

INSTITUTE FOR SUSTAINABLE FUTURES

# ISF: LITERATURE REVIEW

## ASSESSMENT OF ALTERNATIVE WATER RESTRICTION MODELS

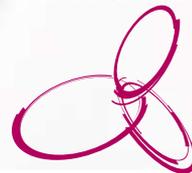
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# LITERATURE REVIEW

Assessment of Alternative Water Restriction Models

May 2008

Final v1.2

for the Victorian Smart Water Fund

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Institute for Sustainable Futures

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## Abbreviations

BSC	Ballina Shire Council
CBD	Central Business District
DOHS	Department of Human Services
EDC	Every Drop Counts (Sydney Water Program)
EREP	Environment and Resource Efficiency Plans
ICLEI	International Council for Local Environmental Initiatives
ISF	Institute for Sustainable Futures
QWC	Queensland Water Commission
SEQ	South East Queensland
WA ERA	Western Australian Economic Regulation Authority
WEMP	Water Efficiency Management Plan
WMP	Water Management Plan
USD	United States Dollars
UTS	University of Technology, Sydney

# 1 Introduction

Customer-side drought response measures have been a key component of sustainable urban water management in metropolitan Melbourne. Although there has been widespread community support for low levels of restrictions, more recent evidence indicates emerging concerns about the fairness, flexibility and future water savings potential of the current restrictions framework.

This literature review report is a deliverable under Milestone 2 of the project, “Assessment of Alternative Water Restrictions Models”, conducted by the Institute for Sustainable Futures, UTS, for the Smart Water Fund Round 5.

The purpose of this literature review is to identify and document Australian and international applications of water restrictions (customer-side drought response options) in urban water situations.

Restrictions that were applied across Australia are presented in summary form only (section 2), because more detail is contained in the report “Review of Water Restrictions”<sup>1</sup> by Chong et al (2009), which was conducted between December 2006 and August 2007, and because the Steering Committee members are generally familiar with approaches already applied Australia-wide. For international applications, this review has excluded consideration of restrictions in locations with substantially less developed urban water supply systems and planning (and security of supply) than metropolitan Melbourne, i.e. developing countries.

This literature review involved accessing publicly available water management plans and other documents about restrictions and drought responses. The review does not document every restriction regime in place in Australia or internationally, but reflects a wide canvassing of the types of restrictions that have been implemented.

The report is outlined as follows:

- Summary review of water restrictions, water use targets, allocations and rationing implemented recently in Australia (section 2)
- Recent approaches to restrictions implement in recent droughts overseas, including United States, the United Kingdom, Spain, and other countries (sections 3 to 5)
- Summary of approaches (section 6)
- Appendixes providing preliminary information for next milestone(s) of project, including: approaches to drought pricing and trading, cooling tower potential water savings and use, sectoral water use in metropolitan Melbourne

*This research was conducted in March to May 2008. Changes that have occurred since May 2008 are not reflected in this report.*

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<sup>1</sup> Conducted for the National Water Commission, which aimed to assist NWI Parties meet their commitment under paragraph 91 (iii) of the National Water Initiative.

## 2 Australia

### 2.1 WATER RESTRICTIONS

Water restrictions continue to apply across Australia, in many locations for longer periods or at greater severity than previously experienced. Restrictions in Australia are characterised by diversity, or lack of consistency, between different states and (in some states) between different locations within the same state. Widespread differences exist in restrictions rules and stages, the pace at which restrictions levels have been increased, and approaches to designing, implementing and promoting compliance.

Generally, restrictions have been prohibition-style, with compliance achieved through a mixture of education, promotion, and the threat of punitive-style penalties for non-compliance (although actual implementation of these has been reasonably limited).

This section briefly documents the approaches to drought restrictions that have been applied across Australia, with a focus on capital cities. These restrictions are “temporary” restrictions which intend to achieve water savings during drought only, as distinct from permanent water savings measures.

*Note that approaches to drought planning across Australian jurisdictions are not within the scope of this literature review.*

State	Metro Water Area*	Recent restrictions (date of introduction) <sup>+</sup>	
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
	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
New South Wales	Sydney, Illawarra, Blue-Mountains	Level 1	1-Oct-03
		Level 2	1-Jun-04
		Level 3	1-Jun-05
	Gosford-Wyong	Stage 1	1-Feb-02
		Stage 2a	1-Aug-04
		Stage 2b	4-Dec-05
		Stage 3	3-Jun-06
Queensland	Brisbane/SEQ	Level 1 (voluntary)	13-May-05
		Level 2	3-Oct-05
		Level 3	13-Jun-06
		Level 4	1-Nov-06
		Level 5	10-Apr-07
		Level 6	23-Nov-07
South Australia	Adelaide	Stage 2	23-Oct-06
		Stage 3	1-Jan-07
Western Australia	Perth	Stage 1	1-Nov-94
		Stage 4	8-Sep-01

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	1-Nov-05
	Stage 1 - PWCM	1-Apr-06
	Stage 2	1-Nov-06
	Stage 3	16-Dec-06

+ Note that restrictions rules may have changed since February 2008, when the information in this table was compiled.

## 2.1.1 Residential sector

Residential water use restrictions across Australia have predominantly reflected prohibition-style models, with rules places on types, timing and technologies (methods) of water use. The key types of residential water uses that face restrictions are gardens and lawns, swimming pools and spas, and the washing of vehicles and other hard surfaces. Some of the different approaches to restrictions on residential water use are summarised below.

### Gardens and lawns

Across the majority of Australian capital cities, watering of private gardens and lawns has been restricted, ranging from sprinklers being restricted to two evenings per week (Perth, since September 2001) to a total ban against mains water being used for (various Victorian regional locations, introduced from 2006). However, the approach to restricting garden and lawn watering *as levels/stages of restrictions increase* varies between locations. Although these restrictions may not appear significantly different, subtle differences between rules may have substantial differences in impacts on residential water users, and those industries associated with supplying restricted water-use equipment. Approaches include:

- Restricting watering to more labour-intensive, less time-efficient (although not necessarily more water-efficient) methods:** In Brisbane and south-east Queensland, it appears that the approach to achieving consumption savings has been to progressively restrict the more time-efficient (and less labour-intensive) watering technologies as restrictions levels increased eg. sprinklers banned at level 2, sprinklers and hoses banned at level 3, with allowable times for bucket and can watering reduced from level 3 (any time) to the current level 6 (3 hours, 3 times a week). This is also the general approach in Adelaide, where allowable sprinkler time has been reduced as restrictions levels increased.
- Restricting watering times but encouraging more water-efficient methods:** In Melbourne (stage 3a) Sydney (stage 3) and the ACT (stage 3), distinctions are made between dripper and other sprinkler watering systems – these restrictions at least partly aim to encourage more water-efficient practices (although micro-spray systems can be very efficient in some circumstances).
- Banning certain types of water uses:** In Melbourne, Canberra and south-east Queensland, lawn watering is banned, although garden watering is allowed (but restricted).

### Towns water vs. all water

Most restrictions rules apply to water sourced from mains or town water and do not apply to water sourced from private bores, rainwater collected from roofs, indoor re-use or other sources. However, in some locations, restrictions apply to non-mains water – for example, in the Gosford/Wyong area, stage 4 restrictions apply to mains water use and stage 2a restrictions apply to rainwater use.

## Outdoors, indoors and offsets

Restrictions on residents predominantly focus on outdoor water use. However, some restrictions frameworks include offset plans that require water savings indoors. For example, in Victoria and in south-east Queensland, some topping-up of existing pools and outdoor spas is allowed subject to various conditions, such as installing efficient appliances or fixtures indoors.

### 2.1.2 Non-residential sector

The main non-residential (commercial) business sectors facing water restrictions are nurseries and market gardens, public pools, commercial car washers, building and construction and motor vehicle dealers. (Sportsgrounds are discussed in section 2.1.3). However, a range of approaches has been taken to restricting non-residential water use, including:

- **Specific water restrictions rules for different industry sectors or subsectors:** In Victoria and (applying to a less extensive range of sectors) Adelaide and south-east Queensland, rules are specified for several non-residential water-using sectors. Some of these rules, eg. outdoor watering of pools, may be the same or similar to those applying to residents.
- **Requiring water-efficiency management plans for certain industry sectors:** For example, in south-east Queensland under current level 6 restrictions, there are no specific rules on nurseries, turf farms and market gardens but they are required to water in accordance with a water efficiency management plan that has been submitted to and accepted by the water service provider.
- **Requiring water-efficiency management plans, possibly specifying indoor water-use efficiency, for large water users:** Restrictions levels in both Victoria and south-east Queensland require large water users to develop water-efficiency management plans. In south-east Queensland under current stage 6 restrictions, premises which used greater than 1 ML per year are required to install water-efficient taps and showers, in order to be able to use reticulated water on bathroom, laundry, ablution and kitchen fittings.
- **General rules for all water uses (residential or non-residential) with specific exemptions for the non-residential sector:** In Sydney (level 3), restrictions apply to all water users with specific exemptions for various non-residential sectors. In effect, this is the same as specific water restrictions rules applying for different industry sectors and subsectors, although the mode of communication is different.

### 2.1.3 Open space: sportsgrounds and public parks and reserves

A range of approaches are used to restrict water use on sportsground (public and private) and public parks, reserves, and recreational spaces:

- **Distinction between sportsgrounds and other recreational spaces:** In ACT (level 3) and Adelaide, the same rules apply to all types of recreational spaces. In other locations, such as south-east Queensland, Victoria and Sydney, specific rules or exemptions apply to watered sportsgrounds (compared to parks).
- **Sportsgrounds:** football fields, netball courts, school ovals, hockey fields, baseball and softball fields, public tennis courts, golf tees, bowling greens, croquet lawns.
- **Outright bans** on watering sportsgrounds and recreational spaces are not widespread, however in south-east Queensland under level 6, parks and reserves are not to be watered using reticulated water supply, and in Victoria under level 3, one in four sportsgrounds can be watered.
- **Water savings** are required in several states, for example in ACT (35% saving under level 3) and Victoria (25% saving under restrictions implemented).

- **Limiting hosing and sprinkler times:** Adelaide and Sydney.
- **Water efficiency management plans:** In south-east Queensland, sportsgrounds are not subject to specific rules however must abide by water efficiency management plan requirements applying to other non-residential water users.

## 2.2 WATER USE TARGETS, ALLOCATIONS, AND RATIONING

One subset of customer side drought response options are based on the provision of a per-user quota of water over a pre-determined time period. There are a variety of compliance mechanisms that apply to this category of options, from voluntary compliance to aspirational targets to a combination of fines and rebates ('carrot and stick' approaches) for customers that consume over or under the specified quota. This section describes a selection of this category of options being implemented in Australia, including voluntary targets, rationing and allocation schemes.

*See Appendix A for further discussion on the potential of targets and allocations as an alternative restrictions model.*

### 2.2.1 Voluntary targets

In **south-east Queensland**, recent restrictions regimes have included a combination of specific requirements coupled with a residential voluntary target. As part of restriction levels 5 and 6, Target 140 is a community education campaign to encourage all residents of South East Queensland to reduce their water use, on average, to below 140 litres of water a day. The implications of this target for the average household are minimal outdoor water use (bucketed water use only) and efficient use of water indoors. Although introduced as part of Level 5 restrictions in April 2007, this target has continued as part of the Level 6 restrictions that have been implemented in Queensland since November 2007.

The Target 140 education campaign includes a website ([www.target140.com.au](http://www.target140.com.au)) which is updated regularly to reflect current progress toward this target. The program has been successful in reducing water use below 140 litres per person per day, with daily water usage reaching below 120 litres per person per day in April 2008 (Queensland Government 2008).

In **Gosford city and Wyong Shire** communities in New South Wales, a water consumption target has been placed on the bulk water supply quantity of 490 megalitres per week under Level 4 water restrictions. Under the level 3 restriction requirements, there is a voluntary residential target of 150 litres per person per day.

### 2.2.2 Residential Allocations

**Gladstone City Council** introduced a rationing system in response to the 2002-2003 drought whereby households were required to limit water use to approximately 6 kilolitres per week, depending on the number of occupants in each household.

Meters were read at the start of the rationing period and rationing for each house applied following this initial meter read and following this the aim was to read meters at least every quarter. Residents received slips in their mailboxes advising them of the reading as well as instructions on how to read their meters. If people used more than the allocated amount, a series of penalties applied. A first offence attracted a warning, but second and subsequent offences would result in water supply cut backs. A second high reading would mean a restrictor valve would be fitted to the water meter, cutting back the pressure available to households (Mitchell et al 2003).

In **south-east Queensland** a fine of \$1050 applies for excessive water use by households (above 200 litres per person per day, or above 800 litres per household per day). Through the "Excessive water user program", high water-using households are notified of excessive usage

through Council's normal billing process, and asked to explain their excessive use. If households do not respond to this request they face an outdoor water ban. If the household continues to use water excessively without a legitimate excuse, a penalty of \$450 and an outdoor watering ban applies. If a second offence is committed, an additional penalty of \$1050 may apply.

In the mid-1990s, **Ballina Shire Council** (New South Wales) had in place a combined allowance and four-step residential tariff structure. Although this tariff structure was not introduced specifically as a drought response measure, it is an example of how bill discounts could create incentives to reduce water use. For example in 1997, a discount applied to customers who used less than 350 kL/a, comprising a reduction of 30 c/kL for every kL reduced below 350 kL/a, with the maximum discount payable being \$60 (Preferred Options 1997).

### 2.2.3 Non-residential allocations

Gladstone is one of the most intensive areas of industry in Australia, producing 8 per cent of Australia's total exports. Responding to the 2002-03 drought, water restrictions were introduced on industrial water use, and industry responded through a variety of water efficiency measures.

Restrictions of 10% then 25% for industrial water use in the 2002-2003 drought prompted industrial users to improve water efficiency in their systems, resulting in longer term savings in the post-drought period (Corder and Moran 2006). For example Boyne Smelters Limited reduced their 2003 consumption by 32% (Corder and Moran 2006).

### 2.2.4 Open space allocations

As part of level 3a water restrictions in Melbourne, councils were only permitted to irrigate one in four sportsgrounds. However, in a bid to provide councils with greater flexibility to maintain their sportsgrounds, a water allocation system was developed so that councils were able to use the same volume of water they would use for one sportsground on any number of sportsgrounds. The aim of the sportsground allocation program was to save the same volume of water as when one in four parks are irrigated (under stages 3 and 3a), but to provide greater choice for councils.

The 'ceiling' water consumption for the allocation program was based on the volume of water used for irrigating council sportsgrounds in Jan – Dec 2007, when the "1 in 4" restriction was in place. Councils participating in the scheme were required to:

- Develop and implement short, medium and long-term water management strategies,
- Provide information on the turf species being used on each irrigated sportsground,
- Provide information on the total m<sup>2</sup> of irrigated area (and ensure that the irrigated areas were sportsgrounds only)
- Develop refurbishment plans for ovals requiring transition to drought tolerant species by July 2008
- Implement real time consumption monitoring by 31 Dec 08
- Implement real time central control of irrigation system by 31 Dec 08
- Complete independent audit of irrigation systems by July 2008
- Provide monthly reporting of water consumption and quarterly reporting of progress on all other initiatives, including the refurbishment plan (Horton and Cini 2008).

In its initial phases this program had the highest uptake in areas of Melbourne that tended to have higher rainfall and better soil conditions, as these environmental conditions provided those council areas with greater flexibility to extend their watering allocation. However, there was very

low uptake in the drier areas of Melbourne where clayey soils were more prevalent (Horton, pers. comm. April 2008).

## 2.3 ENFORCEMENT AND COMPLIANCE

Although there are legal provisions in most states for enforcing restrictions through the courts, this mechanism has not been implemented to date, due to the expense and difficulties associated with obtaining evidence. In most locations, utilities implement a provision to issue on-the-spot fines (usually between \$100 and \$500) to individuals.

The number of fines issued varies according to location, partly reflecting:

- The continuous duration of restrictions for several years, such as in Sydney and Perth.
- The more recent provision for on-the-spot fines in some areas, such as in Victoria and Adelaide. However, although more fines have been issued per residential connection in Perth than elsewhere, this still represents a relatively small proportion of households.

In most locations, monitoring compliance is conducted through a combination of telephone "dob-ins" from the community and active patrol by utility (or council) staff. Warning notices that include educational material are usually issued for the first offence and fines are not issued until breaches are confirmed by on-site inspection.

While telephone "dob-ins" are an important component of monitoring restrictions, in many locations a large proportion of reports has subsequently been revealed to concern use of greywater or rainwater (which are not generally restricted). Visible monitoring of restrictions, for example through staff or meter readers wearing identifiable clothing, is supported generally by the community, as an indication that utilities and organisations intend to enforce restrictions rules (Victorian Drought Coordinating Committee, pers. comm. March 2007).

A snapshot of compliance rates and numbers of fines issued in various states and territories is available in Chong et al (2009).

## 2.4 ASSESSING WATER SAVINGS

Ideally, **measuring water savings** due to restrictions would be estimated by collecting information and data about the extent to which specific water restrictions rules affect residential and non-residential water use behaviour. However, to date comprehensive data required does not exist. Given the absence of end-use data, estimating savings is limited to using available data on total consumption – that is, metered total consumption observed during restrictions less total consumption estimated to have occurred in the absence of restrictions. Using a range of methods, to correct for the impacts of weather, savings of between 8% and 33% have been estimated, depending on location and stage (however note that due to aggregation, most of these estimates include savings due to any other demand management programmes). Notably, restrictions savings have not been assessed for any individual components within an overall restrictions regime.

Cities for which water savings due to restrictions have been assessed compared to climate-corrected demand include Perth (September 2001-September 2007), Sydney (October 2003-July 2006), ACT (December 2002 – October 2005) and Melbourne (November 2002 to April 2005). Cities for which savings were estimated by comparing observed consumption against historical averages include Geelong, Adelaide and Brisbane. Reporting of savings data (calculated against climate-corrected demand) is not generally made publicly available, although during restrictions periods various agencies have published on their websites time series data, comparing current consumption to historical consumption, or progress against per capita consumption targets. Further information on water savings from restrictions is available in Chong et al (2009).

## 3 United States of America

Responses to drought in the United States vary by individual state and locality. A comprehensive review of all drought management approaches has not been conducted, however, this section draws on examples from various urban locations in the following jurisdictions: California, Colorado, New York, Texas and Georgia.

### 3.1 URBAN DROUGHT PLANNING

In the United States, development of responses to reduce vulnerability to drought has occurred mainly at state and local scales. During the widespread U.S. drought of 1975-77, no state had a formal drought plan. However, by October 2006, all except nine states had formal drought plans (or were developing such plans) (NDMC 2006). Many of these state-based plans take into consideration allocation tradeoffs between major urban and rural (i.e. irrigated agricultural) areas, as well as the security of water sources shared between states. Specific responses to drought for urban water-using sectors are contained in city- or locality-based plans.

In **California**, since 1983, under the *Urban Water Management Planning Act*, every urban water supplier that provides water to more than 3000 customers or provides more than 3000 acre-feet (3700 ML) annually are required to develop and implement an Urban Water Management Plan. Each supplier is required to prepare an “urban water contingency analysis” including six components (California Water Code Section 10632):

1. A description of the stages of action an agency will take in response to water shortages
2. An estimate of supply for three consecutive dry years
3. A plan for dealing with catastrophic supply interruption
4. A list of the prohibitions, penalties and consumption reduction methods to be used
5. An analysis of expected revenue effects of reduced sales during shortages and proposed measures to overcome those effects
6. How it will monitor and document water cutbacks.

A review conducted in 2005 revealed that about 90% of agencies had not updated their Urban Water Management Plan since 1991. However, since then, about 40 of 400 major agencies have updated their plans (Farwell, pers. comm. May 2008).

Drought Emergency Rules, contained in the *Rules of the City of New York* (Title 15, Chapter 21), were implemented in **New York City** for seven months from 1 April to 1 November 2002. During this drought period, a Drought Emergency Variance Board was appointed to deal with exemptions to these rules. Subsequent to this drought, the Department of Environment Protection streamlined and simplified the rules for the three different stages (NYC DEP 2004).

The preparation of a drought management plan, however, has not necessarily ensured immunity for urban regions, or their water planners, against the consequences of prolonged or severe drought. For example, in 2007 states in the south-east of the US. sharing water from Lake Lanier (including **Georgia**, **Florida** and **Alabama**) suffered extreme drought. Although state-wide drought management plans, such as Georgia's, detailed stages of drought and drought response including restrictions rules applicable in urban centres, as the drought progressed these were criticised as being insufficient, and that state-wide water plans should take into account regional water sharing arrangements and development controls (Dewan and Goodman 2007).

Across the states, a number of different approaches are taken to establishing **indicators** and **trigger** levels for stages of drought and drought responses. Indicators are variables used to

describe the magnitude, duration, severity and spatial extent of drought, whereas triggers are the threshold values of an indicator that distinguish drought level/stage (Steinemann et al 2005). In the U.S., indicators are based on hydrological, water supply and meteorological variables (including where relevant variables relating to snowpack and snowmelt). Triggers are determined based on stochastic modelling (i.e. based on security of supply), or set to ensure supply through conditions equivalent to “past worst droughts”. However triggers are not always determined or announced publicly in advance. For example:

- The **City of New York’s** Drought Management Plan and Rules (NWC DEP 1998) state that a ‘Drought Emergency’ is declared when there is ‘reasonable probability’ that the city’s reservoirs would be drained. Trigger levels for restrictions are not pre-determined.
- In **Austin, Texas**, triggers are set and revised annually, depending on water supply, system capacity (particularly treatment capacity) and demand conditions. The triggers reflect a mix of indicators - for example, in 2004-05 Stage 1 ‘trigger’ was set to apply from May through September; the stage 2 trigger was related to demand (247 mgd for three consecutive days or 251 mgd for one day), and the stage II trigger was “to be determined by the Director of the Austin Water Utility” (Austin Water Utility 2005).

### 3.2 RESTRICTIONS MODELS

Like for Australian jurisdictions, **publicly available quantitative or qualitative evaluations of specific restrictions are not easily available**. Whilst some jurisdictions during drought may report consumption savings of a restrictions period compared to previous years, few report climate-corrected savings evaluations. No studies formally evaluating demand hardening or long-term conservation potential of *specific, individual* restrictions models have been identified as part of this literature review.

**Compliance mechanisms** associated with prohibition-style restrictions generally involve warnings and fines, with visible enforcement from “water cops”. Farwell (pers. comm. May 2008) recommended that the most effective fine system, in terms of ensuring compliance and promoting confidence in the restrictions, involved only one warning.

#### **City of Boulder, Colorado: Enforcement of restrictions during the 2002 drought.**

In response to drought, Boulder requested voluntary watering restrictions in early May 2002 and imposed mandatory restrictions in early June. The mandatory restrictions were primarily targeted at irrigation use. Penalties were established from %50 for the first violation to \$300 for third violation.

A private security firm was hired to assist with compliance efforts. Of 523 notices issues in 2002, 53 citizens requested a court hearing to contest the charge, which was upheld in 30 of 40 cases held. The number of water use violations dropped steadily over the course of the summer, the last observed in October.

Over these 3 months, the city collected \$27,615 in fines. The cost of staff time was approximately \$39280 for private security staff as well as substantial time cost for city staff.

*Source: City of Boulder Drought Plan 2003.*

In terms of restrictions models, **time of day and week residential garden watering restrictions** are common. Some examples are listed below.

- Year round restrictions on landscape watering (sprinklers) between certain times, on certain days except if using a watering can, hand held hose or bucket – San Antonio and Frisco in Texas and Southwest Florida (San Antonio Water System 2006, City of Frisco 2007, Southwest Florida Water Management District 2007)
- Time of day sprinkler use restricted – Albuquerque, New Mexico (City of Albuquerque 2007)

- Penalties for sprinkler use in cold temperatures or during rain – City of Frisco, Texas (City of Frisco 2007)
- Drip irrigation any day, sprinkler irrigation only once a week – Southern Nevada (Southern Nevada Water Authority 2006)
- Lawn watering restriction in Colorado ranged from once to three times a week and were either voluntary or mandatory. The greatest water savings were found in cities with the most aggressive and stringent mandatory restrictions (Kenney et al 2004)

The remainder of this section describes other types of restrictions instruments.

### 3.2.1 California – water budgets

Customer-side approaches to rationing during drought (i.e. the introduction or tightening of individual customer ‘water budgets’) have long been applied in California. In 1976-77 drought, a range of mandatory and voluntary residential rationing programmes were implemented, with savings beyond that required. For example, the Marin Municipal Water District required savings of 57% per capita but achieved 65% (to 35 gallons per person per day, around 132L/p/day). East Bay Municipal Utility District required 35% reduction per household, and achieved 40%. (California DOWR 2008).

Since then, various water budget rate systems have been implemented. There are a variety of water budget systems, many of them including tiers or blocks of allocations at different pricing, and all with some degree of individualisation according to customer characteristics (such as household size and irrigable area). Although these are primarily a model for billing for water, there is emergent potential for these rate systems to be used as a drought response measure, and applications include reducing allocations during drought based on percent reductions, on financial rationing, on per connection allocations, on per capita allocations, and hybrid per capita/percentage reductions. California DOWR (2008) describes the advantages and disadvantages of each type of model.

As in elsewhere in the United States, the focus of drought responses has been on the **residential and open-space sectors**. Farwell (pers. comm. May 2008) noted the maintaining employment as a key driver for not applying cross-industry prohibitive measures during drought, but also suggested that due to heterogeneity across and within commercial and industrial sectors, more targeted long-term demand reduction programmes are more appropriate for promoting water use efficiency.

A key implementation requirement of monthly water budgets in California is **monthly metering**. Automated (‘smart’) metering has the additional advantage of enabling users and water agencies to detect leaks (Farwell, pers. comm. May 2008).

#### **Irvine Ranch – water budgets**

Irvine Ranch is a semi-arid area that has developed water allocations combined with an ascending block tariff structure in order to reduce water consumption. Residential allocations are calculated based on the occupancy and the landscape square footage.

To ensure compliance, customers who exceed their water allocation can accrue penalties, which are then hypothecated back into further water conservation programs to help those receiving penalties become more efficient.

Water Budgets support optimum landscape irrigation, as the allocations change weekly based on current weather data and evapotranspiration rates. As a result, the most effective way for customers to reduce water bills is to monitor weekly usage and compare this to their weekly allocations, which can be calculated using the website of the local water authority (Irvine Ranch Water District 2008).

### **San Diego – water budgets with banking**

In San Diego, California, participation in the water budget programme by multi-family, commercial and public sites is currently voluntary (San Diego County Water Authority 2008).

However, in the past, allocations for large landscape managers have been determined for each month, based on historical averages of evapotranspiration during the year. During times of drought, these allocations are reduced, and customers who choose to reduce their water use below these reduced levels could “bank” the difference, which could then be drawn upon at a later date. This allows the landscape managers to irrigate more during the hottest months when the water stress is the greatest. Deficit irrigation during the earlier stages of the drought can also help the plants adjust to water stress, and increase the hardiness of the plants (Brown 2003).

### **Goleta – hybrid per capita and percentage reduction**

The Goleta Water District’s rationing plan established a hybrid per capita and percentage reduction for residential accounts. Each residential account received a health and safety allocation, varying between single family and multi-residential units, and a percentage of its average use. Residential allocations were increased for **additional residents**, for **health exemptions** and **fruit trees**, but only if the customer had installed efficient toilets and showerheads and drip irrigation was used. Commercial accounts were also reduced by a percentage from their five year average. The program was implemented in May 1989 with a goal of 15 per cent conservation and achieved a 30 per cent reduction (against historical average). (California DOWR 2008).

## **3.2.2 Colorado**

Drought conditions in the summer of 2002 prompted several cities along Colorado’s Front Range to impose restrictions on outdoor water use, focusing primarily on limiting the frequency of lawn watering, but also with an innovative application of drought surcharges in Denver.

Analysis by Kenney et al (2004) represents one of the very few assessments of savings due to drought restrictions which have been measured against climate-corrected (rather than historical average) demand. Savings in nine municipal water regions were assessed, and ranged from 18 to 56 per cent in use per capita during mandatory restrictions compared to 4 to 12 per cent during periods of voluntary restrictions. Savings from the drought surcharge period in Denver are discussed below. A study by Howe and Goemans (2002) suggested that if prohibitive restrictions were already in place, any drought surcharge would have to be significantly high (as was in the case of Denver) to achieve additional water savings.

### **Denver – drought surcharges**

Following a severe drought in 2001/02, Denver Water introduced residential drought surcharges in addition to water restrictions in Denver, Colorado. Prior to introduction of the surcharge, customers generally supported the idea, although community members did not feel that they were wasting water. They believed ‘someone else’ was responsible for wasting water (Kuykendoll 2003).

Initially set at a relatively low rate, in the summer of 2003 these surcharges were increased dramatically. The structure reflected increasing 8-block tariff increasing the standard rate by 50% to 500%:

- A surcharge on top of the standard tariff of US\$1.58/1000 gallons (US\$0.42/kL) of US \$0.80 per kilogallon for consumption levels for 19,000 to 22,000 gallons in a two month period (equivalent to US\$0.21 per kL for consumption 36kL to 42kL/month),
- For large water users, the summer surcharge on the highest block tariff was USD \$14.22 per kilogallon, \$11.85 in excess of the normal rate of \$2.37. Large users were defined as customers using above 60 kilogallons over each billing period (bi-monthly).

The drought surcharge dramatically reduced water reduction, by about 70% compared to forecast consumption (Denver Water, pers. comm. March 2007). Water savings appeared to continue through the winter of 2004/05, when restrictions and surcharges had been lifted, with usage 20-28% below normal winter usage (Denver Water, pers. comm. June 2005). However, the financial impact on water users was significant, with up to 79% of customers paying a surcharge and some paying substantial amounts. One of the lessons learned from the experience in Denver was that block tariff schemes may result in equity issues for households, depending upon occupancy and lot size. In response to these issues, some community members called for individualised billing, indexed to account for the occupancy and lot size of each household, also known as 'water budgets'.

Denver Water also experienced revenue shortfall which required postponement of maintenance works and deferral of some capital projects (Denver Water, pers. comm. June 2005). They also note that the relationship between water users and Denver Water was adversely affected by the implementation of drought surcharges.

For commercial, industrial and governmental customers, a target water set to achieve 70% of the water consumed relative to a 2001 baseline.

*See Appendix A for further discussion on the potential of drought pricing as an alternative restrictions model.*

#### **Boulder – proposed allocation for city parks**

The City of Boulder Drought Plan (2003) establishes guidelines for triggers and response strategies, however suggests that these should be reviewed and develop in detail each drought period. Most of the suggested restrictions on residents are conventional prohibition-style models, with percentage decreases also suggested for commercial, industrial and open-space sectors at more severe levels of restrictions.

More innovative approaches for restrictions on water use for city parks and street landscaping are also proposed in the Drought Plan. Municipal use, comprising parks irrigation, recreation centres, and street median irrigation, accounts for about 3% of the total annual demand of the city water system. As part of the city's on-going water conservation program, an annual water allocation has been set for all irrigated city parks – 75% of the theoretical maximum water requirement for bluegrass for these properties (i.e. maximum ET rate). The Drought Plan notes that there is strong public support for these properties to be managed under an allocation system, rather than a prohibition system, during drought. Decreasing allocations would be provided for park watering as drought stages progress.

### **3.2.3 New York City – restrictions & regulations**

Like restrictions rules in Australia, most of the restrictions applying in New York City involve limiting the timing, technology or banning typical outdoor water uses. Key restrictions rules, which may have the potential for substantial water savings but are not applied in Australia, include (NWC DEP 2004):

- Prohibition of leakage and waste – “The continuing of an leak of waste from any water pipe, valve, faucet, conduit, equipment, facility or device connected to the city water system, or that utilises city water’.
- Cooling towers - Limiting minimum dry-bulb air temperature of indoor environments cooled by cooling tower systems to 79 degrees Fahrenheit (26 degrees centigrade). *See Appendix B for further discussion on the potential for water savings in cooling towers.*
- Provision to raise water prices to limit demand.

### 3.2.4 Florida – restrictions

Florida has established a process to prioritise demand reduction actions, based on *qualitative* assessments of potential amount of water to be saved, cost-effectiveness, and ease of implementation. High priority measures recommended include conservation rate structures, incentives, and statewide irrigation design and installation standards (California DOWR 2008).

**South Florida** has a restrictions regime consisting of different rules for residents, golf courses, agriculture and other recreational areas (South Florida Water Management District 2008). These include:

- Golf Courses must reduce their allocated water use by 30 percent and limit watering to early morning or evenings. Weekly water usage must be reported on the website of the water authority.
- Sports ovals can be watered for a maximum of 20 minutes overnight.
- Tennis courts can be watered for up to 10 minutes daily.
- For tennis courts, sports turfs, and other athletics facilities no irrigation is allowed if there has been sufficient rainfall prior to scheduled irrigation. Users must have installed a rainfall cut-off device to implement this.

### 3.2.5 Texas - incentives for landscape managers

A common issue faced in Texas, and in other areas relates to some water customers increasing their water use prior to restrictions, when drought storage levels begin to drop. This phenomenon, known as “hoarding”, is counter productive to the objectives of restrictions and may have the effect of bringing restrictions on earlier than they would otherwise have been implemented (Brown 2003).

In response to this, San Antonio in Texas have introduced water saving measures that reduce water consumption year round. The program encouraged landscape managers of golf courses to install computer controlled irrigation systems change the water use depending on the evapotranspiration. “Conforming” Golf Courses that installed the devices would have less severe water restrictions during drought periods. This approach takes advantage of the benefits of year round savings that result from installing these systems, which have been estimates at 15-30% of water use (Brown 2003).

### 3.2.6 Georgia

In Georgia, a severe drought has been in place since 2007, with dry weather beginning in 2006. Georgia sources most of its water from the Buford Dam on Lake Lanier, which achieved record low levels in late 2007. This situation was exacerbated by incorrect reading of the dam levels, which led to greater than necessary water releases over the dam into Chattahoochee River (Redmon 2008). In early 2008 it appears that the lake has had a relatively consistent period of increasing the water level.

In 2004, the state adopted a drought management plan (Georgia DNR 2003) which outlined four levels of restrictions that could be triggered as the drought becomes progressively severe. This plan became the framework for responding to the 2007-2008 drought across the state.

As of September 2007, the northern 40% of the state is in level 4 drought restrictions, which includes a complete outdoor water use ban. Restrictions also apply to the filling of swimming pools, washing cars and boats, washing buildings or structures and using water for ornamental purposes such as fountains, pools and water features. The remainder of the state are in level 2 restrictions, which includes watering on scheduled days between midnight and 10am. There is also a ban on washing hard surfaces under the Level 2 Restrictions.

In early 2008, Georgia State provided an option for users under level 4 restrictions. One options was to partake in an exemption to the level four drought response which allowed watering for 25 minutes a day under an odd and evens schedule, between midnight and 10am. Watering must be conducted with spray nozzles that shut off after use.

Alternatively, if the user decides to opt in the Outdoor Water Use Registration Program the user can install new water efficient or “waterSmart” landscapes (Georgia Urban Agricultural Program, 2008). The new landscapes may be watered at any time during installation, and afterwards at any time between midnight and 10am for a period of 10 weeks. After this grace period when the new gardens are established, the customer should revert to the 25 minutes a day schedule.

Additionally, there are permits issued to customers withdrawing in excess of 100,000 gallons (approximately 380,000 litres). Applications for permits are considered by the Georgia Environmental Protection Division on the basis of a site specific water conservation plan and progress reports.

## 4 United Kingdom

### 4.1 DROUGHT PLANNING IN THE UK

The UK Environment Agency coordinates drought planning in England and Wales and is responsible for monitoring and mitigating the impact of drought on the environment. The Environment Agency has produced a high level national drought plan as well as regional and local area plans which are more detailed. These plans are kept under yearly review and are updated when necessary. At each level these plans set out:

- A drought management structure
- Drought monitoring to be undertaken
- Triggers and actions for the drought management team
- Responsibilities with regards to drought permit and drought order applications from water companies
- Drought communications and reporting (UK Environment Agency 2007a).

In addition, water companies are required to produce their own drought response plans. The Water Industry Act states that “it shall be the duty of each water undertaker to prepare and maintain a drought plan” and that these drought plans should set out a course of action for water companies to continue to provide water during drought without resorting to drought orders or drought permits. The first water company drought plans were produced in 1999 and since then have been updated every 3 years (UK Environment Agency 2003). The Environment Agency reviews these plans and reports back on any improvements required. The Environment Agency’s recommendations for improvements to water companies drought plans in 2007 included the following:

- Include further leakage reduction as a drought management measure
- Drought plans should include an assessment of likely environmental impacts that would occur as a result of greater water extraction during a drought
- Allow sufficient lead time when implementing drought measures (initiate drought measures in advance of when they are needed) (UK Environment Agency 2007b).

The most widely used drought measure in the UK are ‘hosepipe’ bans and apart from these water companies are also permitted to apply to the government for bans on non-essential water use including:

- the use of mains water to water outdoor areas for both residential and commercial users,
- filling pools and ponds and operating ornamental fountains,
- using mechanical vehicle washers and washing any large vehicles e.g. boats, planes, trains
- cleaning the outside of buildings, except for windows, and
- cleaning industrial premises, except for safety reasons.

Emergency drought orders could include rota cuts (service interruptions during certain times of day) and the use of standpipes or water tankers in the street (UK Environment Agency 2008).

### 4.2 RESPONSES DURING DROUGHT

Southeast England experienced the worst drought in 100 years during 2004-2006. Eight water companies in the southeast put hosepipe bans in place, which restricted up to 16 million people

from using hoses to wash cars and water private gardens. It is estimated that these outdoor water use bans as well as awareness campaigns reduced residential water demand by 5-15% (DEFRA 2007).

Enforcement of hosepipe bans in the UK relies largely on the public. Due to the privatisation of water companies in the UK, private water companies prefer to refrain from issuing fines to those who breach water restrictions in order to maintain good customer relations (Turton pers. comm. April 2008).

Restrictions on water use in public open spaces tend to be prohibitive in the UK, for example during the 2004-2006 drought, Southern Water introduced a blanket ban on irrigating all public open spaces (Turton pers. comm. April 2008).

The drought plans followed during the 2004-2006 drought were generally considered to be adequate. None of the eight water companies that introduced hosepipe bans needed to apply for a drought order. One of the elements of drought planning that was considered vital during this drought were the communications plans that were developed by the UK Environment Agency (Turton pers. comm. April 2008).

### **4.3 MODEL FOR A DOMESTIC WATER TRADING SCHEME**

A proposal for a domestic water trading scheme has been put forward by Griggs et al (2007) to allow households to participate in an online water trading system as an economic incentive to save water. The proposed scheme would operate within catchment areas and a baseline would be determined for each household at the start of the scheme. For metered properties, establishing a baseline would be straightforward, however, for the large number of unmetered properties, Griggs proposes to conduct an annual water use audit of each property to estimate the household's water use. At the end of the year, each household would receive a water bill and if their consumption has reduced from the baseline, it would then be possible for the householder to trade their water savings online to receive a reduction in their annual water bill. The process would also provide an incentive for customers to apply for the installation of a water meter to enable full participation in the scheme (see Griggs and Jeffrey 2007).

*See Appendix A for further discussion on the potential of urban water trading as an alternative restrictions model.*

## 5 Other countries

### 5.1 SPAIN

The current drought in Spain is the worst in 40 years and the situation is especially critical in Barcelona (ABC News 2008). In February 2008, Barcelona City Council brought “level 2” water restrictions into force. These restrictions include:

- Drinking water is prohibited for use in watering parks and gardens or for street cleaning, public fountains are to be closed and planting of new trees and shrubs is to be suspended
- Public parks are to be watered using groundwater
- Residents are banned from using hoses and filling pools or ponds, amongst other restrictions

In the next level of restrictions, the council will develop water savings plans with private sports centres and gyms (Ajuntament de Barcelona 2008). In April 2008, water reserves in Catalonia (the region surrounding Barcelona which has a population of 7 million) were at 19 % of capacity. Apart from water restrictions, the response in Barcelona has included plans to divert water from the Ebro River (from another catchment), the construction of a desalination plant and an emergency plan to ship in water from France. The river diversion project had been rejected due to environmental concerns and conflicts between regional governments, but has now been approved as it is feared that Barcelona will literally have no water by October (AP 2008). Construction of a sea water desalination plant is also currently underway (ABC News 2008).

In the past, restrictions in the drier southern regions of Spain have included service interruption and pressure reductions. In Seville during the period from 1992-1996 restrictions during different periods included: voluntary restrictions; pressure reductions of between 4 and 6 hours; and service interruption periods ranging between 6 and 8 hours.

Other measures have included increased block tariffs during drought. Evaluation of these measures showed that pricing policies were more effective than supply interruption, with a lower “welfare loss” than cutting supply (see Valinas 2001).

In general, water demand management in Spain has focussed on efficiency in irrigation as irrigation represents 60% of the country’s water use and for many regions, the cities and rural areas share resources from the same catchment or aquifer. Urban water supplies take a higher priority over agricultural demands in Spain (European Commission 2007). The most effective instruments for reducing demand in the residential sector have been promotion and pricing, followed by regulation and then awareness campaigns (UK Environment Agency 2007c).

Evaluations of water savings achieved as a result of drought measures in Spain were not readily available.

### 5.2 FRANCE

The Ministry for Ecology and Sustainable Development in France issued a drought response plan to local governments during 2005 and these were revised in 2006 based on experiences during 2005. The approach features 3 tiers of water restrictions for residential and non-residential sectors.

The first level of “alarm”:

- Limits vehicle washing to professional stations (with exceptions for vehicles with a specific purpose or safety requirement)
- Prohibits pool filling

- Limits lawn watering in public and private areas including gardens and sporting grounds to between 8pm and 8am
- Industrial and commercial entities are to limit their water consumption to the bare essentials

The second level of “crisis” includes the same restrictions as above, however:

- Draining of public pools is subject to authorisation
- Watering of lawns, public parks and sporting grounds is prohibited and only vegetable gardens and golf greens may be watered between 8pm and 8am
- Public fountains are to be closed
- Road washing is prohibited (except where safety is concerned)

The third level of “reinforced crisis” incorporates the previous restrictions, and:

- Only golf greens can be watered at 30% of the usual volumes between 8pm and 8am (MESD 2006).

In May 2007, three local government areas in France were at level 2 restrictions and two local government areas were at level 1 restrictions (MESD 2007). People who do not adhere to restrictions in France can be fined up to 1500 Euros or 3000 Euros for repeat offenders (European Commission 2007).

Evaluations of water savings achieved as a result of drought measures in France were not readily available.

### **5.3 NEW ZEALAND**

A number of cities and council areas in New Zealand use outdoor water use restrictions to manage demand during dry summers. For example:

- From December 2006 to March 2007, Hamilton City Council put in place a restriction on water sprinklers, adopting the “even numbered properties on even days” approach,
- Carterton District Council has level one water restrictions in place that limit outdoor hosing to every second day, using the same method of “even numbered properties on even days” (Carterton District Council 2008)

These type of outdoor water restrictions have been used in Hamilton over the past 17 years and have been successful in managing demand during summer (Hamilton City Council 2007).

### **5.4 CANADA**

Water restrictions in Canada have focused on reducing outdoor water use during dry summers. In the city of Penticton in Canada, water restrictions are planned for the summer of 2008. Automatic sprinkler use will be restricted to night watering times on alternate days (10am to 4pm) and manual sprinklers are only to be used on alternate days according to the even/odd address system, between 6-8am and 7-10pm (City of Penticton 2008).

In 2006, the city of Tofino in Canada faced a serious summer water shortage and consequently the town’s council set a target of total daily water use that was 50% of the town’s regular consumption. Initially, the council threatened to shut down all hotels and restaurants over a particular long weekend, but later decided that businesses could remain open as long as the target was met. Residents and business were told to follow conservation measures and the water restrictions were in place for 3 weeks. The daily consumption target was met and exceeded and the restrictions were lifted after a weekend of significant rain (CBC News 2006).

## 6 Summary

The majority of drought response restrictions implemented recently across Australia and internationally have been prohibition-style models that target outdoor water use, across residential, open-space and non-residential sectors. Limits have been placed on timing of water use, watering methods have been restricted, and in more extreme situations outright bans on specific end-uses have been implemented. Restrictions rules do not tend to explicitly require source substitution or recycling, but as they almost universally apply to town / mains water, incentives are in effect created for users to seek alternative water sources.

Some restrictions models also target water-use efficiency more directly – for example, through requiring non-residential users (from specific sectors, or large users) to develop water management plans that have water savings targets. There have also been some, although limited, applications of water allocations and drought surcharges in the residential sector.

Restrictions models for the **residential sector** have been characterised by:

- A prevalence of prohibitive rules, particularly limiting timing and sprinkler user for gardens and lawns. At higher levels of restrictions, bans on garden watering apply.
- Limited opportunities for offsetting from indoor water use savings (although restrictions on pool water use is an exception).
- Limited application of allocation systems, although where implemented they have been regarded as successful (Gladstone, for a short period in 2002) or having the potential to be successful (south-east Queensland, current for high water users).
- There are a few examples of innovative approaches to restrictions in the United States. For example, in New York City leakage reduction and efficient showerheads are mandated during drought, and across the United States there have developments in establishing water budgets.
- Pricing has been suggested widely as a potential complement or alternative to restrictions. However, the one application of a drought surcharge (in Denver, Colorado) was successful in terms of water savings but not in terms of customer perceptions, attitudes towards the water authority, and revenue implications.

Restrictions on **open-space sector** generally:

- Distinguish between parks and reserves and sportsgrounds, which generally face less severe restrictions.
- Limit water use in similar ways to restrictions on residential lawn and garden watering, except for exemptions applying to sportsgrounds and new approaches to be implemented in metropolitan Melbourne.
- From the literature review, no evidence of more innovative or flexible approaches internationally (however associations such as ICLEI could be contacted to confirm this).

For the **non-residential sector**, restrictions models:

- Generally target only those end-uses which are visible outdoors, for example lawn and garden space, and those sectors and industries for which most water use tends to be outdoors (eg. nurseries, market gardens, commercial car washers, pool facilities). Impacts on restrictions however on non-residential sectors tend to be through affected sales, rather than because of restrictions on water as an input.
- Reflect the emergence in different locations in Australia of water management plans. Some programmes target specific (indoor or outdoor) water using sectors, whereas others target

large water users. In Queensland these plans require certain (building) efficiency requirements. They also require percentage reductions or demonstration of best practice.

- Except for bans applying also to residential users, there are no bans on non-residential sector water users (i.e. use of water as an input to production is not banned for any sector). There is one example of an allocation system (effectively compulsory reduction in water use) implemented for the non-residential sector, in Gladstone in 2002.
- Internationally, restrictions on the non-residential sector are not widespread. However in New York City an innovative approach is to target cooling tower water use through limiting minimum indoor air temperatures.

### **Opportunities for alternative restrictions models in metropolitan Melbourne**

Key aims for any alternative restrictions models would be to improve the flexibility and fairness of the existing restrictions framework, whilst achieving water savings (although not at the expense of other sustainability impacts such as energy use and greenhouse gas emissions).

Drawing from this literature review, there are a number of opportunities for developing alternative restrictions models for metropolitan Melbourne. These could include:

- *Allocation approach for the residential sector* – There has been limited application of mandatory allocation models in Australia, but emerging implementation as a drought response measure in the U.S. Requiring households to meet an allocation (or allowing households to opt-in to an allocation system), but allowing households freedom to decide how and when they use water up to the allocated amount, could improve flexibility and choice compared to the existing prohibitive restrictions framework. An allocation system could address many specific concerns about fairness of the existing restrictions framework, such as the impact on suppliers of outdoor water-using products, vegetable growers, and the elderly or shiftworkers needing to apply for exemptions. Implementation issues would include: how to allocate; whether to include all of the residential sector; non-metered properties; and increasing the metering cycle.
- *Extending water management plans to the residential sector* – This would address some of the concerns that indoor water use is not targeted, but new compliance models would probably be necessary.
- *Expanding the scope of users required to develop water management plans* – Currently, only large water users are targeted, but during restrictions water users in high water-using sectors (eg. accommodation and hospitality) but where best-practice guidance is readily available, could be required to submit water management plans.
- *Requiring specific efficiency practices for the non-residential sector* - This would address some concerns by residents that the non-residential sector is not sharing the burden of restrictions, and could add further credibility to existing WMP and EREP requirements. Possibilities include: end-uses in buildings, mandating maintenance on cooling towers, boilers and other major water users of industrial or manufacturing processes, mandating leakage reduction and elimination, mandating minimum temperatures for air-conditioners linked to cooling towers. *See Appendix B for information on cooling towers.*
- *Local council/industry offset system* – There may be opportunities to link to buyers and sellers in other sectors, for example buyers in the residential sector (if linked to an allocation system), and implementing in conjunction with other programmes to ensure equitable access to choice by local councils in all areas.

**Examples of restrictions models**

	Residential outdoor	Open space	Non-residential
<b>Restrictions – conventional prohibitive</b>			
<b>Rules on timing or technology</b>	Garden and lawn watering times, sprinkler bans (various locations)	Garden and lawn watering times, sprinkler bans (various locations)	Cooling towers > 79 degF (NYC) Various limits on water use (eg. timing, nozzles required) by nurseries, market gardens, animal husbandry, building and construction sectors, car dealers, cleaning operations, pools etc (various locations)
<b>Bans on end-uses</b>	Lawn watering, garden watering, new or topping up pools, hard surfaces, fountains and ponds (various locations)	Watering parks and reserves banned (various locations)	Lawn watering, garden watering, cleaning of cars in dealerships, hard surfaces cleaning (various locations)
<b>Offsets, water management plans, and efficiency requirements</b>			
<b>Exemptions based on offsets</b>	Pool water use allowed if offset by other efficiency measures (Victoria, SEQ)		
<b>Water management plans</b>		WEMPS (SEQ)	WMPs and EREPs for large users (Victoria) WMPs for all accommodation, public pools and large users (Gosford-Wyong) WEMPs for all large users (SEQ)
<b>Specific technology changes or water sources required</b>		WEMPS for all public parks, gardens and sportsfields (SEQ)	WEMPs for all large users (SEQ)
<b>Water savings or level of water efficiency required</b>	All showerheads in use must be < 2gpm (NYC) Leakages banned (NYC)	25% reduction on sportsgrounds (Victoria), 30% reduction on parks, reserves and sportsgrounds (ACT) 30% reduction on golf courses (South Florida) Leakages banned (NYC)	Efficient car washes required to use < 70L/car (Victoria 3a). Leakages banned (NYC)
<b>Allocations</b>			
<b>Voluntary targets</b>	Target 140 (SEQ)		
<b>Maximum cap with fine and/or other punitive measures</b>	Major water users limited to 200 kL/person (SEQ). All households limited to on average 6 kL/week, based occupancy (Gladstone, 2002-03).	California (various), Melbourne metropolitan (current)	10% increasing to 25% reduction in industrial water use for all non-residential users (Gladstone, 2002-03) Total reduction of 50% required, if target not met then

	Water budgets based on land size and water requirements, with fines hypothecated for water conservation programmes (Irvine Ranch, US)		penalty of business shut-down (Tofino, Canada 2006)
<b>Maximum cap with fine and discount</b>	Has not been implemented, although discount system part of block tariff structure in Ballina in 1997.		
<b>Scarcity pricing (seasonal or drought-based rates)</b>			
<b>Flat drought price (perhaps with free allocation)</b>			Not yet implemented, but provision to raise water prices included in drought management plan (previous Hunter Water, current NYC)
<b>Drought surcharge on IBT</b>	Rising block surcharge over 8 blocks, same for all households (Denver, Colorado 2002) Surcharge based on household size Beijing 2008.	Local councils (Melbourne)	
<b>Trading allocations</b>			
<b>Urban trade</b>	Proposed by Young (2007) for Australia and Griggs et al (2007) for the United Kingdom		