and cans anytime.

Restrictions framework – Bendigo				
System objectives – *Reliability – 95%* [28]		**Storage capacity**	57GL + share of Lake Eppalock[29]	
		Annual demand (2004-05)	27.3GL (entire Coliban system, including but not only Bendigo) 12.1GL (residential from entire Coliban system) [30]	
		Average annual yield	45GL at 90% reliability, 39 GL at 95% reliability (system incl rural.) [31]	
Restrictions level	**Simplified example of rules on outside watering**[32]		**Trigger - storage level**	**Target water use savings**
Stage 1	Watering systems evens/odds restricted hours. Trigger hoses anytime.		n/a	n/a
Stage 2	Lawns cannot be watered. Gardens as for stage 1.		n/a	n/a
Stage 3	Lawns cannot be watered. Sprinklers not allowed. Drippers and trigger hoses evens/odds restricted hours.		n/a	n/a
Stage 4	No watering.		n/a	n/a

n/a Information not available.

[26] Statistic for 2004-05. Coliban Water (2006). *Waterplan 2055.*
[27] Coliban Water (2006). *Waterplan 2055.*
[28] Coliban Water (2006). *Waterplan 2055.*
[29] http://www.chw.net.au/fact_2005.htm (to be confirmed)
[30] WSAA Facts (2005).
[31] Coliban Water (2006). *Waterplan 2055.*
[32] Coliban Water (2002). *Drought Response Plan.*

Ballarat

Ballarat is supplied by Central Highlands Regional Water Authority.

In Ballarat, Stage 4 restrictions have been in place since 1 November 2006.

Penalties for any person found guilty of an offence against the By-Law include a maximum fine of 40 penalty units (each $107), or 3 months imprisonment for a first offence, and 80 penalty units or 6 months for a subsequent offence. An on-the-spot fine system has been developed of 5 penalty units. There is also the option to restrict supply to 2L/minute for a breach of the Water Act 1989. Central Highlands Water has not yet enforced restrictions, however if to do so would prefer to restrict supply.

Current Restrictions – Ballarat			
Current level	Stage 4 since 1 November 2006.	**Population**	116,000[33]
Recent levels	Stages 1-3 since November 2002, Stage 3 since 1 September 2006.	**Connections** (2004-05)	41,000 residential 3,338 non-residential[34]
Brief summary of key rules • No outside watering of household gardens or lawns, sportsgrounds or public lawns. • New pools cannot be filled. • Vehicle cleaning may only occur with bucket for windows, mirrors, lights and spot-cleaning corrosive substances (households, motor vehicle dealers, or commercial car washes). • Commercial nurseries, gardens and market gardens can apply for approval to use watering systems for 2 hours a day, or use trigger hoses, buckets and cans anytime.			

Restrictions framework – Ballarat and district			
System objectives – *Reliability – 95%*	**Storage capacity**	65 GL [35]	
	Annual demand (2004-05)	18.5 GL[36]	
	Average annual yield	n/a	
Restrictions level	Simplified example of rules on outside watering	**Trigger - storage level (end of Nov)**	**Target water use savings**
Stage 1	Watering systems evens/odds restricted hours. Trigger hoses anytime.	46%	4%
Stage 2	Lawns cannot be watered. Gardens as for stage 1.	38%	11%
Stage 3	Lawns cannot be watered. Sprinklers not allowed. Drippers and trigger hoses evens/odds restricted hours.	29%	17%
Stage 4	No watering.	21%	25%

n/a Information not available.

[33] The Australian Urban Water Industry (2005).*WSAA facts 2005*.
[34] CHW pers. comm. April 2007.
[35] CHW website. Viewed March 2007. <http://www.chw.net.au/default.htm>
[36] The Australian Urban Water Industry (2005).*WSAA facts 2005*.

Geelong

Geelong has been under Stage 4 restrictions since December 2006. Barwon Water (pers. comm. February 2007) reports that Community Consultation for the Water restrictions By-law 187 was undertaken in early 2006 for a period of 3 weeks. The consultation was widely advertised on the website and in local papers. There was not a great deal of take up, and comments received were generally supportive of the by-law.

Since the introduction of Stage 3 & stage 4 water restrictions there appeared to be a shift in attitudes and a great deal of angst within the community. However, there have been no surveys or research into the communities' attitudes toward stage 3 & 4 water restrictions due to resources being allocated to managing the queries and complaints that are received.

Current Restrictions – Geelong			
Current level	Stage 4 since 9 Dec 06	**Population**	246,000[37]
Recent levels	Stage 3 since 1 Nov 06, stage 2 since 16 Sep 06, stage 1 since 1-Jul06. Permanent Water Saving Measures introduced on 1 Dec 2005.	**Connections** (2004-05)	113,000 residential 10,000 non-residential connections.[38]
Brief summary of key rules • No outside watering of household gardens or lawns, sportsgrounds or public lawns. • New pools cannot be filled. • Vehicle cleaning may only occur with bucket for windows, mirrors, lights and spot-cleaning corrosive substances (households, motor vehicle dealers, or commercial car washes). • Commercial nurseries, gardens and market gardens can apply for approval to use watering systems for 2 hours a day, or use trigger hoses, buckets and cans anytime.			

Restrictions framework – Geelong			
System objectives – *Reliability – 95% (would be 10% under Stage 1, 7% under Stage 2, 3% under Stage 3 and 5% under Stage 4 if continued low inflows).*		**Storage capacity**	98GL[39]
		Average annual demand	37 GL
		Average annual supply	43 GL/annum (long term inflows) 29 GL/annum (continued low inflows)[40]
Restrictions level	Illustrative example of rules on outside watering	**Trigger - storage level [41]**	**Target water use savings**
Stage 1	Watering systems evens/odds restricted hours. Trigger hoses anytime.	~ 22 GL (June) to ~ 42 GL (Oct)	
Stage 2	Lawns cannot be watered. Gardens as for stage 1.		
Stage 3	Lawns cannot be watered. Sprinklers not allowed. Drippers & trigger hoses evens/odds restricted hours.		
Stage 4	No watering.	~14 GL (June) to ~30 GL (Oct)	

[37] Department of Sustainability and Environment (2006). *Central Region Sustainable Water Strategy 2055*.
[38] The Australian Urban Water Industry (2005).*WSAA facts 2005*.
[39] Barwon Region Water Authority website. Viewed March 2007. <http://www.barwonwater.vic.gov.au/index.cfm?h2o=services.water_levels>
[40] Department of Sustainability and Environment (2006). *Central Region Sustainable Water Strategy 2055*.
[41] Barwon Region Water Authority. *Drought Response Plan 2006*. Available online <http://www.barwonwater.vic.gov.au/>

New South Wales

Sydney

The demand reduction levels and targeted demand reductions described in the table below are based on advice from Sydney Water. Sydney Water notes that the decision to introduce water restrictions is made by the Portfolio Minister, having regard for storage levels, depletion rates, weather forecasts etc. It notes that the trigger levels used in the current drought differ slightly from the scheduled trigger levels, and that the precise rules for each restrictions level are determined during each drought.

Since the introduction of mandatory water restrictions on 1 October 2003, total usage (until 14 December 2006) was 12.5 per cent below the ten-year average.42 Further information on savings is found in Volume 1.

Sydney Water's 2005-06 Water Conservation and Recycling Implementation Report evaluates progress towards water conservation targets for 2005-06. From the figure presented, water consumption can be estimated to be 65 L/p/day higher if stage 3 restrictions were not in place.

This report also observes that the margin of climate correction has been in a relatively narrow band of around +/- 5 L/capita/day since December 2003, suggesting that "restrictions remove much of the variation in demand that is due to climatic circumstances".

Current Restrictions – Sydney			
Current level	Level 3 since June 2005	**Population** (2004-05)	4,228,000 [43]
Recent levels	Level 1 since 1 October 2003, level 2 since 2 June 2004.	**Connections**	Residential 1 593 157 Other 180 766[44]
Brief summary of key rules • Hand-held hosing and drip systems allowed on Wednesdays and Sundays from 4pm to 10am. • Permits required to fill new pools greater than 10 000L. • Businesses, organisations and in some circumstances households, can apply for exemptions.			

[42] Sydney Water website. Viewed March 2007 <http://www.sydneywater.com.au>
[43] The Australian Urban Water Industry (2005).*WSAA facts 2005*.
[44] Metro Water Directorate, pers. comm., 2007.

Restrictions framework – Sydney			
System objectives		**Storage capacity** (total Sydney region)	2,584 GL[45]
Security	Dams must not approach emptiness (<5% storage) more than 0.01% of the time.	**Annual demand**	526.4 GL[46]
Reliability	97%.		
Robustness	90% (not more than 10 restrictions episodes in any 100-year period.	**Annual yield**	[47]
Restrictions level	Illustrative example of rules on outside watering	**Trigger - storage level (of Warragamba Dam)**	**Target water use savings (tracked monthly)***
Level 1	No sprinklers or watering systems.	55%	7%
Level 2	No sprinklers or watering systems. Hosing allowed 4pm-10am 3 days/week.	45%	12%
Level 3	No sprinklers or watering systems. Drip systems and hosing allowed 4pm-10am 2 days/wee,	40%	15%

Source: Sydney Water

* Note that the target savings in this table are measured relative to a baseline of 600 GL pa, whereas the effectiveness of restrictions in practice is measured relative to modelled demand. (see Report Volume 1).

Gosford/Wyong

The area supplied by Gosford and Wyong Council's Joint Water Authority (the Gosford and Wyong LGAs) has been under restrictions since February 2002. Level 3 restrictions were introduced on June 2006 and Level 4 restrictions introduced on 1 October 2006, which remained in place as at August 2007.

Early in 2006, Gosford Council employed 2 full time water rangers to drive through the municipality looking for breaches of the restrictions and responding to reports of suspected breaches. Council also has Exemptions Assessment Officers – who assess applications for commercial exemptions to the restrictions on outdoor use (eg. brick layers, dog washers, pubs). They conduct site visits as necessary in assessing the applications, and if exemption is granted will conduct follow up visits to ensure the conditions of the exemption are being complied with.

There is a $200 penalty for individual breaches of restrictions and a maximum possible penalty of $2,200 for corporations. There is no 'first warning' system, with all breaches resulting in a fine if there is adequate evidence; only if there is not sufficient evidence will a warning be issued. Between January 2006 and June 2006, 55 fines were issued; between July 2006 and January 2007, 60 fines were issued.48

[45] Sydney Catchment Authority website. Viewed March 2007 < http://www.sca.nsw.gov.au/>
[46] The Australian Urban Water Industry (2005).*WSAA facts 2005*.
[47] To be confirmed.
[48] Pers. comm., Jan 2007.

Education has included weekly advertising in local papers, and regular advertising on radio – addressing the restrictions regime, dam levels and specific campaigns. Other education initiatives include signage placed on the back of toilet doors in public toilets and within hotels and motels to target visitors to the area, signs and banners in public spaces, notices in rates mail outs and water notices, and presentations to industry groups such as Hotel Association and the Nursery Association. A Water Forum was held in September 2006, and information has been provided at stalls at other festival events.

WaterPlan 2050 (draft, currently on exhibition) was developed in consultation with the 'purpose-built' Community Liaison Group between July 2004 and July 2005. The CLG recommended that there be a 'tough line taken when water restrictions are ignored'49

Current Restrictions – Gosford-Wyong			
Current level	Level 4 since 1 October 2006	**Population** (2004-05)	153,000[50]
Recent levels	Level 3 introduced June 2006	**Connections** (2004-05)	62,000 residential 3,000 non-residential[51]
Brief summary of key rules No watering of gardens or lawns using town water. No private pools filled or topped up. No car washing except windows with bucket. Nurseries and commercial gardens may use watering systems for a total of 1 hour per day 6-8am or 6-8pm. Bowling and gold greens and cricket pitches may use watering systems for a total of 1 hour per day Monday, Wednesday or Friday 6-9am or 6-8pm. Sporting fields, schooled ovals and other lawns may not be watered. Water cartage from town water supply permitted for domestic internal use only. Customers with an annual demand greater than 3500kL and all accommodation and public pools must prepare and implement a Water Management Plan.			

[49] GWCWA (2005) Community Liaison Group for Waterplan 2050. Report to Gosford Wyong Council's Joint Water Authority. Final Report, November 2005.

[50] The Australian Urban Water Industry (2005).*WSAA facts 2005.*

[51] The Australian Urban Water Industry (2005).*WSAA facts 2005.*

Restrictions framework – Gosford-Wyong			
System objectives *Security* *Reliability* *Robustness*		**Storage capacity**	202.7GL [52]
		Average annual demand	33GL[53]
		Average annual yield	
Restrictions level	Illustrative example of rules on outside watering	**Trigger - storage level (initiate/remove)**	**Target water use savings**
Level 1		40% (remove at 47%)	8%
Level 2	No fixed hoses or sprinklers, trigger hoses, micro spray and drip systems allowed for 1 hour/day on alternate days 7-8am and 6-7pm.	30%	16%
Level 2a/2b	No fixed hoses or sprinklers, trigger hoses, micro spray and drip systems supplied directly from tank up to half an hour a day 2 days/week 7-9am and 5-7pm.	22%	24%
Level 3	No hoses, sprinklers, drips. Can and buckets anytime.	18%	30%
Level 4	No watering of gardens and lawns	14%	32%
Level 5	n/a	12% (remove at 15%)	38%

Increased environmental flows may be required in future – the DNR Water Sharing Plan currently being prepared (Draft Waterplan 2050) in accordance with the Water Management Act 2000. Approx 68% of demand is residential; and when unrestricted, around 30% is used outdoor, principally for garden watering.54

There are proposed permanent limitations on the hours for garden watering, restrictions on the washing down of hard surfaces and the use of trigger hoses for car washing.55

[52] GWCWA (2006). *Gosford-Wyong Councils' Water Supply System*. Available online < http://www.gwcwater.nsw.gov.au/main/our_system/system_brochure/Joint%20Water%20Supply_061103.pdf>

[53] GWCWA (2005). *WaterPlan 2050*.

[54] GWCWA (2005). *WaterPlan 2050*.

[55] GWCWA (2005). *WaterPlan 2050*.

Hunter

Restrictions framework – Hunter				
System objectives *Reliability – 95%* *Robustness – restrictions not entered into more than once every 10 years*		**Storage capacity**	172GL surface (60GL aquifer)	
		Average annual demand	71 GL	
		Average annual yield	73.5 GL scheduled for increase to 79	
Restrictions level	Illustrative example of rules on outside watering	**Trigger - storage level**	**Expected demand reductions below average**	**Assumed demand ML/day**
Informal	*Publicity campaign*	70%		225
Stage 1	*Ban fixed sprinklers; hoses 5pm-10am 3 days/week, internally connected rainwater tanks may also water on Friday.*	60%	5%	205
Stage 2	*Ban on fixed sprinklers, hoses 5pm-10am 2 days/weel*	50%	10%	195
Stage 3	*Ban on outdoor ue of potable water except internally connected rainwater tanks may also use water on Friday.*	40%	15%	185
Stage 4	*Total outdoor water ban.*	30%	30%	150

The restrictions policy is designed to allow at least 2 months between implementing successively more severe restriction levels. The Policy features:

- Advertising that targets voluntary water use reduction when storage drops below 70%, and continues throughout the entire drought sequence.
- Ban on fixed sprinklers when storage drops below 60%.
- Limitation on when hand held hoses may be used when storage drops below 50%.

Annual supply is 31% of maximum stored volume – Hunter has relatively less storage than most other large urban water authorities. In 2004-05 also began Gosford Wyong Water Authority with water.

- Grahamstown Stage 2 works when complete, the yield of the combined headworks system (Grahamstown, Chichester, Tomago and Anna Bay) will be increased from around 73.5GL/year to around 79GL/year.56
- Various water conservation programs for residential and business, use of recycled water for industry (3000 ML in 2003-04) and use of effluent in irrigation.

[56] Hunter Water. *Integrated Water Resource Plan 2003-04*. Available online <http://www.hunterwater.com.au/iwrp.asp>

Australian Capital Territory

Current Restrictions – Canberra			
Current level	Stage 3 from 16 December 06.	**Population** (2004-05)	361,000[57]
Recent levels	Some form of mandatory restrictions since 16 December 2002. Stage 1 restrictions made permanent on 1 November 2005.	**Connections** (2004-05)	129,000 residential 7,000 non-residential[58]

Brief summary of key rules

- No sprinkler or irrigation systems allowed. Watering of lawns is not allowed.
- Trigger hoses, dripper systems, buckets or cans may be used 7-10am or 7-10pm odds/evens.
- Across the board exemptions are occasionally applied, allowing sprinklers.
- Pools require exemptions for filling or topping up.
- Cars may only be washed at commercial car washes that recycle water and hold exemptions.
- Water storage tanks, dams and lakes must not be filled or topped up unless with non-potable water

On 1 April 2006, ACTEW introduced permanent water conservation measures (PWCM) and moved from a 5-stage restriction scheme to a simplified 4-stage restriction scheme. In effect, stage 1 from the old scheme became PWCM.

ACTEW (2006, Review of Supply Planning Variables) notes that there was insufficient information to calculate how much consumption is reduced by water restrictions, and that observed values of reduction during each restriction level were lower (less effective) than previously thought. New target water use savings have been estimated, including the effects of demand hardening (estimated at 8% ongoing savings from PWCM).

Restrictions framework – Canberra			
		Storage capacity	215 GL[59]
		Annual demand	82.5GL[60]
		Average annual yield	
Restrictions level	Illustrative example of rules on outside watering *NOTE New rules stages 1-4 currently being developed*	**Trigger - storage level** (averages below – triggers vary by month)	**Target water use savings**
PWCM	Sprinkler systems 7pm-7am odds/even; hoses and buckets anytime.		
Stage 1	Sprinkler systems 5-8am and 7-10pm odds/evens; hoses and buckets anytime	50%	10%
Stage 2	No sprinklers. Hoses and buckets 5-8am and 7-10pm odds/evens.	40%	25%
Stage 3	No lawns. No sprinklers. Hoses and buckets 5-8am and 7-10pm odds/evens.	35%	35%
Stage 4	No external watering (except with recycled water).	31%	55%

[57] The Australian Urban Water Industry (2005).*WSAA facts 2005.*
[58] The Australian Urban Water Industry (2005).*WSAA facts 2005.*
[59] To be confirmed
[60] The Australian Urban Water Industry (2005).*WSAA facts 2005.*

Queensland

South-east Queensland (including Brisbane)

The Queensland Water Commission (QWC) was established in March 2006 as a statutory authority. One of its roles, legislated under chapter 2A of the Water Act 2000, is to set and enforce water restrictions. Previously, SEQWater, the major supplier of untreated bulk water in the region, was responsible for designing restrictions.

As at 2007, 12 local councils in the south-east Queensland area (including Brisbane) are covered by restrictions implemented by QWC. Level 5 restrictions were introduced on 10 April 2007, and incorporate the "Target 140" plan, which aims to reduce per capita water consumption to 140 L per day.

Current Restrictions – Brisbane and SEQ			
Current level	Stage 5 since 10 April 2007.	**Population**	SEQ: 1.2 million consumers and businesses[61] Brisbane: 975,000 (2004-05)[62]
Recent levels	Level 4 since 1 November 2006. Level 3 restrictions commenced 13 June 2006. Level 2 restrictions commenced 3 October 2005. Level 1 restrictions (voluntary) commenced 13 May 2005	**Connections**	1 million (includes 6 neighbouring water authorities)
Brief summary of key rules • Only water existing gardens with buckets or watering cans on three allocated days between 4pm–7pm. • High water users (greater than 800L/day) must submit to council a water use assessment form on their water use, and identify savings opportunities.			

Restrictions framework – south east Queensland			
System objectives *Reliability* - Average recurrence interval for level 2 restriction 1:50 to 1:100 *Robustness* – Mean duration 12 months and maximum 36 months; level2 achieving 15% reduction in demand and applying no more than 3% of the time, on average.		**Storage capacity**	1760 GL[63]
		Annual supply 2004-05	285GL[64] 450GL[65]
		Annual yield	630 GL or 450 GL[66]
Restrictions level	Illustrative example of rules on outside watering	**Trigger - storage level (combined supply)[67]**	**Target water use savings**
Stage 1	Voluntary	40% (704 GL)	5%
Stage 2	No sprinklers. Hoses odds/evens 7am-7pm 3 days a week. Buckets anytime.	35% (616 GL)	15%
Stage 3	No sprinklers, no outdoor hosing	30% (530 GL)	20%
Stage 4	No sprinklers, no hoses. Buckets or cans allowed odds/evens 3 days a week 4-8am and 4-8pm.	25% (440 GL)	25%

[61] SEQWater website. Viewed March 2007 <http://www.seqwater.com.au/content/standard.asp?name=FAQs>
[62] The Australian Urban Water Industry (2005).*WSAA facts 2005.*
[63] SEQ website. <http://www.seqwater.com.au/content/standard.asp?name=SEQWatersDams)
[64] WSAA Facts 2005 – total bulk supply by SEQWater in 2004-05.
[65] Baseline demand, The State of Queensland (Department of Natural Resources and Mines) (2005). *South East Queensland Regional Water Supply Strategy, Stage 2 Interim Report*, 2nd. ed. November 2005.
[66] HNFY and derated yields respectively, *South East Queensland Regional Water Supply Strategy, Stage 2 Interim Report.*
[67] *South East Queensland Regional Water Supply Strategy, Stage 2 Interim Report*, 2nd. ed. November 2005.

Western Australia

Perth

In Western Australia (WA), the WA Water Corporation administers restrictions on water sourced from mains (town water). Separate licensing conditions exist for water sourced from private bores.

Water Agencies (Water Restrictions) by-laws specify seven stages of restrictions for Western Australia. In Perth, a daytime sprinkler ban has operated since November 2004 and stage 4 restrictions have been in place since 8 September 2001. To the time of this report, the restrictions have been estimated to save 44.2GL/year. 68

Education and awareness campaign activities have included newspaper and television campaigns, sprinkler days fridge magnet distribution, and a number of community and industry Waterwise Programs. Water Corporation of WA estimates that $1.2million is spent statewide on marketing and education for water conservation activities, about one-third directly related to water restrictions. 69 Spent over what period of time?

The penalties for non-compliance are a warning followed by $1000 fine for second and subsequent offences. Up to 16 staff carry out enforcement activities, which are estimated to cost approximately $600 000 per year.

Water Corporation of WA suggests that the additional savings to be made through moving from a 1-day-a-week sprinkler rule to a sprinkler ban are not significant, but are likely to be less acceptable by the community (due to inconvenience). 70 The corporation was considering incorporating a 1-in-200-year reliability rule (regarding total sprinkler ban) into future planning at the time of this report.

The Water Corporation of Western Australia has also undertaken the following emergency responses at this time:

- Initially emergency response included new groundwater bores (9 superficial aquifer bores at Mirrabooka and 3 deep Yarragadee artesian bores), 2 new pipehead dams (Samson and Wokalup). These projects were delivered during 2002 and 2003.
- Planning and investigations were also advanced for
    - a seawater desalination plant (subsequently delivered in 2006);
    - development of the South West Yarragadee groundwater source (project awaiting regulatory and funding approval as at August 2007);
    - catchment thinning trial to improve runoff from surface water (commenced in 2006);

[68] WA Water Corporation pers. comm., December 2007.
[69] WA Water Corporation pers. comm., December 2007.
[70] WA Water Corporation pers. comm., December 2007.

- water trading with irrigators (initial temporary trade in 2003/04 has now progressed to include permanent trades from 2005/06); and
- water recycling opportunities advanced (Kwinana Water Reclamation Plant commenced in 2004 and an aquifer replenishment trial using highly treated wastewater is being planned awaiting Federal funding support from the National Water initiative.

- 2006 emergency response to prevent increase in restriction level:
  - additional 2 Leederville bores to allow increase in abstraction from 165 to 175GL/yr in extreme circumstances;
  - maximising groundwater usage and minimising production down-time;
  - maximising dam capacity (i.e. minimum useable level).

Current Restrictions – Perth			
Current level	Level 4 introduced 8 September 2001, estimated savings 15% of 45 GL per year.	**Population** (2004-05)	1,484,000[71]
Recent levels	Daytime sprinkler ban permanent from November 2004.	**Connections**	741321 connections, 652362 residential
Brief summary of key rules • Watering by sprinklers may occur only once per day on two designated watering days per week (based on house number) between the hours of 6pm and 9am. • No restriction on hose watering of gardens but hosing of paved surfaces not permitted. • Self-supplied groundwater only subject to daytime sprinkler ban.			

Restrictions framework – Perth			
System objectives No reliability standards have been set from a regulatory point of view. However, the Corporation intends to move from a reliability standard (for total sprinkler bans) of 3% of years to one year in 200. This standard is currently being reviewed in response to concerns from the Economic Regulation Authority.		**Storage capacity**	188 GL
		Annual demand (2004-05)	228.6GL[72]
		Average annual yield	
Restrictions level	Illustrative example of rules on outside watering	**Trigger - storage level**	**Target water use savings**
Stage 1	Daytime sprinkler ban	Trigger levels not fixed but assessed annually based on sources available including groundwater allocation and water trade opportunities.	20 GL/year
Stage 2	Odds & Evens sprinkler watering		30 GL/year
Stage 3	3 days a week sprinkler watering		35 GL/year
Stage 4	2 days a week sprinkler watering		45 GL/year
Stage 5	1 day a week sprinkler water		60 GL/year
Stage 6	Sprinkler watering ban		70 GL/year
Stage 7	Total sprinkler and hose watering ban		100 GL/year

[71] The Australian Urban Water Industry (2005).*WSAA facts 2005.*
[72] The Australian Urban Water Industry (2005).*WSAA facts 2005.*

Tasmania

Hobart Water

Stage 1 water restrictions came into force for Hobart, Glenorchy, Clarence, Kingborough and Derwent Valley Councils on 17th December 2006. The 'odds and evens' watering system under State 1 restrictions were implemented primarily as a precaution for the hotter summer weather and for fire fighting.

The Water, Sewer & Drains By-law 1998 has provisions for on-the-spot fines to be issued for third offence against restrictions rules.

Relaxation Permits for restrictions are available in some circumstances on written request to address issues of safety and financial hardship.

Current Restrictions – Hobart			
Current level	Stage 1	**Population** (2004-05)	188 000[73]
Recent levels	Stage 1 17th December 2006	**Connections (**2004-05)	83 000[74] (Total)

Brief summary of key rules

- Residential - odds/evens can water using fixed, moveable and non-automatically timed sprinklers (including microspray and drip systems) - Tues/Thurs/Sat, Wed, Fri, Sun - no sprinkler watering Mondays. Hand held hoses may be used at anytime on any day. On Total Fire Ban days declared by the State Fire Commission, watering by fixed, moveable or automatically times sprinklers is totally prohibited. Window washing by bucket and hand held hose. Washing of paths and driveways not permitted. Cars by bucket and hand held hose.
- No restriction on any outdoor water use which is part of the incoming earning process of the business.
- Water use for non-income earning purposes of businesses such as landscape irrigation and pavement washing activities are restricted as per domestic use. Discretion: Councils may exercise discretion in applying restrictions for special circumstances such as filling public or commercial swimming pools, dams and like structures; filling tankers for other than non-potable water use; and water use on cultural and tourist areas considered to have cultural or significant tourist value.

Sources: Hobart Water - Water Supply Policies – Water Restrictions, GPOC 2005 Local Government Water and Wastewater Businesses Cost Recovery, Compliance Review 2003-04 Report Government Prices Oversight Commission Hobart.

[73] The Australian Urban Water Industry (2005).*WSAA facts 2005.*

[74] The Australian Urban Water Industry (2005).*WSAA facts 2005.*

Restrictions framework – Hobart			
		Storage capacity	11 GL[75]
		Average annual demand (2004-05)	41.4GL[76]
		Average annual yield	
Restrictions level	Illustrative example of rules on outside watering	**Trigger - storage level**	**Target water use savings**
Stage 1	Odds and evens use of outdoor water system, hand-watering at all times. Cars by bucket and hand held hose. No hard surfaces.	60%*	
Stage 2		50%**	
Stage 3		40%[3]	

Sources:

*Stage 1 – implemented when Weather conditions are or are predicted to be such that demand may increase to a level where it may prevent the refilling of Council reticulation reservoirs overnight, or Hobart Water is unable to sustain at least 60% of normally useable storage in the bulk system

** Water restrictions may be increased to the next stage where the current Stage of restrictions are not having the desired effect and / or where there are difficulties regarding overnight recovery of reticulation storage, or Hobart water is unable to sustain at least the trigger level (%) of normally useable storage in the bulk system storages

Launceston

There are currently no restrictions in place in any of the areas supplied by Esk Water, and have not been since Esk water was formed in 1997. Some of the individual Councils serviced by Esk Water may have had restrictions in place prior to 1997, but there has been a 30% reduction in demand since 1997 – attributed to a combination of pricing regime change, metering, demand management programs and general growing community awareness about water conservation due to national drought issues.

Within the City of Launceston, the township of Lilydale (a small bush town with 190 houses and unmetered supply) has been subject to restrictions between December 2006 and April 2007, to protect pressures of supply (this is not supplied by Esk Water). These applied only to the township and were triggered by resident feedback and after liaison with the water committee.

There is currently no restrictions policy or regime for Esk Water, and systems objectives such as reliability and robustness do not have numerical targets. It is believed that there will be no need for restrictions at any time in the near future.77

Most of the supply is from run of river rather than storage. A recent report (unpublished) reviewed the last 30 years of streamflow data and concluded that they would need another 40% reduction in streamflow to require restrictions.78

[75] The Australian Urban Water Industry (2005).*WSAA facts 2004.*
[76] The Australian Urban Water Industry (2005).*WSAA facts 2005.*
[77] Pers. comm., Jan 2007.

Northern Territory

There are no current water restrictions in place in the Northern Territory. This study has not included a review of water restrictions for the Northern Territory.

[78] Pers. comm., Jan 2007.