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1 Appendix 1: The United Kingdom

1.1 Water Policy Review

Inman and Jeffrey. A review of residential water conservation tool performance and influences and implementation effectiveness. Urban Water Journal, Vol 3, No 3, September 2006 127-143.

Successful implementation of water demand management requires commitment from the local water utility and its customers as well as the required political will and leadership from governments to generate consensus and provide suitable legislation. Here the authors report their findings regarding implementation of demand management under five "tool" categories:

- financial tools
- technological tools
- educational tools
- operation and maintenance tools
- regulations and legislation

Iman and Jeffrey identified a number of influences on the effectiveness of these tools and their method of implementation. A key consideration was what they describe ass off-setting behaviour. An example is that when people know that they have had a low flow shower head installed, they may feel free to take longer showers. An interesting observation is that ignorance can prevent off-setting behaviour which the study points out can have grave implications for citizenship and governance. It is suggested that "personalized" communication can enhance the water saving potential of implementation and decrease the effect of off-setting behaviour. Iman and Jeffrey also infer that communication is even more important than self-selection. The possibility of off-setting behaviour should be a consideration in any form of demand management approach.

The overall conclusions from the study were that:

- The replacement of old toilets offers the greatest water saving potential; due in part to the incidental repair of toilet leaks. It is possible to make substantial indoor water savings amongst low income households but water efficient appliances need to be offered and installed free of charge to achieve significant coverage of this demographic.
- Indoor water consumption is relatively price inelastic. Large price increases are needed to significantly reduce indoor water consumption which raises problems for low-income families which then needs to be addressed.
- Outdoor water use however is more elastic to water price rises.

Suggestions for addressing these situations are to have pricing structures which are accompanied by other demand management policies including:

- A "lifeline" rate to accommodate low-income groups.
- Sufficient opportunities for water consumers to reduce their indoor water consumption without excessive costs
- Seasonal rates to reflect variations in seasonal (outdoor) demand.

The study concludes that demand management can be expected to reduce water consumption by 10 to 20% over a 10 to 20 year period depending on the type of approach.

1.2 Financial analysis and modelling

Foxon, T. J., An assessment of water demand management options from a systems approach. J CIWEM, 2000 14 June.

This study developed a reference sustainability system (RSS) for representing the resource and material flows on which the environmental sustainability of cities depends. Furthermore, it considers how RSS could be used to enable systematic assessment of the potential of technologies and resource management strategies to enhance urban sustainability. RSS was used to consider scenarios arising from the expansion of future demand over the next 20 years. The researchers used data from Thames Water to develop their scenarios. Their baseline assumption was based on a combination of rising demand through more garden watering and power showers along with rising population. The average water use was projected to rise from 159 l/ph/pd (per household/per day) to 183 l/ph/pd and the number of households to rise by 23%.

The researchers then tested the ability of several demand management options to reduce the increased demand. The interventions were leak reduction from the current 16.03 l/property/hr to 4.05 l/prop/hr, compulsory metering which it was anticipated would result in a 10% reduction, greywater recycling with 90% penetration and toilet conversion to dual flush. To compare these options the study compared a range of indicators; water which was saved, wastewater discharges avoided and cost per unit of water saved for different options. They did not include environmental indicators such as water quality and nutrient flows. For each demand management scenario the levelised cost per unit water saved for that option was calculated. This included the annual installation and operating costs, operating expenditure savings and water saving at the end of the 20 year period. The operating costs and savings and the water savings were also included for the next 20 years as it was assumed those benefits would be on-going. The net present value (npv) of both the costs and benefits over the 40 years was calculated using a 6% discount rate. The levelised cost per unit of water saved is the net present cost/ the net present value of water saved. The recognition of these savings is not always used in these calculations so that demand management can appear as a cost. Using levelised cost is a more balanced approach.

The calculations showed that reducing leakage by the suggested amount gave by far the largest reduction. Greywater recycling was next, followed by compulsory metering and in this study converting to a 6/3 litre dual flush toilet came last.

The study then considered the impact of environmental values estimated through an assessment of people's "willingness to pay" to avoid low flows through abstraction for domestic use.[1] It was estimated that an average figure of 5 pence/m^3 (NZ12c) could be added for environmental protection and if added to the savings from reduced wastewater further increased its effectiveness as an intervention.

Associated Incremental Social Costs **(Water Efficiency in the South East of England. Environment Agency, April 2007.)**

The central premise of the paper was that comparing demand management implementation strategies with more traditional water supply schemes shows that measures could produce more effective cost savings. Following a review of potential best practice in water demand retrofit in the South East of the UK, five approaches were selected for further investigation. The initial study analysed a wide range of water efficiency interventions to determine which were likely to give the most potential for gains.

- **Cistern displacement devices such as gizmos or bricks** - Most people have these devices in their single flush toilet or had purchased a low water use dual flush toilet.
- **Rainwater harvesting** - Incorporating rainwater harvesting as part of domestic new builds is not well advanced in the UK, mainly because of the longish pay-back periods and maintenance issues. However schools and community centres were starting to use them so possibly that will stimulate increased interest at home.
- **Water butts** - These are widely used for garden watering although their impact on water demand is not considered great, given their small storage capacity.
- **Greywater recycling** - Greywater recycling is uncommon in homes in the UK. A report[2] concludes that reliable systems that operate more or less on a "fit and forget" basis are required to reduce the need for on-going maintenance and have greater appeal to the general public.
- **Water audits** - There have been a number of household water audits carried out by water companies in the South East of the UK. The "Household Water Audits" project completed by Essex and Suffolk Water in 2002 which audited over 1,400 houses did not provide good evidence that this type of scheme can achieve reliable savings in the long-term.
- **Water efficiency promotion/publicity** - There appeared to be insufficient research into the benefits of educational material to determine its value or that it resulted in reliable savings.

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[1] Turner, K. and Pearce, D. Appendix 8 in Yorkshire Water Services Ltd. Establishing the Economic Level of leakage. Yorkshire Water, Leeds June 1997.

[2] A study of domestic greywater recycling, 2005. Environment Agency

- **Retrofitting single flush toilets with variable flush devices** - Evidence from large-scale studies had indicated that this could be large-scale results.[3]
- **Low flush replacement toilets** - Determined that the potential savings could be high.
- **Low Flow Showers** - The analysis showed that the savings were relatively small but consistent.
- **Metering** - This was considered a good option as it generated a price signal against which to compare consumption.
- **Tariffs** - There was a lack of quality studies on the use of tariff and their ability to achieve savings.
- **Water efficient garden irrigation** - Although there is the ability to generate significant savings from efficient garden irrigation, the impact was determined to be only a seasonal effect and not suitable for the study.

From the above analysis they identified the top contenders as:

- ultra low flush toilet replacement scheme
- variable flush retrofit devices
- low flow showers
- metering
- a range of low water use fittings

and considered their application in a range of settings being:

- all Housing Association households in the South East
- all water resource zones with a tight supply-demand balance
- typical population and demand sized water company in the South East.

Finally they considered two implementation strategies consisting of combinations of schemes which were:

- metering combined with dual flush retrofit devices and low flush replacement toilets
- metering combined with low use fittings.

The methodology to compare the costs and savings of the relative schemes was to calculate the average incremental social cost for each scheme. The social cost is the measure of the costs associated with any disruption or damage caused by implementing the scheme. It uses the formula:

AISC (pence/m3) = C+O+S-OS/W*10

[3] ***Retrofitting variable flush mechanisms to existing toilets, 2005. Environment Agency. Also The Water Efficiency of retrofit dual flush toilets, 2000. Southern Water.***

Where:

C = net present value of the capital expenditure (CAPEX during set up)
O = net present value of the operating cost, that is the cost of achieving or maintaining the water saving (operating costs when implementing the scheme)
OS = net present value of the opex saving, that is the money saved by not producing the water saved by the scheme (the amount saved by not having to produce the water saved by the scheme)
S = net present value of the social cost of the scheme
W = net present value of the total water saved in megalitres (Ml)

They used a discount factor for a given year = $1/(1-a^b)$, a= discount rate of 0.055 and b = implementation year 1 to 60 (60 years being in line with Water Resources Planning Guidelines). Environmental costs were not considered in the scheme.

The study acknowledged that it was difficult to estimate the potential savings from water efficiency schemes, mainly because of uncertainties in the way people behave. They based their assumptions on previous studies and the knowledge of associates operating in the water management field. For each intervention considered the study assumed that the full cost of the retrofit was being covered and was free to the householder to maximize its uptake. Average Incremental Social Costs (AISC) can then be used for different intervention options to compare with the cost of a new supply for a given level of water savings and compared with the cost of a new supply which would generate the saved amount of water. AISCs have been calculated in broad terms for new supply alternatives in the UK. These costs would vary for differing situations but were:

- New reservoir: 300-1000 pence(p)/m3
- Desalination plant: 400-800 p/m3
- Groundwater development: 100-500 p/m3
- Surface water development: 100-500 p/m3

The key conclusions of the study were as follows:

In general the AISCs of retrofitting water efficiency measures compare favourably with the costs of traditional resource development schemes, accepting that there are significant uncertainties around the assumptions used to calculate savings and costs.

The combined strategies that are made up of metering supported by water efficiency measures provide the highest savings Metering with variable flush retrofit devices generated the largest savings with compulsory rather than metering on change of occupancy given the better cost benefit. Metering used with low water use fittings also achieved similar results.

Compulsory metering alone was considered to give the largest savings for 176 pence /m3 when applied across the whole region. This compares well with any of the possible new alternatives considered above.

The low use fittings options showed that significant savings could be made with limited costs through combining a number of different measures. It used a variable flush retrofit device, low flow showerhead and low flow taps, all installed in one visit of the plumber to limit costs.

Maybe not surprising the results for individual demand management measures generally show that methods that provide the largest incentive for the customer, such as full subsidy and free installation, achieve higher savings with marginal increases in costs, due to the higher uptake rates these incentives are likely to receive.

Housing Associations are potentially in a strong position to help implement water efficiency schemes because they own and maintain large numbers of properties.

The study concluded by recognizing that implementing a range of retrofit options along with the introduction of compulsory metering would result in about 50% savings of the increase in consumption that would otherwise occur through population growth.

1.3 Community Engagement

Stakeholder involvement in water resource planning. De Garis, Y et al Conference presentation Towards a Consensus for Integrated Water Management in the UK, London 2001.

This paper considered processes of stakeholder involvement in the South of England in water management, especially site selection for new supply options. De Garis et al discussed the pros and cons that were encountered. While the paper does not consider demand management, it does shed light onto many of the issues that are encountered in any resource planning process.

Stakeholder involvement is expected to play a significant part in government decision making processes; it is a stated goal of government at central and local levels. The UK Article 14 of the Water Framework Directive[4] calls for the active involvement of all parties in the production, review and updating of the river-basin management plans, a directive which has apparently caused challenges for the UK water industry.

The Thames catchment is one of the most heavily allocated water systems in the World. The balance between supply and demand is a fine line and many studies have been carried out over

4 Council of European communities. Directive of the European parliament and the council of 23 October 2000 establishing a framework for the community action in the field of water policy. Official Journal L 327, 22/12/2000 pp 1-72

the last thirty years on how best to achieve this. The research approach has moved from experts revealing their results at the end of the study to the current situation where a variety of stakeholders are being involved early on in the process in order to capture their ideas.

It is well accepted that the lead in time for new water supply options may be decades, with years spent in design options and detail as well as the legislative process to get through. In that respect New Zealand is no different from the UK. There are many uncertainties in predicting demand; variations in economic growth altering the balance of industry and non-household use, the extent to which metering policies are pursued, changes in customer behaviour such as the increased interest in gardening apparent in the UK in the last decade, changes in consumer appliances and the variation in the amount of water lost through leakages. There are some uncertainties in predicting supply, including variations in yield with climate change adding to that uncertainty. In particular a situation facing the UK and some parts of New Zealand would be hotter, drier weather which both reduces supply and increases demand.

The key issues that were identified in the study through either the consultation exercises or during discussions at meetings or the stakeholder dialogue sessions were as follows:

- An ignorance of the process of water-resource planning and the importance of water – resource issues outside the water industry and associated stakeholders.
- A perceived requirement for absolute certainty on the need for further resource development.
- The difficulty of communicating complex technical arguments to those with no technical background
- The inability to expose the results of the site selection to scrutiny due to the threat of imposing planning blight on alternative sites and unnecessary stress and anxiety on residents near those sites.
- The lack of acceptance that water companies have a statutory duty to supply water and therefore that some resource development is inevitable unless demand can be restricted.
- The difficulty in identifying all the affected public. Local residents show the most interest; however a strategic water resource for the South-East of England would be relevant to a much wider population.

Some conclusions included:

The nature of the water industry in the South East of the UK does not facilitate the objectives of public participation. Private companies with an obligation to deliver returns to shareholders and statutory duties place heavy constraints on the industry in terms of the extent to which decisions can be made in accordance with public participation. It is unclear at what stage the public should be involved and who is the audience; usually local residents near to the area of a proposed abstraction are most involved even though the abstraction may have a much wider impact.

1.4 Metering

A study of "Metering for demand management: The Cambridge Experience". Kay, S.B., Presented at the CIWEM conference on Water Resources, Planning the Peak Demand. 1996.

In March 1991 the first hosepipe ban in the 138 year history of Cambridge Water Company was imposed. The Company then decided to meter all sprinkler users, compulsorily, as part of its strategy to reduce peak summer demands. The meters were installed before the summer of 1993 and lower peak flows between the hot periods of 1995 and 1996 point to apparent success.

Metering had been introduced as compulsory for all new builds after 1989. Various attempts have been and are continuing to be made to retrofit meters and to make the use of them compulsory, including installing them when people change house or when an area is designated an area of extreme water shortage. Generally the costs are paid for by the water utility.

In Cambridge, people who wanted to use a sprinkler for the garden already had to have a sprinkler licence although this requirement was not always followed. This had been introduced because of the significant evening and weekend peaks from automatic and hand held sprinkler systems. In this study a personal contact was made with each person who had a sprinkler permit and they were given three options;

- Continue to use a sprinkler and be metered at the company's expense
- Use a hand held hosepipe only and pay the appropriate permit fee and
- Abandon the use of the hosepipe or a sprinkler.

About 20% chose the meter and the majority of the rest chose a hosepipe only with a licence. The following six years, saw a 4.5% increase in population while the average peak demand in the peak week of the year fell from 98.8 million litres/pd in 1990 to 95 million litres/pd in 1996.

Cambridge Water was the first company to standardize on internal meters and remote reading of encoded meters. Customers preferred internal meters, found them to be more convenient and they were also sheltered from a harsher external environment. The meters are read by linking the internal meter to an external pad and a probe placed on the pad records the water reading. The studies analysis found that the cost of installing meters was high, about NZ$400 per household but the savings following installation were forecast to be in the region of 20%. The use of flexible tariffs will encourage the use of meters and demand management by using the price mechanism to enable consumers to be aware of their water use and control the cost. Flexible tariffs will include rising block charges and seasonal demand.

2 Appendix 2: US Studies

2.1 A National Water Efficiency Organisation

The report 'Developing a Framework for an Alliance for Water Efficiency Issues & Options', December 31, 2005[5], examined the need for a national water efficiency organisation through a number of workshops and industry interviews across the U.S. They considered:

- An inventory of what organisational structures would be most effective
- What missions and initiatives would be desirable to stakeholders
- How an organisation could be made self-sustaining over time through contributions of partner members

This study into a potential U.S. national water efficiency organisation shows that many of the issues, problems and recommendations identified are equally applicable to New Zealand.

Water Efficiency Organisations
Sixteen water efficiency organisations across the U.S. were assessed. The organisations fell into four distinct categories:

- Associations
- Ad Hoc Coalitions Water Conservation Non-profit 501(c)(3) Organisations
- Professional Associations
- Inter-agency

Regardless of the wide range in budgets and services, none of the water conservation groups were designed to be the "one stop source" of information and services for national water efficiency issues.

Energy Efficiency Organisations
Research was also conducted on energy efficiency and renewable energy organisations as well as water associations. The energy efficiency industry is about 15 years senior to the water efficiency industry due to the energy crises of the 1970s. Both have key commonalities in that both industries were created to reduce demand for natural resources, both engage the utility as a major delivery system for efficiency improvements and both encourage technical innovation.

The maturity of energy efficiency issues and the larger slice of the economic pie devoted to electricity and natural gas, as compared with drinking water and wastewater, have resulted in more structure and more policy-making 'levers' to advance energy efficiency than currently exist with regard to water efficiency.

5 Ditto. California Urban Water Conservation Council, December 31, 2005.

Organisational Conclusions
Successful organisations shared several attributes:

- Dues-paying participants (may or may not be called 'members')
- Receipt of foundation, government, or corporate grants
- Production of vendible products (conferences, publications, codes and manuals, other services), and
- Paid professional staff.

Of the several organisations involved in public policy and advocacy, the prevailing approach was to seek to influence decision makers with technical expertise, rather than other forms of political influence. This drove the missions toward the development and use of analytical tools and presents the continual challenge of translating technical expertise into usable information for lay audiences and decision makers.

When comparing the existing U.S. national water efficiency industry to the energy industry, the water efficiency industry lacked the following:

- A research program to systematically explore new technologies and practices for water efficiency
- An organisation that provides utilities with technical support and design assistance for water efficiency programs
- Regional or national institutions or incentives dedicated to upgrading the water efficiency of existing buildings
- An advocacy group for national policy on water efficiency, including stronger codes and standards
- An organisation to develop uniform product specifications for premium water efficient performance
- A trade association for companies providing water efficiency services.

Outputs from Stakeholder Workshops
Of the four proposed governance structures:

- New council within the American Water Works Association (AWWA)
- New organisation with elected stakeholder board staffed by AWWA
- New organisation with elected stakeholder board located within an academic research institution
- New stand-alone 501 (c)(3) organisation with elected stakeholder board.

The last option, the new stand-alone organisation with elected stakeholder board was the clear favorite.

The three most important issues facing water efficiency were identified as:

- "Need for better and more comprehensive efficiency standards"
- "Lack of reliable information on efficient products and programs"
- "Lack of sufficient research of products and conservation savings"

The most important core missions and functions were:

- Mission – "Information sharing on products, practices, programs and legislation nationwide"
- Function – "Centralised source of information on water efficiency programs, practices and products"
- The top three areas to cover – "commercial and industrial efficiency", "indoor plumbing products and appliances", and "water products labeling".

Overall Conclusions and Recommendations

The overall conclusions were:

- Standardised efficiency standards and a centralised source for information are requirements for the creation of a successful National Organisation for Water Efficiency.
- Membership in a National Organisation for Water Efficiency would be high.
- State and national needs must be taken into consideration.
- Forming a non-profit, all-inclusive organisation is the way to go.
- Take into consideration that the diverse group of stakeholders will have a variety of needs.
- The level of financial support is still questionable.

The recommended mission statement and functions were:

Mission Statement – "*To promote, facilitate and achieve a market transformation to greater water efficiency and resource sustainability by raising awareness, creating a national dialogue, educating and consolidating efficiency efforts*."

Functions:

- Create a national water efficiency clearinghouse and network for program information and sharing.
- Advocate and research plumbing and code standard setting.
- Independently research and test new products and programs for reliable water savings.
- Coordinate with green building programs.
- Train water conservation professionals.
- Develop consumer education programs.
- Assist with market transformation for high efficiency products.
- Advocate strongly for water efficiency overall.

Main Points Relevant to New Zealand

The main points from the above developments in the United States that are relevant to the New Zealand water efficiency industry are:

- The need for water efficiency practitioners to be more involved in the standards and codes setting process.
- Making most use of the synergies between the existing energy efficiency and the new water efficiency labelling schemes.
- The need to integrate the importance of water efficiency into green building rating tools.
- The need to tackle common barriers of consumer apathy, lack of understanding of the true cost of water and fragmentation and lack of uniformity in the industry.
- The possible benefits from the formation of a 'National Water Efficiency Organisation'.

2.2 General water demand/efficiency instruments

The three primary sources of information on general water demand efficiency instruments in the U.S. summarised below are from:

- 'National City Water Survey 2005', November 15, 2005[6].
- 'BMP Costs & Savings Study, A Guide to Data and Methods for Cost-effectiveness Analysis of Urban Water Conservation Best Management Practices', March 2005[7].
- 'Factors Influencing Residential Water Demand: A Review of the Literature (updated 1/12/07)'[8] by Bobbie Klein, Doug Kenny, Jessica Lowery and Chris Goemans.

National City Water Survey 2005

The United States Conference on Mayors' Urban Water Council (UWC) conducted a survey of the nation's principal cities to examine water resources priorities and trends. Mayors were asked in the survey to provide current information in four key water resource areas:

- Issues and priorities
- Recent and planned major capital investments in water and wastewater infrastructure
- Adequacy of water supplies
- Water conservation activities

6 United States Conference of Mayors Urban Water Council, 2005. 'National City Water Survey', November 15, 2005.

7 A&N Technical Services, Inc. March 2005. 'BMP Costs & Savings Study, A Guide to Data and Methods for Cost-effectiveness Analysis of Urban Water Conservation Best Management Practices'. Report prepared for The California Urban Water Conservation Council.

8 Bobbie Klein, Doug Kenny, Jessica Lowery, Chris Goemans, updated 1/12/07. 'Factors Influencing Residential Water Demand: A Review of the Literature'.

The survey was distributed to 1,200 cities with mayoral forms of government. Nearly 30% (414) of the principal cities responded. The survey response was greater than usual and forms a robust database.

Of these 414 cities:
- 40% smaller cities less than 50,000
- 35% medium cities 50,000 to 100,000
- 25% larger cities greater than 100,000

The most frequent priority was chronic "every-day" problems associated with maintaining and rehabilitating aging water and wastewater infrastructure.

With regard to water conservation activities, the two most widely used system-wide methods effective in water conservation were automated meters because they accurately gage use and billing and altering water rate structures as a demand-management tool:

- 73% of cities had traditional water meters. 70% said they would be interested in automatic metering if they could save water or money
- Water rate structures was a function of city size:
  - Almost half larger cities use it
  - 40% of medium sized cities
  - 30% of smaller cities
- Two thirds of cities surveyed had water conservation programs (80% large cities and 60% smaller cities)
- Cities planning to make major capital investments in water supply infrastructure for the period 2005 to 2009 were nearly four times as likely to have an established water conservation program.

2.3 Factors Influencing Residential Water Demand: A Review of the Literature.

A brief summary of the main findings relating to factors influencing residential water demand in the US is presented below.

Price: Many studies carried out show that price elasticity generally ranges from -0.02 to -0.75. Price Elasticity, P.E. = % change in quantity demand / % change in price.

Socio-economic: one study found that low income households (i.e. annual income less than $20,000) were more than 5 times more responsive to price changes as households with income greater than $100,000 per year.

Rate Structure: One study found households facing a two-tier increasing block rate were 5 times more sensitive to changes in price than households facing a uniform rate structure.

Consumer Awareness of Price: studies show small awareness of price, as little as 6%.

Interaction between price and non-price policy changes: If introducing more than one policy it is important to try to be able to differentiate the impacts from each policy Rather than just assess the total package.

Non-Price Mechanisms
Often there is a reluctance to increase price (political) but instead rely on voluntary or mandatory water use restrictions, public education offering rebates and irrigation technologies. However, evidence of the effectiveness of such measures is mixed, and often ends up costing more after program costs are factored in. Some people have criticised efficiency of mandating reductions in specific areas rather than simply allowing households to select the most cost-effective ways to reduce water use.

Public Information Campaigns: Short term can be up to 25% but uncertain on long term. Reduction only continued if campaign continues. In summary; mandatory produced savings of 13 to 63%, voluntary from 7 to 33%. Retrofits: Reduced average household by 10% for low flow toilets and 8% for low flow showerheads.

Environmental
Temperature versus precipitation, evaporation-related, the amount it rains or if it just rains? Most studies find weather variables are significant. Precipitation, or quantity of rainfall, is often singled out as more useful than temperature.

Household and House Characteristics
Household – demographic characteristics of water users themselves.
House Characteristics – physical qualities of structures served.
Hinges on ability to model “demographic: factors.

Household Characteristics:
Personal Wealth – most income elasticity’s are in the range of 0.2 to 0.6. (Note: an income elasticity of +0.2 means that a 10% increase in income increases water demand by 2%) [Note Beacon water studies show Housing NZ households use up to 30% more water, but this could be due to tenants not having to pay for the water]. Family Size and Age – has not been heavily researched. One study found each additional household resident increased daily demand by 22%, but this figure is not linear due to water using activities like gardening remaining constant regardless of number of people per household because the area gardened remains the same. Attitudes About Water Use/Conservation: Varied.

House Characteristics
Type of Dwelling: Single versus multi.
Age of House: Old use more than new.

Size of House and Lot: varied results for size of house, but size of lot did influence due to irrigation.
Home Technology: varied results.

To summarise:
Non-price interventions generally grouped into Water Restrictions, Public Education and Technological Improvements.
Water Restrictions – voluntary versus mandatory outdoor water use programs: significant (often 30% or more) savings from mandatory.
Public Education – suggest need a 'critical mass' to generate significant benefits, but that reach a point of declining returns.
Technological Improvements – toilets have most benefit, but showerheads and washing machines still good. Irrigation advances have mixed response.
Households – strong positive relationship between wealth and water use. Large households use more than small but effect of age uncertain.
Physical features – type of dwelling, age of house (old already retrofitted, new have new technologies, perhaps work on middle age group)

2.4 Best Management Practices Study

BMP Costs & Savings Study. Author: A & N Technical Services, Inc. 2000.

The purpose of the report was to update the best available information on program costs and water savings needed to quantify and gauge the cost effectiveness of specific BMPs (Best Management Practices). The document is 142 pages long.

A summary of the findings are included in the tables below.

Table 1: Urban Water Conservation Best management Practices
Lists 14 'Best Management Practices' with example program requirements

Table 1-2: Devices and Activities applicable to each BMP
Lists different activities and how they relate to the 14 BMP's

Table 2: Costs and Savings Summary
Lists costs and savings by device activity

More detailed savings were also given for each device taking into account the probability of installation and lifespan of the device using the following formula:

Savings = Device Savings x No. of Devices x Probability of Installation x Lifespan.

The "lifespan" is a factor to take into account possible reduction in savings over the long term due to lack of maintenance, physical deterioration and decline in behavioral compliance. In cost-benefit analysis (CBA) the convention of characterising energy savings as a 'positive-benefit' not a 'negative-cost' was used. These detailed costs are not presented here but can be obtained from the publications California Urban Water Conservation Council web site (www.cuwcc.com/publications)

Table 1: Urban Water Conservation Best Management Practices

#	**BMP**	**Requirements**
1	Water Survey Programs for Single and Multi Family Residential Customers	*Survey 15% of residential customers within 10 years*
2	Residential Plumbing Retrofit	*Retrofit 75% of residential housing constructed prior to 1992 with low-flow showerheads, toilet displacement devices, toilet flappers and aerators*
3	System Water Audits, Leak Detection and Repair	*Audit the water utility distribution system regularly and repair any identified leaks*
4	Metering with Commodity Rates for All New Connections and Retrofit of Existing Connections	*Install meters in 100% of existing un-metered accounts within 10 years; bill by volume of water use; assess feasibility of installing dedicated landscape meters*
5	Large Landscape Conservation Programs and Incentives	*Prepare water budgets for 90% of commercial and industrial accounts with dedicated meters; provide irrigation surveys to 15% of mixed-metered customers*
6	High-Efficiency Washing Machine Rebate Programs	*Provide cost-effective customer incentives, such as rebates, to encourage purchase of machines that use 40% less water per load*
7	Public Information Programs	*Water utilities to provide active public information programs to promote and educate customers about water conservation*
8	School Education Programs	*Provide active school education programs to educate students about water conservation and efficient water uses*
9	Conservation Programs for Commercial, Industrial, and Institutional Accounts	*Provide a water survey of 10% of these customers within 10 years and identify retrofitting options; OR reduce water use by an amount equal to 10% of the baseline use within 10 years*
10	Wholesale Agency Assistance Programs	*Provide financial incentives to water*

		agencies and cities to encourage implementation of water conservation programs
11	Conservation Pricing	*Eliminate non-conserving pricing policies and adopt pricing structure such as uniform rates or inclining block rates, incentives to customers to reduce average or peak use, and surcharges to encourage conservation*
12	Conservation Coordinator	*Designate a water agency staff member to have the responsibility to manage the water conservation programs*
13	Water Waste Prohibition	*Adopt water waste ordinances to prohibit gutter flooding, single-pass cooling systems in new connections, non-recirculating systems in all new car wash and commercial laundry systems, and non-recycling decorative water fountains*
14	Residential Ultra-Low-Flush Toilet Replacement Programs	*Replace older toilets for residential customers at a rate equal to that of an ordinance requiring retrofit upon resale*

Table 1-2 Devices and Activities Potentially Applicable to BMPs*

Device/Activity Category	BMPs 1 Residential Water Surveys	2 Residential Plumbing Retrofits	3 System Water Audits, Leak Detection	4 Metering and Commodity Rates	5 Large Landscape	6 High Efficiency Washing Machines	7 Public Information	8 School Education	9 Commercial, Industrial, Institutional	10 Wholesale Agency Assistance**	11 Conservation Pricing	12 Conservation Coordinator	13 Water Waste Prohibition	14 Residential ULFT Replacements	Sector
Educational Events and Materials	X	O	O		X	O	X	X	X					O	Residential
ET Controllers															
Graywater Systems		O			O				O						
High Efficiency Washing Machines		O				X	O	O	O						
Hot Water on Demand Units		O							O						
Metering				X	O						X				
Pricing				X							X				
Residential Plumbing Retrofit Devices	X	X													
Residential Surveys	X	X					O	O							
Ultra Low Flush Toilets (Residential)		O	O				O	O						X	
CII Surveys					X				X						CII
Film Processing (X-Ray)							O		X						
Food Service Appliances							O		X						
Self-Closing Faucets		O					O		X						
Ultra Low Flush Toilets (CII)							O		X						
Urinals							O		X						
Large Landscape Devices					X				X						Landscape
System Audits and Leak Detection			X				O								Distribution System

Key: X indicates that the device/activity is widely understood to be associated with the BMP or PBMP; O indicates potential association.
Notes: * This table is not intended to be proscriptive, authoritative, or limiting to the creativity of future ways to better implement BMPs.
** This table does not directly apply to wholesale agencies. Wholesale agencies, under BMP 10 of the MOU, are required to provide financial incentives and/or technical assistance for cost-effective BMPs. Hence, any of the above BMPs/measures may or may not be required to be supported by a wholesale agency depending soley on the cost-effectiveness of that BMP or measure.

Table 2: Costs and Savings Summary by Device/Activity (USA)

Device/Activity	**Cost Range**	**Savings Range** (converted from 1 USgpd = 3.8 litres/day)
Residential Sector		
Educational Events and Materials	Costs vary widely	Savings not quantified
ET Controllers	$75 to $100 installation $4 monthly fee	140 lpd 16% of outdoor use
Greywater Systems	$750 in parts	75 to 300 lpd
High Efficiency Washing Machines	Difference between high and low efficiency machines $400 - $1000	300 to 400 l/week/machine 50 to 100lpd - single family 200 to 400lpd – multi-family

Hot Water on Demand	$200 (uninstalled) $500 (installed)	20 to 100 lpd
Metering	$250 to $750 per meter	20 to 30% savings overall Up to 40% savings during peaks
Conservation Pricing	Vary	Under study
Residential Plumbing Retrofits	Typical Retrofit Kit Cost: ? Direct installation per household: $10-$15.	Showerheads: 20-22 lpd Toilet Dams: 15 lpd Aerators: 6 lpd
Residential Survey	$40 to $200 per survey	Targeted houses: 120 lpd Untargeted houses: 80 lpd
ULF Toilets (Residential)	$60 to $230 per unit	Single Family: 80-100 lpd Multi-Family: 140-240 lpd

2.5 Selected City/State Programs

A summary of water demand and conservation practices of some selected cities across the U.S. are presented below for comparison purposes, including:

- Seattle – a major city that is achieving a reduction in water demand with an increasing population, with significant delays in commissioning new infrastructure
- San Jose – how one of California's major cities is achieving the California Urban Water Conservation Council's fourteen Best Management Practices and has a tiered water volume rate structure.
- Portland – a sample city's ranking of water conservation programs in terms of overall acceptability and cost-effectiveness.
- Maryland – the use of mandatory Water Conservation Plans.
- Albuquerque – water conservation in a desert community.

The above cities are also representative of the widely varying monthly rainfall patterns across the U.S. (See Figure 1 below) from:

- The desert community of Albuquerque (total rainfall of 225mm per year);
- A uniform rainfall of 80 to 100mm per month in Baltimore (Maryland) (total rainfall of 1,000mm per year);
- Seattle and Portland with varying rainfall of 150mm in December to 20mm in August (total rainfall of approx 950mm per year);
- Des Moines with varying rainfall of 20mm in January to 110mm in June (total rainfall of 840mm per year)(included for rainfall patterns only);
- To the San Francisco (San Jose) widely varying rainfall of 110mm in January to less than 5mm per month for May, June, July Aug and Sep (total rainfall of 500mm per year).

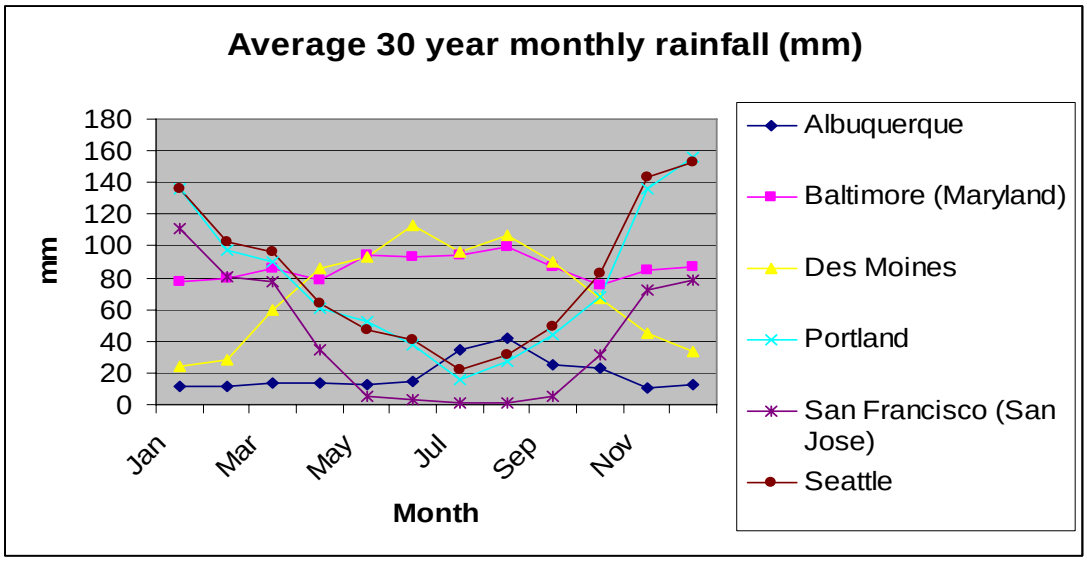

Fig 1: Sample 30 year average monthly rainfall for selected U.S. cities

It is important to note that although some of the U.S. cities report significant reductions in water demand (up to 30% reduction in 10 years), their actual water consumption is still significantly higher than other countries. For example, Seattle's reduction from 570 to 380 litres/pp/pd and Albuquerque's 950 to 660 litres/pp/pd compared to Auckland at 300 litres/pp/pd. These figures are a total daily water use and include each person's share of non-domestic use.

2.5.1 Seattle

Figure 2 presents a summary of Seattle's growth in population and water consumption from 1975 to 2006[9].

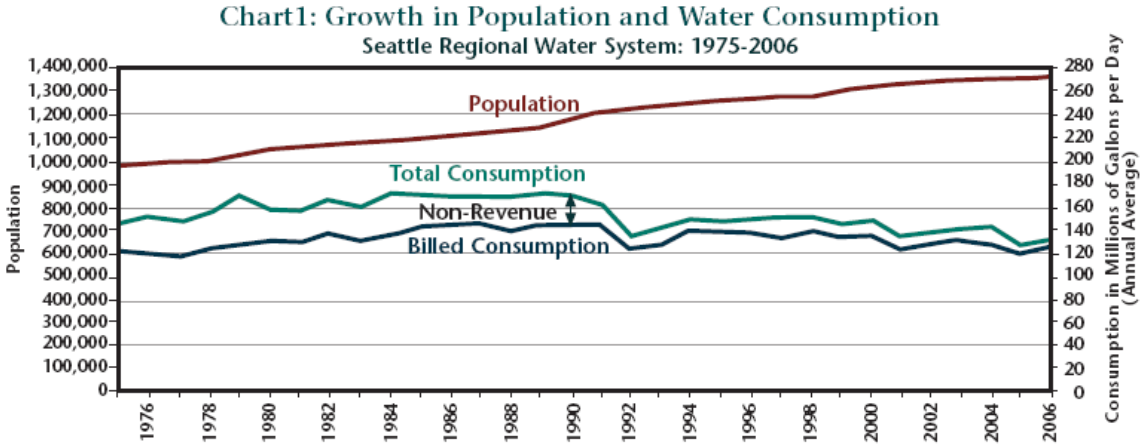

Fig 2: Growth in Population and Water Consumption – Seattle 1975 - 2006

9 Seattle Water Supply System Regional 1% Water Conservation Program, Saving Water Partnership 2006 Annual Report, August 2007.

The reduction in water demand occurred because:

- A new conservation-oriented rate structure was introduced in 1989 and both water and sewer rates increased rapidly over the decade.
- Droughts in 1987 and in 1992 led to mandatory water use restrictions and a sharp (but temporary) drop in summertime water consumption. At the same time, Seattle launched an aggressive conservation program while drastically reducing the amount of water that was lost through in-city reservoir leaks and overflowing.
- In 1993 a new state plumbing code went into effect that established efficiency standards for all new toilets, showerheads and faucet aerators.
- Then in 2000 the "1% Program" was begun with the goal of reducing per person water consumption by 1% every year for 10 years.

Since 1990, Seattle's water system consumption has declined by 24% while population has increased by 11%. On a per person basis, water consumption has shrunk by one third from 150 to 100 gallons per day (570 to 380 litres per day). Figure 3 shows the components of this decline in consumption since 1999.

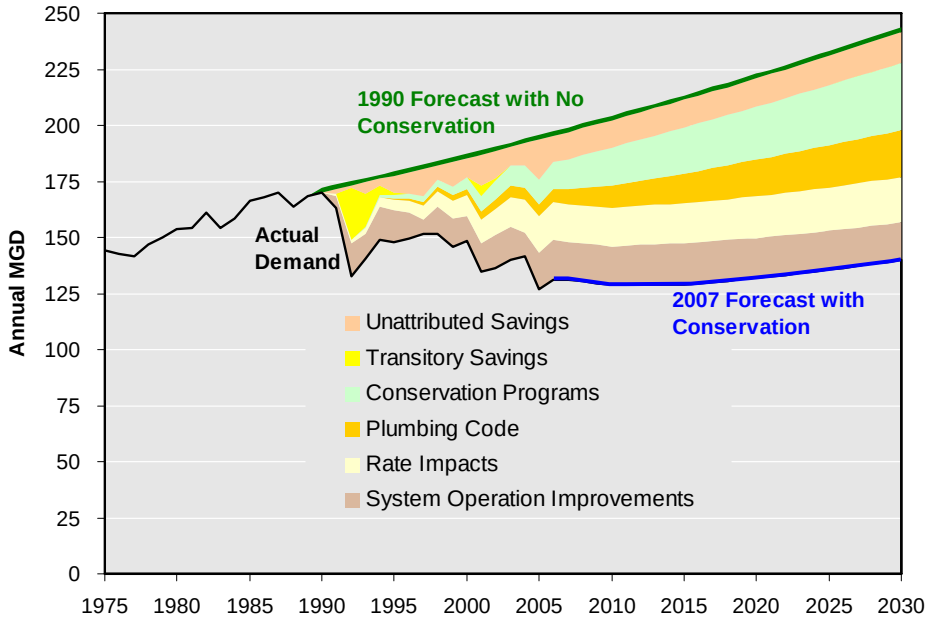

Fig 3: Impact of All Forms of Conservation on Past and Forecast Water Demand

The Regional 1% Water Conservation Program is sponsored by the "Saving Water Partnership" (including the City of Seattle and its retail service area (population of 628,000) and a group of 17 utilities purchasing wholesale water from the City of Seattle (population 416,000)). Water savings come from the following areas:

Hardware Incentive Savings – include new fixtures and equipment upgrades that were supported with program incentives as well as those upgraded without rebates.

Price and Behavioral Savings - from changes in customer water-using behaviours. These are difficult to estimate and separate out.

Plumbing Code Savings – water saved by customers as they remodel plumbing fixtures to meet more stringent building code efficiency standards (1.6 gallons per flush toilets, 1.0 gallons per flush for urinals, 2.5 gallons per minute showerheads and aerators)

System Operation Savings – reduction in non-revenue water (water used for in-city reservoir cleaning and overflowing, water main and tank flushing, water main leaks, metering inaccuracies and other actions not related to specific customer demand reduction activities.

The overall Regional 1% Program progress to date from 2000 to 2006 is tracking on target to reach the 2010 goal of 1% savings each year for ten years.

Other information on Seattle's Saving Water Partnership Rebates can be found at http://savingwater.org/rebates.htm as well as a case study of reducing Seattle's peak water demand[10].

2.5.2 San Jose

San Jose is the third largest city in California following Los Angeles and San Diego, and is the 10th largest city in the U.S.

The 1983 California Urban Water Management Act requires all urban water suppliers who directly serve 3,000 or more customers or who provide 3,000 or more acre-feet (1 acre-feet = 1200m3) of water per year to prepare an Urban Water Management Plan. The City of San Jose submitted its first plan in 1985, with the required 5 year updates in 1990, 1995, 2000 and 2005. Amendments to the Act since 2000 have added new requirements such as to improve the link between water supply availability and certain land use decisions made by cities and counties.

The San Jose Municipal Water System (SJMWS) has been a signatory of the California Urban Water Conservation Council since 1995 and submits Best Management Practice (BMP) Activity Reports on a biennial basis. The California Urban Water Conservation Council's fourteen Best Management Practices that they have to meet are as outlined in Table 3. How the City of San Jose is meeting the California Urban Water Conservation Council's fourteen BMP's are summarised in the table below[11].

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[10] Dietemann, Allan, Resource Conservation Section, Seattle Public Utilities, 'A Peek at the Peak. Case Study: Reducing Seattle's Peak Water Demand'.

11 City of San Jose, Municipal Water System, Environmental Services Department, December 2005. '2005 Urban Water Management Plan'. www.sjmuniwater.com

Table 3: How San Jose is meeting the fourteen BMPs

#	**BMP**	**How San Jose is meeting each BMP**
1	Water Survey Programs for Single and Multi Family Residential Customers	*Need to increase the number of surveys.*
2	Residential Plumbing Retrofit	*Although the city has installed 215,000 low-flow shower heads and aerators, the district is still just under the required 75% saturation target.*
3	System Water Audits, Leak Detection and Repair	Yes
4	Metering with Commodity Rates for All New Connections and Retrofit of Existing Connections	Yes
5	Large Landscape Conservation Programs and Incentives	*The city is developing a web-based water-budget program (Web-ITAP) which will be offered to all large landscape sites.*
6	High-Efficiency Washing Machine Rebate Programs	*Yes*
7	Public Information Programs	*Yes*
8	School Education Programs	*Yes*
9	Conservation Programs for Commercial, Industrial, and Institutional Accounts (CII)	*The city is carrying out a study to see how it is meeting the required water savings through its "Water Efficient Technologies" program which includes the following technologies:* • *Water surveys* • *Commercial Toilet Retrofit Program* • *Commercial Washer Program* • *Pre-Rinse Sprayer Installation Program* • *Innovative CII Retrofits Program*
10	Wholesale Agency Assistance Programs	*?*
11	Conservation Pricing	*Yes*
12	Conservation Coordinator	*Yes*
13	Water Waste Prohibition	*The city is looking into the feasibility of introducing ordinances prohibiting single-pass cooling towers and single-pass laundries.*
14	Residential Ultra-Low-Flush Toilet Replacement Programs	*Yes*

The San Jose Municipal Water system has an inclining tiered rate structure for residential customers so the less water used, the less households pay. The units used are hundreds of cubic feet (HCF). One HCF is equivalent to 748 gallons, or 2,840 litres. Non-residential customers pay a flat rate. Examples of bi-monthly quantity charges are presented in Table 4.

Table 4: Example Bi-monthly Water Quantity Charges

Residential				
Tier	**Total cubic metres**	**Litres/day**	**Zone 1 $/HCF**	**Zone 1 $/m^3**
0 – 14 HCF	0 – 40	660	$1.65	$0.58
15 - 28	41 – 80	670 – 1300	$1.89	$0.66
29 - 42	81 – 120	1310 – 2000	$2.10	$0.74
42+	120,000+	2000+	$2.32	$0.82
Non-Residential			$1.89	$0.66
Recycled Water				
Irrigation			$1.346	$0.47
Industrial			$0.906	$0.32

2.5.3 Portland

Portland's Regional Water Supply Plan (RWSP)[12] is based on the premise that water conservation is a resource that can play a key role in meeting future water supply needs. In the original RWSP more than 150 conservation measures were evaluated. Twenty-four programs were selected and further refined to include only outdoor programs. Outdoor programs were selected as they supply savings when supplies are the most limited (summer) and the programs are generally cost-effective. While indoor conservation was not recommended in the implementation strategy, there was a recommendation to continue to explore indoor programs and technologies.

In 2003/04 a review of the water conservation programs was carried out, ranking the programs by overall acceptability and cost-effectiveness. The results are summarised below in Table 5.

[12] ***Portland Regional Water Supply Plan, December 2004***

Table 5: Ranking and Grouping of Conservation Programs

	Program	Overall Acceptability	Cost-Effective
Acceptable and Cost-Effective	Residential Information, Education & Awareness	Good	Good
	Property Manager Workshops	Good	Good
	Trade Ally Irrigation & Landscape Workshops	Good	Good
Mixed Acceptability and Cost-Effective	Large Landscape Audit B	Mixed	Good
	CII (Commercial, Industrial, Industry) Irrigation ET Controller Retrofit A	Mixed	Good
	Nonresidential Irrigation Submetering	Poor	Good
	Multifamily Submetering	Poor	Good
Mixed Acceptability and Mixed Cost-Effectiveness	CII Indoor Audits A	Good	Mixed
	CII Indoor Audits B	Mixed	Mixed
	Toilet Rebate or Replacement	Mixed	Mixed
	Residential Indoor Audits A	Poor	Mixed
	Residential Irrigation ET Controller Retrofit	Poor	Mixed
	Waterless Urinals	Poor	Mixed
	Residential Indoor Audits B	Poor	Mixed
	CII Outdoor Ordinance	Poor	Mixed
Mixed Acceptability, Poor Acceptability and Not Cost-Effective	Washing Machine Rebate $50	Mixed	Mixed

2.5.4 Maryland

Drought conditions experienced in Maryland in both 1999 and 2002 impacted some water systems' ability to meet their customers' needs and prompted the State to consider measures that might improve water systems' water use efficiency[13].

Since 2002, all water systems in Maryland are encouraged to develop water conservation plans. Current Maryland Department of the Environment (MDE) policies require water conservation plans for water systems that serve a population of greater than 10,000 and produce more than

[13] ***Maryland Department of the Environment, Water Supply Program, 'Developing and Implementing a Water Conservation Plan, Guidance for Maryland Public Water Systems on Best Management Practices for Improving Water Conservation and Water Use Efficiency'.***

100 gallons of water pc/pd and for systems that are awarded financial assistance from the State for infrastructure improvements. A water conservation plan includes:

- Evaluation of current and projected water use.
- Assesses infrastructure, operations and management practices.
- Describes actions to be taken to reduce water losses, waste or consumption and increase the efficiency with which water is used, treated, stored and transmitted.
- Conservation plans for supply and demand side.

It is interesting to note that MDE states that water systems practicing an approved water conservation plan will not be penalized with a reduction of their current water appropriation permit limitations if they use less water.

The Maryland Water Conservation Plan involves the following steps:

1. Establish the goals of the water conservation plan.
2. Conduct a water system audit.
3. Prepare a demand forecast.
4. Identify and select potential water conservation measures. MDE categorised water conservation measures into 'Required Elements' and 'Recommended Elements', as follows:
    a. Required Elements – these should be included in all plans
        i. Metering
        ii. Water Accounting and Loss Control
        iii. Pricing
        iv. Information and Education Program
    b. Recommended Elements
        i. Develop outreach for specific users (water use audits, fixture retrofits and replacement, rebates and incentives, promote water reuse and recycling, encourage landscape efficiency)
        ii. Pressure management (install pressure reducing valves)
        iii. Water-Use Regulations (restrictions or bans on certain non-essential water uses, standards for new developments and fine or penalties for frequent misuse during drought emergencies)
5. Develop and present implementation strategy.

2.5.5 Albuquerque

Albuquerque is a high desert community. In 2006, Albuquerque won a World Leadership Award for its sustainable water management planning[14]. In 1994, Mayor Chavez and the Albuquerque City Council called for a 30% reduction in water use in ten years. By the end of 2004 they had reduced water usage by 33%. However they were reducing from 250 gallons

[14] ***www.cabq.gov/sustainability/green-goals/water***

(950 litres) per capita per day in 1995 to 174 gallons (660 litres) by the end of 2005. The new goal is 40% reduction from 1994 levels by the year 2014.

These saving are being achieved through the following programs:

- Better meters - older parks now have water meters to better manage irrigation.
- Xeriscaping – only low water use landscaping is being used in new city development, with the exception of some parks and new golf courses.
- Irrigation – the Southside Water Reclamation Plant is treating and recycling wastewater for irrigation.
- Low Flow Fixtures – Community Centers and nearly 300 public housing units have switched to low flow fixtures.
- Recycled Water – Rio Grande Zoo exhibits used recycled water.
- Water Rebates
  - Low flow toilet rebate
  - Washing machine rebate
  - Hot water recirculating system rebate
  - Rainwater harvesting barrel rebate
  - Multi-setting sprinkler timer rebate.

3 Appendix 3: Canada

3.1 The Water Sustainability Project

One of the significant Canadian projects on water demand/efficiency is the Water Sustainability Project. The Water Sustainability Project (WSP) began in January of 2003 at the University of Victoria's POLIS Project on Ecological Governance in British Columbia, Canada[15]. The POLIS Project on Ecological Governance is a centre for transdisciplinary research that investigates and promotes sustainability[16]. **Polis** was established in 2000 by the Eco-Research Chair of Environmental Law and Policy at the University of Victoria. The POLIS mission is to cultivate ecological governance through innovative research, policy analysis and strategic advocacy, law reform, education and community action.

The initial focus of the WSP was to understand the structure and dynamics of urban water use, and to provide mechanisms to help reorient Canadian water management from supply to demand-side approaches. Formerly the Urban Water Demand Management Project (UWDM), the initiative changed its name in 2005 to reflect a transition to promoting demand management and ecological governance as part of the broader goal of sustainable water management.

[15] ***www.waterdsm.org***

[16] ***www.polisproject.org***

The projects overall objectives are:

- **To develop innovative governance options** that promote sustainable water management, including "watershed governance" as an alternative to centralized, hierarchical and sectoral governance approaches;
- **To develop water policy decision-making tools** that promote sustainable water management, long-term integrative planning, and regulatory mechanisms (including legal and institutional reform) to enable ecologically based water allocation;
- **To create a national network of experts** and others interested in the new paradigm of sustainable water management to contribute to and use these models as practical tools for policy and institutional change;
- **To continue to examine urban and emerging water issues in Canada**, including a survey of best practices in demand-side management (DSM) in Canada and abroad; and,

To increase public awareness around the importance, and limits, of water in Canada, thereby ensuring that the above happens as part of a larger cultural change.

Research Areas:

The work within the WSP is divided into three focus areas:

- New Water Infrastructure - including the "social infrastructure" of conservation policies and programs.
- Demand Management & Soft Path - two complementary approaches to that move away from the supply-side toward sustainable water management.
- Watershed Governance - an emerging field of research that addresses issues of governance in the context of water sustainability.

3.1.1 New Water Infrastructure

The "new water infrastructure" refers to an expanded definition of urban water infrastructure -- one that goes beyond the existing physical infrastructure of water pipes, pumps and reservoirs. This new infrastructure includes innovative decentralized technologies such as low-flow fixtures and rainwater harvesting and lasting local programs that inspire behavioural change. Most importantly, it relies on building and maintaining “social infrastructure”—the planning processes and specific programs needed to liberate the full potential of water efficiency and conservation.

In October 2006 the Polis Project on Ecological Governance published the report ‘Thinking Beyond Pipes and Pumps’. One of the key outcomes of this report was the identification of the ‘Top 10 Ways Communities can Save Water and Money’. These top 10 ways are:

1. Fix the leaks! – and reduce waste with detection and repair.

2. Stop flushing the future – by installing efficient fixtures and appliances.
3. Make managing demand part of daily business.
4. Link conservation to development.
5. Price it right - with "full cost" water prices and volume-based pricing structures.
6. Plan for sustainability – with strategic water planning.
7. Look to the sky – for rainwater as the resource.
8. Reclaim, reuse and recycle - water to better match water quality to end uses.
9. Design communities for conservation – with water sensitive urban design.
10. Educate, educate, educate - with programs that engage and inspire citizens to change behaviours.

3.1.2 Demand Management & Soft Path

Demand management and the soft path for water are complementary approaches to water management, Table 6[17]. At one end of the water management spectrum is the conventional supply-side paradigm that seeks to increase supplies through infrastructure including bigger pipes and reservoirs. At the other end of the spectrum is the comprehensive and long-term approach of the soft path. Demand management falls between the two and is the first incremental step toward a holistic and sustainable soft path approach. Demand management measures reduce the demand on water by changing behaviour, exploring alternative water sources and developing new technologies.

17 'The Soft Path for Water in a Nutshell', A joint publication of Friends of the Earth Canada, Ottawa, ON and the POLIS Project on Ecological Governance, University of Victoria, Victoria, BC, Revised Edition August 2007

Table 6: A Spectrum of Water Management Approaches

Policy and dominant discipline	Range of Policy Choices	Fundamental Question	Planning Process	Outcome
Supply Management - Engineering	Policies based on presumed need for new infrastructure.	How can we meet projected water needs given current trends in water use and population growth?	Planners extrapolate from current consumption patterns to determine future "requirements" and then locate and develop new sources of supply to meet this projected demand.	Construction of dams, pipelines, canals, wells, desalination systems, and interbasin transfers, where necessary.
Demand Management - Economics	Policies based on short-term cost-benefit calculations.	How can we reduce needs for water to conserve the resource, save money and reduce environmental impacts?	Planners incorporate efficiency and information programs together with improved pricing patterns to maximize use of existing infrastructure. Increasing capacity is only one option among others in a least-cost approach.	Efficiency gains through technical fixes and consumer education.
Soft Path – Multi-disciplinary	Policies based on stakeholder consultation and political review.	How can we deliver services currently provided by water in ways that recognize the need for economic, social and ecological sustainability?	Planners model a sustainable future state for water use with attention to long-term economic and social prosperity. They then "backcast" to devise a feasible and desirable path to reach that state. Ecological sustainability is fundamental to all economic, political and socio-cultural choices.	Options to reduce water use through innovation, conservation, water reallocation and changing patterns of use and re-use. More water is left in situ.

The first three WSP POLIS research reports specifically address the issues surrounding urban water demand management:

- 'Flushing the Future? Examining Urban Water Use in Canada'[18]
- 'What the Experts Think: Understanding Urban Water Demand Management in Canada'[19]

[18] ***Brandes, Oliver M., Ferguson, Keith; POLIS Project on Ecological Governance, University of Victoria, Victoria BC. 'Flushing the Future? Examining Urban Water Use in Canada.'***

- 'The Future in Every Drop. The benefits, barriers, and practice of urban water demand management in Canada Summary Report'[20]

A snap shot of twenty Canadian Cities in the first report, *'Flushing the Future?* *Examining Urban Water Use in Canada'* showed a significant variation in both domestic and total daily municipal water use per capita. In terms of per capita daily domestic use, the lowest and highest users were:

Lowest users (per capita daily)	**Highest users (per capita daily)**
Charlottetown – 156 litres	Hamilton – 470 litres
Yellowknife – 164 litres	Whitehorse – 519 litres
Iqaluit – 167 litres	St. Johns – 659 litres

The report concluded that while some variation is to be expected due to climate, availability of supply, prices etc., the four fold difference is more than what would be expected. The report survey found that individual metering and the use of volume based pricing (where customers are charged according to the amount of water they use) generally corresponded with lower water use.

The report provided two conclusions:

- The significant variance in water use suggested a potential exists to reduce water use by adopting available best practices and programs.
- Better data and uniform information are required to assist water managers to compare and assess water use in their region and across Canada.

The second report, *'What the Experts Think: Understanding Urban Water Demand Management in Canada'*, suggested that demand-side management (DSM) could be divided into two broad categories of activities:

- Providing the **means** for reducing demand:
- **Behavioural change** – to modify water use habits and activities
- **Physical measures** – technology such as water-efficient fixtures etc and creating the **policy instruments** to motivate these means
- **Education** – raise awareness.
- **Economic incentives** – pricing (the experts agreed that while the lack of a strong pricing stimulus is the pre-eminent barrier to reducing water demand, many also noted

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[19] Maas, Tony; The POLIS Project on Ecological Governance, University of Victoria, Victoria BC. 'What the Experts Think: Understanding Urban Water demand Management in Canada.'

20 Brandes, Oliver M., Ferguson, Keith; POLIS Project on Ecological Governance, University of Victoria, Victoria BC. 'The Future in Every Drop. The benefits, barriers, and practice of urban water demand management in Canada.'

that pricing was not a 'silver-bullet' but works best as part of an integrated policy package).

- **Other mandatory mechanisms** such as building and plumbing codes and regulations.

The experts agreed on the following obstacles:

- Entrenched, supply-oriented engineering approaches.
- Fragmentation in management, both horizontally among various agencies and vertically. between different levels of government.
- Lack of political leadership.

The third report, ***'The Future in Every Drop. The benefits, barriers, and practice of urban water demand management in Canada Summary Report'*** provided a detailed description of why a comprehensive, long-term, and integrated approach to demand management is necessary and how such an approach could be undertaken. The following boxes, from the report, give a summary of:

- Box 1: The Case for Demand Management.
- Box 2: Barriers That Impede the Adoption of DSM in Canada.
- Box 3: Conceptual Model of Relationships among the Barriers to Adopting DSM in Canada.
- Box 4: Principles of Action.
- Box 5: Key Principles and Steps in Developing a Successful Water Supply and Conservation Plan.

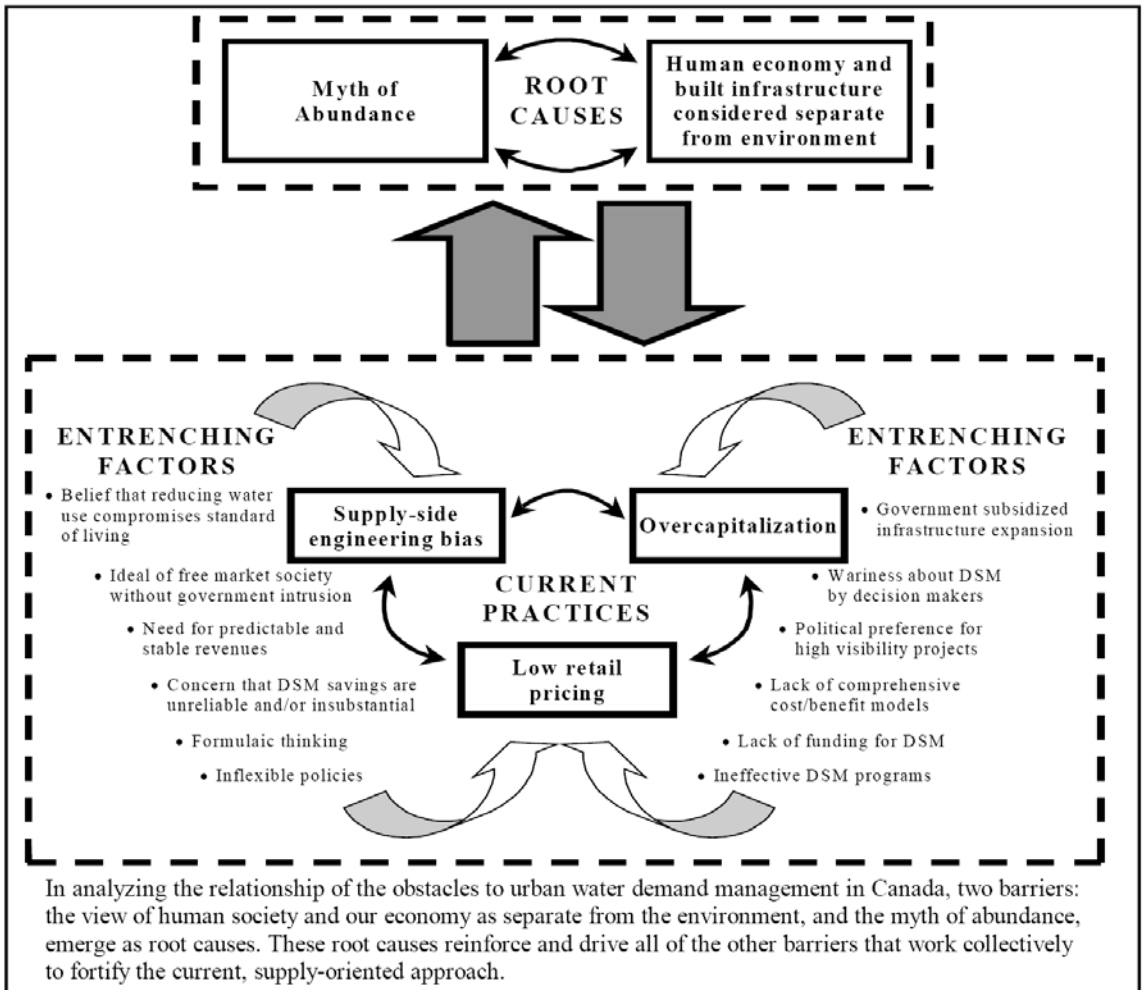
Box 1: The Case for Demand Management

High Urban Water Use	*Supply Limitations*	*Capital Costs*	*Environmental Impacts*	*Drinking Water Quality*
• The average Canadian uses 343 litres per capita per day (lcd) residentially. • Canadians are the 2nd highest urban water users in the world. • Total municipal water use increased 6% during the 1990s. • Total residential water use increased 21% during the 1990s.	• A number of surface waters have reached or are nearing their capacity for withdrawals. • Groundwater extraction is depleting a number of aquifers. • Many water sources are contaminated or are at risk of contamination. • Uncertainties of stream flows and lake levels are increasing due to climate change.	• Significant unmet capital costs (estimated at $23-$49 billion) exist for aging water and wastewater infrastructure upgrades. • Increasing peak water and/or wastewater treatment demands create additional capital costs.	• Urban water withdrawals and wastewater returns are highly geographically concentrated, amplifying their impact. • Water development projects destroy aquatic and land habitat, introduce exotic species, and block fish migration. • Both ground and surface water withdrawals can reduce surface water flows, altering marine habitat and affecting fish populations.	• Reducing water flows allows financial resources to be reallocated to meet higher levels of drinking water standards, while it reduces the amount of water that needs to be treated to these levels. • Decreasing wastewater volume increases the effectiveness of sewage treatment, thus decreasing pollution of receiving waters (often source waters for downstream users). • Reducing demand avoids the development of additional inferior water sources, and protects groundwater sources by reducing overpumping.

Box 2: Barriers That Impede the Adoption of DSM in Canada

Attitudinal barriers	*Financial barriers*	*Data and informational barriers*	*Administrative barriers*
• Myth of superabundance • Human economy and human-built infrastructure considered separate from the environment • Ideal of free market society without government intrusion • Belief that reduced water use imposes a reduced standard of living • Concern that DSM savings are unreliable and/or insubstantial • Political preference for high visibility projects	• Subsidies and low pricing • Need for predictable and stable revenues • Need to maintain sufficient revenues in the face of overcapitalization • Lack of funding for DSM • Gap in payback period	• Wariness about DSM by decision-makers • Lack of comprehensive cost/benefit models • Ineffective DSM programs	• Fragmented administration • Centralized engineering bias • Formulaic thinking • Inflexible policies

Box 3: Conceptual Model of Relationships Among the Barriers to Adopting DSM in Canada



In analyzing the relationship of the obstacles to urban water demand management in Canada, two barriers: the view of human society and our economy as separate from the environment, and the myth of abundance, emerge as root causes. These root causes reinforce and drive all of the other barriers that work collectively to fortify the current, supply-oriented approach.

Box 4: Principles for Action

- ***Fair value for water***

Eliminate inappropriate subsidies and ensure that full costs, including environmental considerations, are included in the price of water. At the same time, recognize the primacy of fresh water to human life and ecosystem health by ensuring both equitable access for all members of society, and adequate flows for the environment.

- ***Comprehensive, long-term and integrated approach***

Take into account all water uses and water-related activities, and allocate permanent budgets for staff, training, planning and implementation. Investing in such permanent institutional changes will establish demand management as a central feature of water provision and as an ongoing adaptive process. Adopting a watershed-based approach will also ensure that the cumulative impacts of *all* human activities on ecosystem health are addressed.

- ***Stakeholder involvement and participatory decision-making***

Create processes for meaningful stakeholder participation to ensure community values are expressed and citizens are engaged in identifying and implementing long-term, sustainable solutions.

- ***Innovation***

Foster creative solutions by focusing on the underlying ***service*** that water provides, rather than simply delivering water. Improve the ***market*** for water efficient technology and commence ***future proofing*** with anticipatory measures that can mitigate uncertainties.

- ***Leadership***

Ensure all institutions lead by example, incorporating best practices and cutting edge environmentally-based technologies and processes. Build capacity to effectively advise on existing and emerging domestic and international water management issues. Expand scientific, ecological and socio-economic research through enhanced data collection, technological development and pilot projects.

Box 5: Key Principles and Steps in Developing a Successful Water Supply and Conservation Plan	
Planning principles	• Integrated management i.e. include consideration of all related resources and services, including water, wastewater, and energy. • Stakeholder participation i.e. include all stakeholders during DSM planning. • Focus on underlying services i.e. focus on providing services such as bathing and sanitation rather than water provision *per se*. By keeping the true objective in focus, creative alternatives may appear.
Planning steps	• Demand management study Predicts future water and wastewater demands and infrastructure requirements, and so determines where to focus conservation efforts. • Identify goals Specific conservation goals can help focus a planning process, provide guidance and a benchmark for evaluation. • Inventory of options From a comprehensive study of available DSM measures and supply-side options, create an initial list of feasible combinations. • Cost-benefit analysis Compare and assess the various combinations. • Water conservation and supply plan Develop a blueprint for action. • Implementation and evaluation Evaluation is critical to determine the impacts of the program and necessary changes on a continuous basis.
Sources: (Vickers 1994: 94,95; CRM 1996: 8-16; Water Conservation Strategy for B.C. 1998: 31; Opitz and Dziegielewski 1998; Vickers 2001: 2-4,405-407)	

3.2.1.1 Scenario Planning

Another unique aspect of the "soft path" is the concept of "backcasting". Traditional planning starts from the present and projects forward to the future. Soft path planning does the reverse. First it defines a sustainable and desirable future state of society, at least as far as water sources and use are concerned, and then works backward to identify policies and programs that will connect the future to the present.

The report, 'The Soft Path for Water in a Nutshell', revised edition August 2007[21], gives an example of an urban scale scenario for a generic urban area with a base population of 200,000 in 2005 that was projected to grow to 300,000 by 2050. The case was developed by applying the

[21] ***Brandes, Oliver M., Brooks, David B.; 'The Soft Path for Water in a Nutshell', A joint publication of Friends of the Earth Canada, Ottawa, ON, and the POLIS Project on Ecological Governance, University of Victoria, Victoria, BC, November 2005, revised September 2007.***

soft path methodology to specific communities in British Columbia and southern Ontario (see Fig. 4 below).

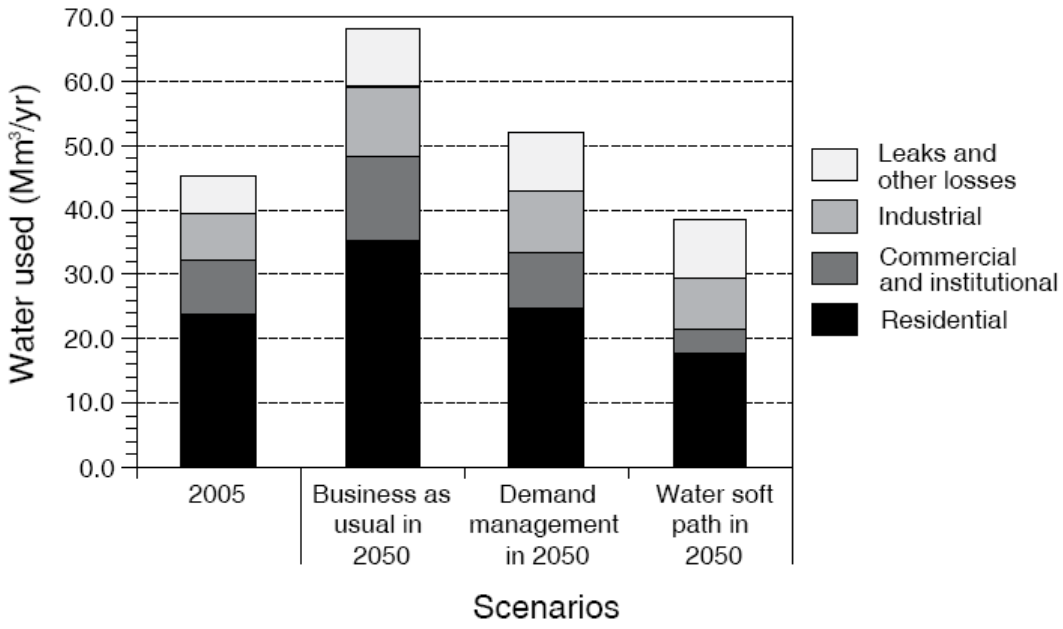


Fig 4: Water Use Scenarios

In this example, under a Business-as-Usual projection, water use grows in parallel with population growth and, by 2050, water use is 50 per cent higher than it is today.

The Demand Management scenario emphasizes enhanced efficiency with readily available technologies, such as dual flush toilets, high efficiency washing machines, drip irrigation, reduced outdoor use through native drought resistant plants, education and modest pricing reform. However, demand management alone does not provide large enough water savings to offset increased use stemming from projected population growth.

The Soft Path scenario adds cutting-edge technologies, such as dry sanitation, extensive Xeriscaping, widespread reuse and recycling, rainwater harvesting, and longer-term policies and programs to change behaviour. With these additions, the Water Soft Path scenario demonstrates that water use in 2050 could be below 2005 levels, thereby ensuring no “new” water is used despite a growing community.

A more detailed example of individual water demand technologies for a minimal water savings scenario, the ‘enhanced efficiency’ compared to the far more comprehensive ‘soft path’ from

'Urban Water Soft Path 'Back of the envelope' Backcasting Framework', February 2007[22] is reproduced below:

Table 1: Water reduction scenario assumptions

Water Use Sector	Water End Use	Scenarios					
		Enhanced Efficiency			Soft Path		
		Measure	Factor	Penetration	Measure	Factor	Penetration
Residential Indoor	Toilets	6-L Dual-flush	.36 .20	90%* 10%*	Dual-flush Composting or alternative source	.20 0	80%* 20%*
	Laundry	High-eff washing machine	.55	100%*	High-eff WM Alternative source	.55 0	50%* 50%*
	Showers	Low-flow ULF**	.58 .48	50%* 50%*	ULF Changed behaviour	.48 .30*	50%* 50%*
	Bath	No change			Changed behaviour	.75*	100%
	Faucets	Low-flow	.71	50%*	Low-flow	.71	100%*
	Dishwashers	High-eff	.71	100%*	High-eff Super high-eff	.71 .51	50%* 50%*
	Leaks	25% leak reduction	.75	100%	50% Aggressive leak reduction	.50	100%
Residential Outdoor	Lawn	Appropriate time of day, technology Modest Xeriscaping	.70 .50	50% 10%*	Appropriate time of day, technology Modest Xeriscaping	.70* .50	30% 70%*
	Garden	No change			No change		
	Other (car washing, outdoor cleaning etc.)	By-law limitations	.90	100%	Aggressive by-law limitations and enforcement	.50	100%
Institutional-Commercial	Restrooms and kitchens	Mid-eff package: 6L toilets,spray-nozzles, LF faucets, high-eff DWs	.60	100%	High-eff package: dual-flush toilets, spray nozzles, ULF faucets, super hight-eff washers, alternative sources	.40	100%
	Outdoor	Appropriate time of day, technology Modest Xeriscaping	.70 .50	50%* 10%*	Modest Xeriscaping Aggressive Xeriscaping and alternative source	.70 0	25%* 75%*
	Cooling/ heating	Single pass cooling ban	.50	100%*	Looping and reuse/ recycling	0	100%*
Industrial	Details location specific	Technological innovation	.90	100%*	Technological innovation	.75	100%*
Unaccounted	Including: fire prev. parks & rec leakage	System audits	.90	100%	Aggressive system audits and alternative sources for public lands	.75	100%

* denotes increased penetration impacts from pricing and/or targeted education programs

**ULF = Ultra Low-Flow

[22] *Brandes, Oliver M., Maas, Tony. POLIS Discussion Series Paper 07-02, February 2007. 'Urban Water Soft Path 'Back of the Envelope' Backcasting Framework', POLIS Project on Ecological Governance, University of Victoria, Victoria, BC.*

The report indicates that the soft path scenario (with the characteristics outlined in the above table) is a good indication of what a realistic, yet aggressive, commitment to conservation might entail. The report also includes three pages as *Annex B: Literature Review of Water Conservation Measures*, representing a wide range of water conservation options of:

- Structural and Operational Strategies – toilets, faucets, clothes washers etc.
- Socio-Political Strategies – bylaws, regulations etc.
- Economic Strategies – rebates, metering etc.

Table B. Literature review of water conservation measures				
Technology/ Practice	**Water Saving (%)**	**Water Saving[10]**	**Context**	**Source**
Structural and Operational Strategies				
Toilets				
6-L toilet	64%	52.5 L/day	6-L replacing 16.5 L	Mayer et al., 1999, pg 232. City of Calgary, 2005, pg 13 AWWA, 2006, pg 53
6-L toilet (commercial)	54%	21 L/day	6 L replacing 13 L	AWWA, 2006, pg 53
3.78 L/flush urinal	50%	11.36 L/day	Replacing 7.57 L/flush urinals with 3.785 L/flush urinals	AWWA, 2006, pg 53
1.89 L/flush urinal	50%	1.89 L/flush	Require low flush urinals in new ICI	AWWA, 2006, pg 63
Dual-flush toilet	78%	12.8	4.4/3 L replacing 16.5L	Mayer et al., 1999, pg 23
Dry use/ composting toilet	100%	82.5 L/day	Replacing 16.5 L average water use for toilet	Commonwealth of Australia, 2005, pg 1
Waterless urinal	100%	11.36 L/day	Replacing 3.785 litre/flush urinal with no water urinal	AWWA, 2006, pg 53
Alternative water source toilet (grey-water/ rainwater)	100%	82.5 L/day	Replacing 16.5 L toilet	CEVE, 2000, pg. 1
Early closure device	Up to 35%	11.35 L	Installing an early closure device on toilet	Province of Manitoba, Undated, pg 2; AWWA, 2006, pg 53
Water displacement device	57%	9.46 L/day	Installing a device that reduces the amount of water used by older toilet types	AWWA, 2006, pg 53
Showerheads and Faucets				
Low-flow showerheads	53%	120 L/day	7 L/min replacing 15L/min	City of Davis, Undated, pg 12 City of Calgary, 2005, pg 3 Gleick, Peter et al, 2003, pg 75
Shorter showers	47%	64 L/day	Reduce time for shower from 15 min to 8 min	City of Calgary, 2005, pg 2
Low-flow faucets	21%	20 L/day	9.5 L/min replacing 12 L/min	City of Calgary, 2005, pg 12 U.S. Department of Energy, 2004, pg 13. AWWA, 2006, 53
Ultra low-flow faucets	53%	50.4 L/day	5.7 L/min replacing 12 L/min	Efficiency Partnership, 2005 Mayer et al, 1999, pg. 563. Region of Waterloo, 2005, pg. 2
Aerators	15.8%	15.16 L/day	Adding an aerator to a faucet to reduce water use	AWWA, 2006, pg. 125
Restaurant low-flow spray nozzles	50% of kitchen spray use	3900 L/day	Installing a low-flow spray nozzle in restaurant	AWWA, 2006, pg 63 (based on average daily demand per connection in GVRD: Vickers, 2002, pg 233)
Pre-rinse spray valve (commercial)		757 L/day	Installing a low-flow valve for pre-rinse sprays in restaurants	AWWA, 2006, pg 125
Insulate hot water pipes		7.57 L/day	Protect hot water pipes from losing energy and water	AWWA, 2006, pg 53
Pressure reducer		17 L/day	Installing a device on a faucet or general supply to reduce water pressure	AWWA, 2006, pg 53
Self-closing spray taps	50%	48 L/day	6 L/min replacing 12 L/min	Louw, DB and WE Kassler, 2002, pg. 34
	25% of faucet end use		Install self-closing spray taps in new ICI buildings	AWWA, 2006, pg 63

[10] The water savings is based on three flushes per person per day.

Structural and Operational Strategies continued.

Dishwashers and Clothes washers				
Water efficient dishwashers	24%	10 L/week	30L/load replacing 40L/load	City of Davis, Undated, pg 2
Water efficient dishwashers	36%	14.4 L/week	25.6L/load replacing 40L/load	EPCOR Canada, Undated, pg 1
Water efficient dishwashers	44%	17.5 L/week	22.5L/load replacing 40L/load	City of Calgary, 2005, pg 1
Water efficient dishwashers	55%	22 L/week	18L/load replacing 40L/load	Government of Australia, 2005, pg 1
Water efficient clothes washer (commercial)		170 L/day	Replacing a regular clothes washer with water efficient model	AWWA, 2006, pg 125
Water efficient clothes washer	45%	77.3 L/load	Average 92.7L (average) replacing 170L	Gleick, Peter et al, 2003, pg 125 (source for frequency of use): Louw, DB and WE Kassier. 2002, pg 118
Horizontal axis washing machine	33%	20.8 L/day	Average 113.5 L replacing 170L	AWWA, 2006, pg. 53
Outdoor Water Uses				
Water saving equipment in a swimming pool	30%	6411 L/day	Reducing/ eliminating leaks; ensuring pools are water efficient	European Environment Agency. 2001, pg. 69
Xeriscaping	30%	995.5 L/day	Xeric landscape replacing turfgrass	Sovocool et al., 2006, pg 92
Xeriscape mix	50%	51.5 L/day	Reducing green turf by half	Gleick, Peter et al, 2003, pg 64
Water saving "equipment" for irrigation	Approx 62%	117.8 L/day	Increase water efficiency of municipal irrigation	European Environment Agency. 2001, pg 69
Rain shutoffs		75.7 L/day	Installing a rain gauge to shut sprinkler off when raining	AWWA, 2006, pg 125
Hose timers		11.5 L/day	Putting a timer on a garden hose to reduce excess watering	AWWA, 2006, pg 125
Smart controllers	24%	24.72 L/day	Add smart controller to automatic irrigation systems	CUWC Council, 2005, pg 37
Rainbarrel program		900,000 L/ year	Using rainwater for residential lawn irrigation	BCMOE, 2001, pg 5
Agriculture				
Surface systems (flood)	55%efficient		Efficient agriculture	Louw, DB and WE Kassier 2002, pg 9
Conventional sprinkler	75% efficient		Efficient agriculture	Louw, DB and WE Kassier 2002, pg 9
Mechanical (centre pivot)	80% efficient		Efficient agriculture	Louw, DB and WE Kassier 2002, pg 9
Micro jet	85% efficient		Efficient agriculture	Louw, DB and WE Kassier 2002, pg 9
Leaks etc.				
Fixing leaks	75.6%	18.9 L/day	Repairing household leaks	AWWA, 2006, pg 53
		21801 L/day	Fixing one belowground leak averaging 15L/min	Jones, Marcellus Jr., 2006, pg 33
	12-15%		Repairing leaks in water supply system	Louw, DB and WE Kassier. 2002, pg 44
Household leaks	77%	19.3/L/day	"with conservation"	Louw, DB and WE Kassier, 2002, pg 118
Remove garbage grinder (commercial)		1514 L/day	Removing apparatus that grinds garbage in restaurant	AWWA, 2006, pg 125
Water saving equipment and leakage detection in individual schools	51-79%	15058 L/day	Improving efficiency of schools	European Environmental Agency, 2001, pg 69.
Cooling tower meters (commercial)	20% of cooling use		Sub-meter installation for cooling towers	AWWA, 2006, pg 63

Socio-political strategies				
By-laws	30%	32.96 L/day	Mandatory restriction limiting watering to twice per week	Vickers, Amy, 2006, pg 60
By-laws	53%	57.68 L/day	Mandatory restriction limiting lawn watering to once per week	Vickers, Amy, 2006, pg 60
Public Education and Behaviour changes	2-5% (of all end uses)	22.78 L/day	Information and education of water conservation	Louw, DB and WE Kassler. 2002, pg 120; BCMOE, 2001, pg 6; AWWA, 2006, pg 63
Public Education and Behaviour changes	15%	99.65 L/day	Reduce peak water usage	Derdali, 2002, pg 1
Irrigation Audit		113.55 L/day	Using an audit to identify residential water inefficiencies	AWWA, 2006, pg 125
Water use regulation		94.6 L/pers/ day	Greywater reuse, residential	Louw, DB and WE Kassler. 2002; pg 120
A reuse program for hotel and motel owners(in Florida: encouraging room occupants to reuse towels rather than get fresh ones every day)		189.25 L/ room/day	The estimated average was 50 gallons of water saved per occupied room per day. Participating hotels and motels also saved an average of 20 to 30% on laundry costs, and the amount of detergent used also decreased.	WaterBucket, 2006, pg 1 (Estimated results show that program participants saved a combined 100 million gallons of water in only one year. The audits covered properties ranging in size from one to 1000 rooms.)
Indoor audit (commercial)	15% of all end uses	378.5 L/day	Using an audit to identify water inefficiencies	AWWA, 2006, pgs 63, 125
Irrigation audits (commercial)		946.25 L/day	Using an audit to identify irrigation inefficiencies	AWWA, 2006, pg 125
Indoor water audits (residential)		75.7 L/day	Using an audit to identify water inefficiencies	AWWA, 2006, pg 125
Economic Strategies				
Home retrofit program		106.85 L/day	Providing households with rebates to install low-flow fixtures: showerhead $7, bathroom aerator $1; up to $14 per household	BCMOE, 2001, pg 6
Rainbarrel rebates		22.7 L/day	Providing money back on purchase of rainbarrel	AWWA; 2006, pg 125
Irrigation rebate		113.55 L/day	Rebates on high-efficiency product purchases	AWWA; 2006, pg 125
Clothes washer rebates(residential)		56.8 L/day	Rebate on high-efficiency clothes washer purchase	AWWA; 2006, pg 125
Coin-op clothes washer rebates (multifamily and commercial)	35% of laundry		Rebate on high-efficiency clothes washer purchase	AWWA, 2006, pg 63
Toilet rebates (residential)		94.6 L/day	Rebate on high-efficiency toilet purchase	AWWA; 2006, pg 125
Toilet rebates (commercial)		128.69 L/day	Providing commercial users with rebates to install low-flow toilets	AWWA, 2006, pg 125
Water rate/ sewer rate; rebates; stormwater utility approach; integration of water issues (rain, grey, potable)	5-13.8% reduction using an increasing block rate		Utility pricing to include full cost; increase water rate; rebates on efficient water fixtures; a 10% increase in water rates provided about 3% more revenue while triggering a 7% reduction in use	USEPA, 1995, pg 122 Louw, DB and WE Kassler, 2002, pg 43
Increasing residential water ratesUniversal metering	2-4%	19.53 L/day	10% increase in price	Louw, DB and WE Kassler. 2002, pg 120
	25-30%		Replacing flat rate with meter; pay according to use	Louw, DB and WE Kassler. 2002, pg 43
	34%		Installing meter on residential water accounts	BCMOE, 2001, pg 5
Submetering	20-40%		Install meters in subunits, such as apartments and condominiums	USEPA, 1995, pg 10

3.1.3 Watershed Governance

The area of governance was covered in the report, ***'At a Watershed: Ecological Governance and Sustainable Water management in Canada', May 2005***[23], a collaborative project involving both The POLIS Project on Ecological Governance and the Environmental Law Centre at the University of Victoria.

The report recommended four key concepts to guide water planning and management:

'1. Prevention and Precaution
To maintain ecosystem integrity, prevention of harm is better than subsequent compensation or remediation. A precautionary approach is the best hedge against an uncertain future.

2. Ecosystem-based management
Ecosystem-based management adapts economic, political and social processes to fit within the ecosystem, instead of the reverse. Rather than managing a watershed as an adjunct to human needs, ecosystem integrity sets the context for management decisions.

3. Matching authority to jurisdiction
Watershed governance recognizes that local people and institutions are best situated to monitor environmental feedback and respond with tailored solutions. However, local powers must also be "nested" within higher level institutions that hold them accountable, co-ordinate with other local institutions, and participate in broader collective actions.

4. Adaptive management
Plans and policies should be continually modified to respond to ecological, economic and social feedback through an ongoing process of informed "trial and error." Decisions that are provisional and reversible can create and apply critical knowledge to refine decision making in an uncertain world.'

The study concluded that a long-term solution requires a fundamental shift to watershed governance – an institutional shift towards ecologically-based water allocation, innovation in planning, managing water use with a "soft path" approach, and ecosystem-based management at the watershed scale.

[23] ***At a Watershed: Ecological Governance and Sustainable Water Management in Canada / Oliver M. Brandes et al.***

4 Appendix 4: Australia

4.1 Institute for Sustainable Futures

An organisation that has carried out an extensive amount of work in the area of demand management is the Institute for Sustainable Futures (The Institute)[24 25 26 27]. The Institute of Sustainable Futures was established in 1996 as a flagship research institute of the University of Technology, Sydney. The university research institute conducts independent project based research for Australian and international cities across a wide range of research areas, including building and design, transport, social sustainability and water.

The Institute has produced numerous reports and papers on demand management, such as:

- Demand management programs in Australia (See Section 1.1):
  - *'Does demand management work over the long term? What are the critical success factors?'*, Sustainable Water in the Urban Environment Conference 2006, Andrea Turner and Stuart White, Institute of Sustainable Futures.
  - *Designing Cost Effective Water Demand Management Programs in Australia'*, Water Science and Technology, vol. 46, no. 6-7, pp. 225-232, IWA Publishing, 2001, S.B. White and S.A. Fane, Institute for Sustainable Futures.
  - *Have we Achieved the Savings? The Importance of Evaluations when Implementing Demand Management*, Proceedings of 4th IWA Specialist Conference on Efficient Use and Management of Urban Water Supply 2007, Andrea Turner, Stuart White, Alex Kazaglis and Sonia Simard, The Institute of Sustainable Futures.
- The development of an international demand management framework (See Section 1.2):
  - *The International Demand Management Framework, Stage 1, Final Report*, December 2006, Prepared by Institute for Sustainable Futures for Canal de Isabel II
- Demand management programs for specific cities (See Section 2.):
  - *ACT Water Strategy, Preliminary Demand Management and Least Cost Planning Assessment, Final Report*, October 2003, Prepared by Institute for Sustainable Futures for ACTEW Corporation Ltd.
  - *Alice Springs Water Efficiency Study Stage III, Implementation – Feasibility Study*, May 2007, Institute for Sustainable Futures.

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[24] www.isf.uts.edu.au

[25] Turner, A., White, S., Institute of Sustainable Futures; 'Does demand management work over the long term? What are the critical success factors?, Sustainable Water in the Urban Environment Conference 2006.

[26] White, S.B., Fane, S.A., Institute for Sustainable Futures; 'Designing Cost Effective Water Demand Management Programs in Australia', Water Science and Technology, Vol 46, no. 6-7, pp225-232, IWA Publishing, 2001.

[27] Turner, A., et al., Institute of Sustainable Futures; 'Have we Achieved the Savings? The Importance of Evaluations when Implementing Demand Management', Proceedings of 4th IWA Specialist Conference on Efficient Use and Management of Urban Water Supply, 2007.

From the work carried out by the Institute, they have concluded that while demand management in Australia has been going on since the late 1980s, there is little evidence of real long-term commitment such as adequate budgeting and staff resources and only more recently have demand management plans been taken seriously. For example, investigations in Sydney are unveiling the true potential of the combination of demand management, potable source substitution, reuse and low cost supply options which are resulting in projected reductions in demand of about 145,000 ML/a (1ML = 1,000,000 litres). Although the expenditure will increase to over Aus $500 million, the investment in demand management is less than half the unit cost of the alternative large-scale desalination plant supply option.

The Institute has identified the following key factors that can assist water planners to tap into and maintain water savings:

- Overall planning and commitment by water planners.
- Water planners becoming water service providers.
- Considering water conservation potential of a specific region by disaggregating demand into sectors and end users to clarify how water is used and might be saved.
- The use of both structural and behavioural changes as well as combining measures (what to change) and instruments (how to change them).
- Control and influence issues and how water planners need to develop a broad spectrum of options that show other stakeholders the importance of their involvement.
- Careful implementation planning, development of a demand management team and the importance of pilots/phasing of programs prior to full implementation to fine tune program design.
- The need for ongoing review and evaluation of implementation programs including the use of best practice statistical analysis methods to facilitate ongoing improvement, maximise savings and reduce costs.

When water planners see themselves as ‘water service providers’ they recognize that a kilolitre saved is equivalent to a kilolitre provided and that in fact water saved provides significant benefits in terms of deferring capital expenditure and reducing water and wastewater operating and treatment costs, energy costs (for both the water service provider and customer) and greenhouse gases. Recognising and actually calculating not only the whole of society costs but also benefits to various stakeholders assists in determining how to share the cost and benefits to the community and enables justification for price path when there is a risk the water service provider may incur lost revenue.

To help water service providers plan, review and improve their approach, the Institute has developed a process/framework based on the internationally recognized best practice approach of integrated resource planning (See Section 1.2 below).

One critical area, often left out in demand management, is the importance of evaluating their performance. The effectiveness of demand management programs can be measured by:

- Assessing whether the required participation rates are achieved.
- Customer satisfaction is obtained and maintained.
- The assumed costs of the programs were accurate.
- The estimated water savings were achieved and maintained over time.

Some relevant points on evaluation methodology are:

- Note that single residential or detached dwellings can have very different water using characteristics to flats and units and should be analysed separately.
- Having obtained the sample data, remove outliers, i.e. water usage with more than a nominated standard deviation which may be due to data anomalies.
- For each participant, a matched control must be found, either by geographical proximity or better still, by matching as closely as possible the mean and variance of their monthly and quarterly water demand.
- The difference between the means of the control and participant, the "relative savings", can be tested within a 95% confidence interval using a paired t-test. (merely considering the demand of a participant before and after implementation in isolation (without a control) will not take into consideration potential "other factors" that might influence water demand and may provide very misleading results, e.g. weather or behavioural changes not specifically related to the demand management program implemented).

An example of such an analysis is that for Sydney Water Corporation's Every Drop Counts Residential Retrofit program called WaterFix. This program is the largest of its type in Australia. The program involves a certified plumber visiting a household and where possible replacing inefficient showerheads with 3 star rated showerheads (flow rate of < 9L/min), installing tap flow regulators and toilet cistern arrestors, checking for leaks and providing general advice on water savings around the home. From the statistical analysis of the program using a paired t-test on a sample of over 17,000 participants and matched controls, a saving of 20.9 kl/household/per annum (+/- 2.5 kl/hh/pa) or 57 l/hh/pd was found to be attributable to the program.

4.1.1 Development of an International Demand Management Framework

Background

The work carried out by the Institute on the development of an International Demand Management Framework (IDMF) is an initiative set up under the auspices of the International Water Association's (IWA) Specialist Group "Efficient Operation and Management" – Task Force No. 7 which was set up in 2004. The objectives of the overall IDMF study are to develop a step-by-step framework and associated manual on best practice approaches to urban water supply-demand planning with a focus on demand management/water efficiency.

The objectives of the Stage 1 Report[28] have been:

- To gather and represent the core international literature in this field.
- To develop an outline and criteria that describes a best practice approach - the field of integrated resources planning, the foundation of the emerging best practice approach advocated by the study).
- Utilise these to benchmark the activities of a case study utility, Canal de Isabel II, the Madrid water utility.

The work has been primarily conducted by the Institute, with review and input from an international working group of experts in this field. The criteria developed have been elaborated at two levels of depth depending on their applicability to strategic, high-level planning, or detailed planning.

The best practice criteria developed in this first stage have proved useful in the case study utility, Canal de Isabel II (CYII) of Madrid in two ways:

- Firstly, it allowed a broad overview of CYII's work through mapping their actions against the different steps in the IDMF process.
- Secondly, at a detailed level, the criteria were used to guide improvement of CYII's activities such as how to increase the reliability in end use data collection.

The next steps of the project will be to conduct a more detailed literature review, and to use and refine the framework in diverse locations including developing and emerging countries.

[28] Institute for Sustainable Futures Report for Canal de Isabel II, 'The International Demand Management Framework, Stage 1, Final Report', December 2006.

The Proposed International Demand Management Framework Process

Fig 5 below shows the overall planning process, which has five main steps, and the models and data/information that support this process[29].

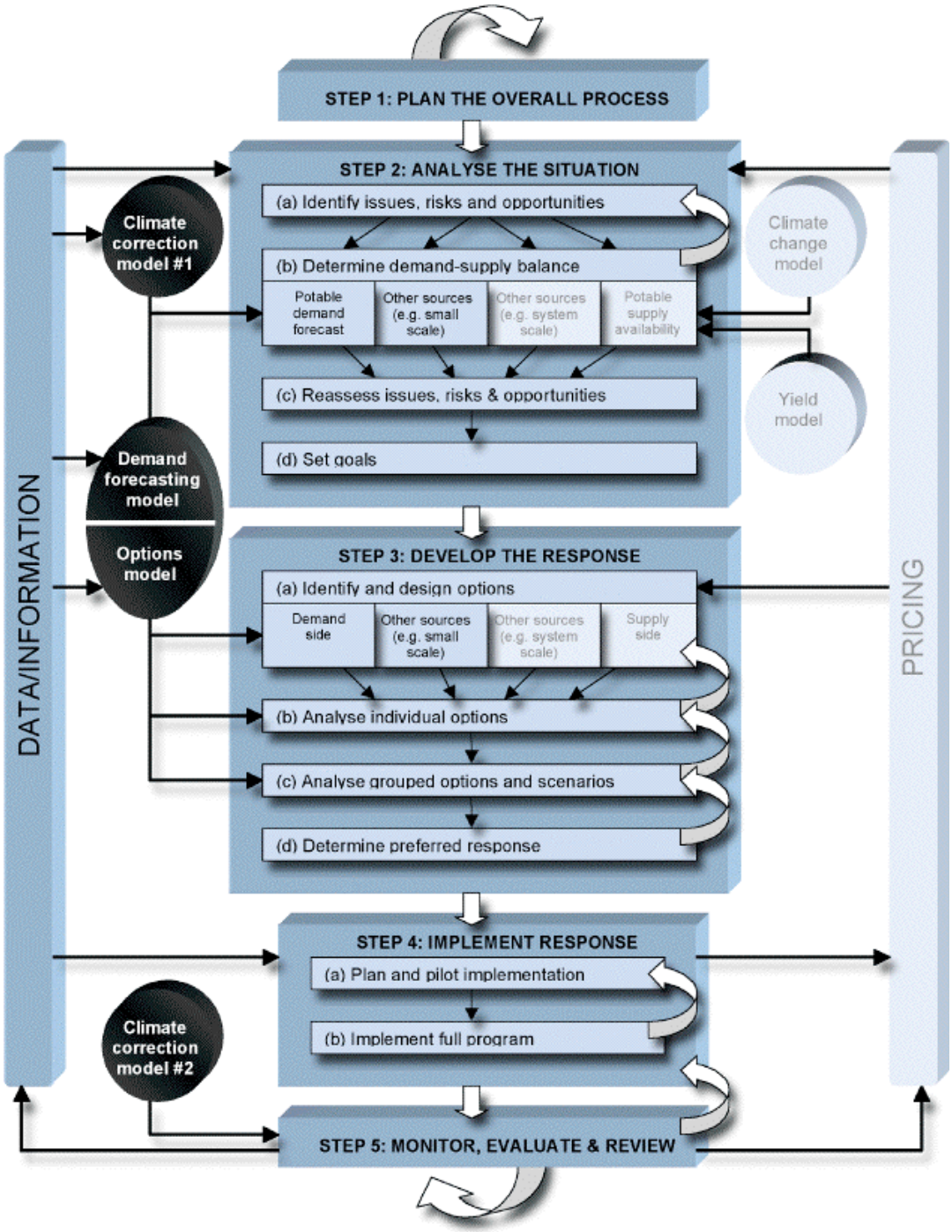


Fig 5 : The International Demand Management Framework

[29] *Ditto. Institute for Sustainable Futures Report for Canal de Isabel II*

A summary of these five steps in note form follows:

Step 1: Plan the overall process

- Clearly defines all steps in process to be followed.
- Clearly defines stakeholder roles in process.
- Matches defined process with available resources and skills.
- Determines general goals and scope.
- Maximises inclusiveness.
- Encourages deliberative decision-making.
- Assesses skill requirements and staff training needs.

Step 2: Analyse the Situation

Identify issues, risks and opportunities

- Defines clear system boundaries.
- Investigates current water supply system characteristics.
- Identifies major sector water usage.
- Investigates current and future demographics.
- Analyses scenarios that describe the likely risks to the demand-supply balance.
- Engages informed stakeholders to decide on initial planning objectives.

Determine supply-demand balance

- Analyse historical and current water demand.
- Forecasts water demand based on disaggregated demand trends.
- Exposes stakeholders to the data, assumptions and method of demand analysis.
- Defines appropriate level of contingency (headroom) in the supply-demand balance.

Reassess issues, risks and opportunities

- Prioritises issues, risks and opportunities.

Set goals

- Clearly defines goals to be met.

Step 3: Develop the Response

Frame the analysis

- Clarifies an appropriate depth of analysis.
- Determines the cost perspectives, cost elements and cost metric.

Identify and design options

- Considers the widest possible range of options and their respective water savings.
- Defines maximum conservation potential.
- Screens options by maximizing conservation potential.
- Defines best applicable instruments associated with each measure to form “options”.

- Gives particular consideration to "best management practice" and local applicability.
- Identifies the total costs and savings of each designed option.
- Defines a suite of well considered individual options for further analysis.
- Conducts sensitivity analysis on each option.

Analyse individual options

- Conducts an economic analysis of each option based on total resource cost and societal cost.
- Analyses explicitly the different cost perspectives in the economic analysis.
- Conducts a robust technical assessment of each option.
- Uses appropriate method for identifying social and political barriers and impacts for each option.
- Conducts an environmental impact assessment of each option.
- Conducts a sensitivity analysis on the various analyses.
- Makes assumptions and intermediate results explicit in the various analyses.
- Uses a participatory process to consider the results of the economic, technical, social and environmental analyses.

Analyse grouped options and scenarios

- Allocates options into groups that meet the goals set in step 2d over time.
- Initially considers "least cost" groups using the present value of each group of options.
- Examines effects of most-likely risks/scenarios on groups of options.
- Performs a risk balancing exercise to determine optimal group of options.
- Optimises synergies, links and dependencies between options.
- Uses a participatory process to deliberate on the required risk balancing and risk-cost trade-offs.

Step 4: Implement Response

Plan implementation

- Clearly identifies demand management team/staff
- Thoroughly plans and documents the details of the implementation process.
- Develops a detailed budget plan.
- Determines cost sharing arrangements for each option and the overall preferred response.
- Plans an education and communication campaign.
- Includes actions to facilitate the necessary culture change and public acceptability.
- Plans the monitoring and evaluation procedure.

Undertake pilot program

- Conducts pilots of options.

Implement full program

- Stakeholders participate according to agreed responsibilities.
- Co-ordinates implementation activities with one another.
- Provides necessary staff training.

- Utilises water efficiency and other equipment being fitted of satisfactory quality.
- Engages public and target groups in the program.
- Conducts monitoring and evaluation in parallel with implementation process.

Step 5: Monitor, evaluate and review

Monitor and evaluate individual programs

- Monitors the individual program processes
- Monitors individual program outcomes.

Evaluate full program against goals

- Evaluates the implemented response against the agreed goals

Review the overall process

- Assesses the 5 step IRP planning process

4.2. Selected City Programs

Brief summaries of the water demand/efficiency programs in the following cities are given below for ACT (Canberra), Melbourne, Sydney Water

For comparison, 30 year monthly rainfall data is given below for the above three cities, plus Adelaide and Perth.

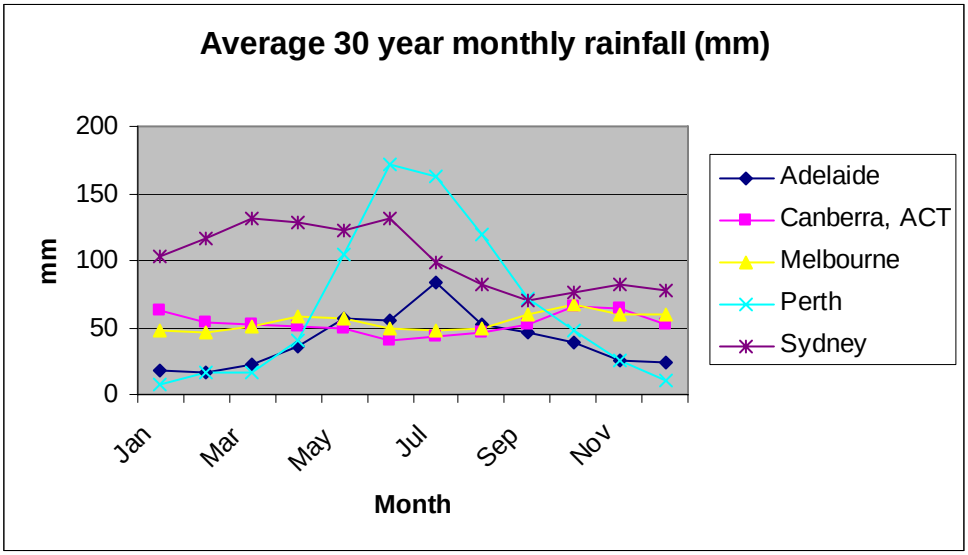


Fig 6: Average 30 year monthly rainfall in Australia

4.2.1 ACT (Canberra)[30]

Population increase, together with other issues associated with drought security, climate change and catchment regeneration after the 2002/03 bush fires have indicated that another supply source may be required for the Canberra area before 2020. However, as part of the World Environment Day Assembly Motion, the ACT Government passed a motion, which agreed that: *"as far as possible the building of further water supply dams in the ACT should be avoided"*.

Therefore, to assist in achieving this goal of avoiding the building of further water supply dams, demand management and other targets (based on the base year of 2003) have been set by the ACT Government as:

- By 2013 reduce per capita potable demand by 12%.
- By 2023 reduce per capita potable demand by 25%.
- By 2013 increase reuse from 5% to 20%.
- Limit stormwater flow in new developed areas to the same that flowed before development.

In August 2003 ACTEW Corporation (ACTEW) commissioned the Institute to provide assistance in developing the ACT Water Resources Strategy to meet the above targets.

A summary of the options considered is given below in Table 7.

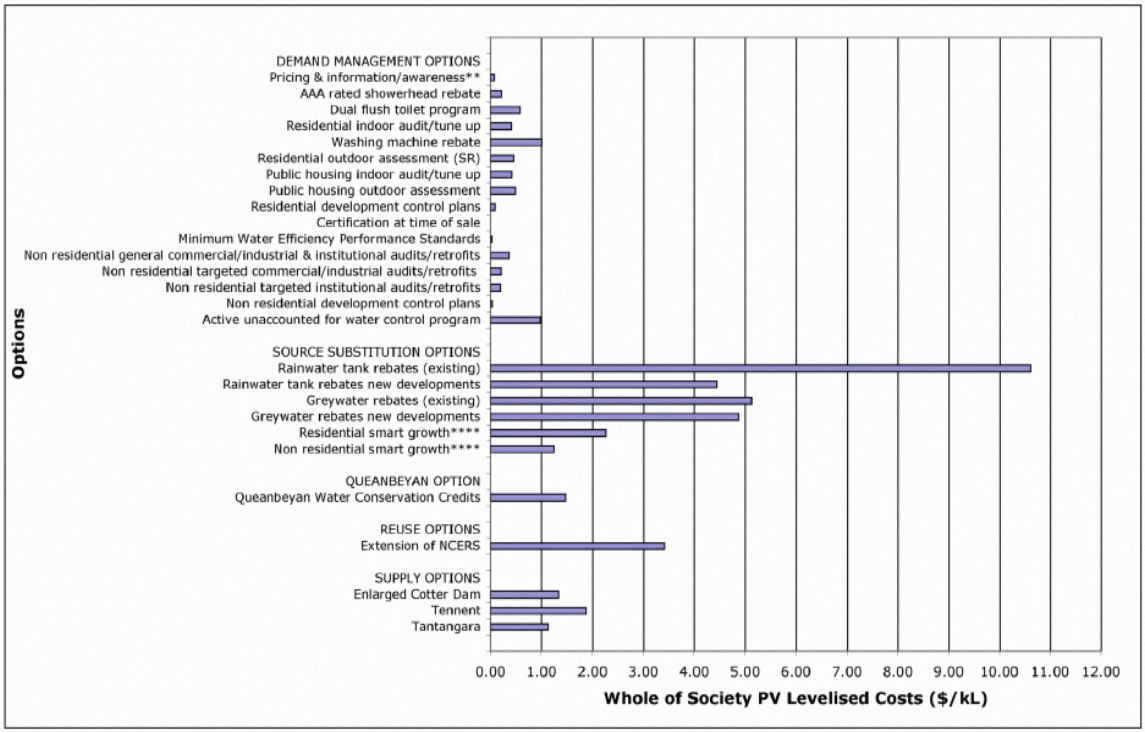
30 Institute for Sustainable Futures, 'ACT Water Strategy, Preliminary Demand Management and Least Cost Planning Assessment Final Report' October, 2003. Report for ACTEW Corporation Ltd.

Option
Demand Management Options
Pricing & information/awareness
AAA rated showerhead rebate
Dual flush toilet program
Residential indoor audit/tune up
Washing machine rebate
Residential outdoor assessment (single residential)
Public housing indoor audit/tune up
Public housing outdoor assessment
Residential development control plans
Certification at time of sale
Minimum Water Efficiency Performance Standards
Non residential general commercial/industrial & institutional audits/retrofits
Non residential targeted commercial/industrial audits/retrofits
Non residential targeted institutional audits/retrofits
Non residential development control plans
Active unaccounted for water control program
Source Substitution Options
Rainwater tank rebates (existing)
Rainwater tank rebates new developments
Greywater rebates (existing)
Greywater rebates new developments
Residential smart growth
Non residential smart growth
Queanbeyan Option
Queanbeyan Water Conservation Credits
Reuse Option
Extension of NCERS
Supply Options
Enlarged Cotter Dam
Tennent
Tantangara

Table 7: Options Considered

A summary of the 'Whole of Society Levelised Costs ($/kL) are also given in Table 8 below. 'Whole of Society Costs' includes all capital and operating costs and in the case of demand management options also includes those costs associated with marketing, project management and evaluation of individual options.

'Levelised Costs', $L = \frac{\text{Present Value (Costs)}}{\text{Present Value (Water Saved or Supplied)}}$



Notes - **Pricing & information/awareness have been modelled as one at this stage, ****Smart growth is a similar concept to water sensitive urban design (WSUD)

Table 8: Whole of Society Levelised Cost

The demand management options and source substitution options in the above table are self explanatory except for the residential and non-residential 'smart growth' terms. 'Smart growth' is a similar concept to water sensitive urban design (WSUD), or low impact design (LID).

The Queanbeyan water conservation credits involve similar demand management and source substitution options but applied to the Queanbeyan City Council. Queanbeyan City Council is an independent city but gets its water supply from the existing ACT supply sources and so will also need to reduce demand per capita in line with that of Canberra.

The extension to the NCERS Reuse Option is an extension to the existing North Canberra Effluent Reuse Scheme which supplies treated effluent from the Fyshwick Sewage Treatment Plant to large ovals, open space and irrigation areas. The supply options include existing or new water supply dam schemes. The Tennent involves building a new dam on the Naas River, and the Tantangarra option involves the transfer of water from the Tantangara Dam to the Cotter system.

Figure 7 shows the cumulative potential savings in potable water demand in terms of per capita per day (LCD) for each of the options considered and how a combination of the options can be used to reduce demand to meet the 2013 and 2023 targets.

It is of interest to note that Fig 7 shows that the 2013 target can be met through demand management options alone.

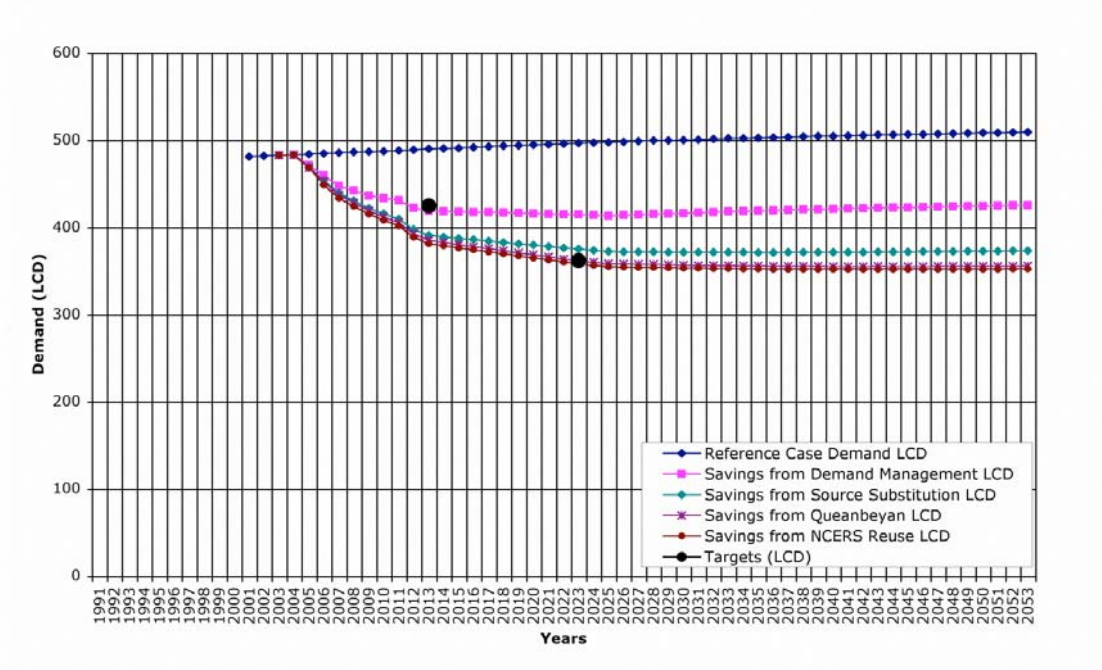


Fig 7: Savings in litres per capita per day (LCD) through to 2053.

Another presentation method of the program costs and water savings is in the form of supply curves. Two such supply curves are presented below in Figs 8 and 9.

Fig 8 shows a detailed breakdown of each individual programs levelised cost ($/kl) on the y-axis versus the water saved or supplied in 2023 (ML/a) on the x-axis. Figure 8 shows the demand management options (numbered 1 to 15) all at less than $1.00 PV levelised cost, compared to greywater and rain tank rebates at $4.50 to $10.50 PV levelised cost.

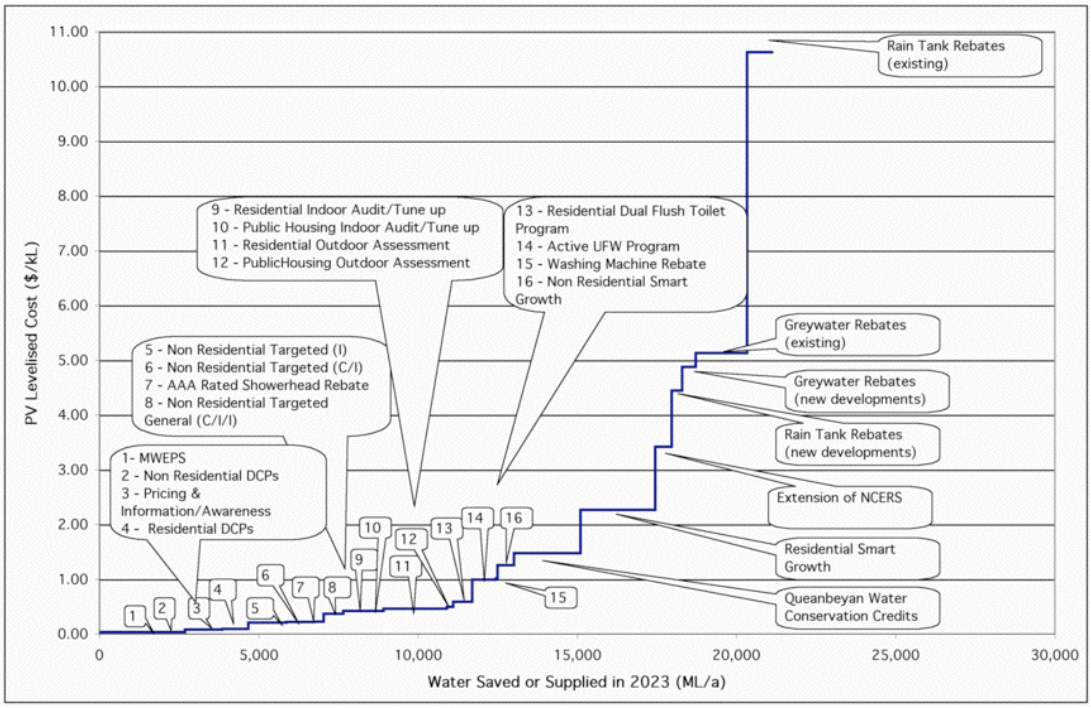


Fig 8: Supply Curve in 2023 (excluding Supply Options)

Figure 9 shows a simplified breakdown of the options considered including the supply side options. In this graph the smart growth (Low Impact Design, LID) has been separated out from the core group of source substitution options due to its relatively lower levelised costs compared to rainwater tank and greywater options. Again, this supply curve helps to illustrate the significant combined savings that can be provided by the demand management options (at an overall PV levelised cost of approx $0.30) compared to the cost of the water supply dam options of approximately $1 to $2 and the rainwater tank and greywater rebate programs (source substitution options without smart growth) of $6.40 $/kl.

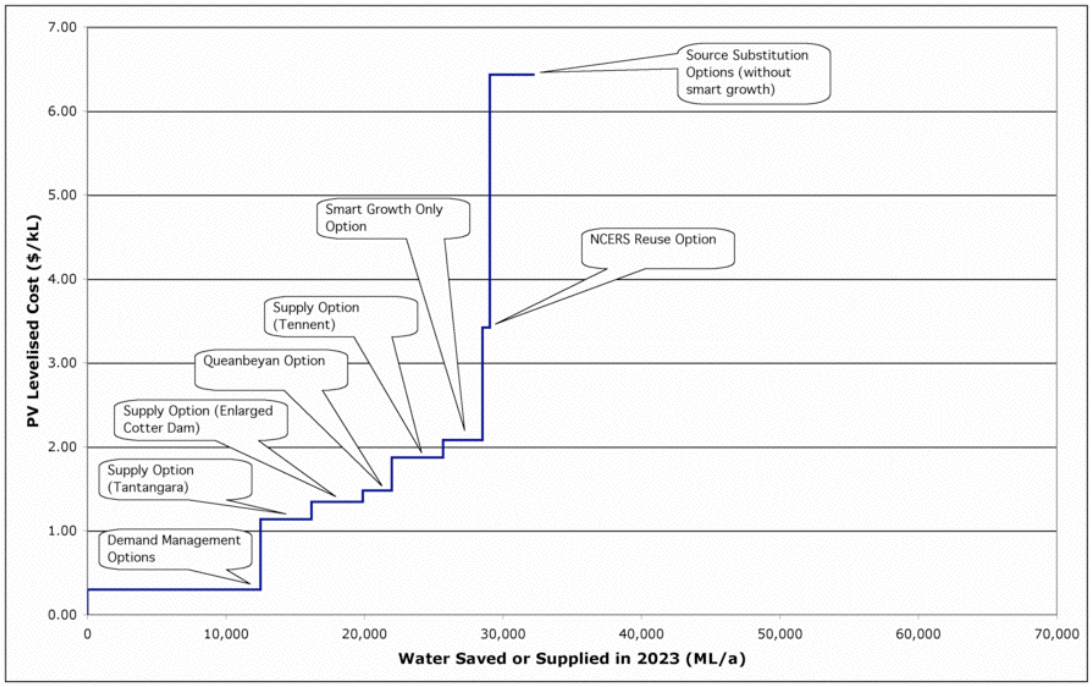


Fig 9: Simplified Supply Curve in 2023 (including Supply Options)

It is important to note that the above costs assume that the government pays for the whole cost of each option as would be assumed if a supply side option (a dam) was being constructed. The less that government contributes to each option, the lower the participation rate and ultimate savings are likely to be less, unless innovative loan systems can be offered which allow customers to contribute to the cost of the programs with the benefits they accrue.

Given the low costs of the demand management options, one strategy recommended to ACT was to develop the suite of lower levelised cost demand management options over the next 10 years, to 2013. During this time, the reference case demand could be projected with greater certainty and allow for the complex issues associated with peak demand, drought security, the effects of climate change and catchment regeneration to be considered. These additional complex issues are not included in the above demand analyses. During this period other reuse and source substitution options could be further investigated and where found to be cost effective, implemented, ultimately assisting in achieving the longer term 2023 target.

4.2.2 Melbourne

A brief summary of Melbourne's water demand/efficiency programs is presented below covering their water restrictions (as of 1 April 2007), educational material and rebate programs[31]. Additional information is also given on their innovative 'Climate Neutral Water Savings Schemes' as this is an initiative unique to Melbourne.

[31] ***http://www.melbourne.vic.gov.au***

Background

Melbourne Water is the bulk water supplier for three retail water companies, City West Water, South East Water and Yarra Valley Water. Inflows into reservoirs in the last 10 years are well below the previous long-term average by 30 to 60%. Last summer Melbourne received only 40 per cent of the average summer rainfall and stream flows into major catchments were well below average. This has lead to the implementation of 'Stage 3a' water restrictions since 1 April 2007. This means:

'Under Stage 3a water restrictions gardens can be watered on specified watering days only in the morning:

- *a hand-held hose fitted with trigger nozzle, a watering can, bucket and manual dripper system can be used to water from 6am to 8am;*
- *an automatic dripper system can be used to water from midnight to 2am;*
- *as with Stage 3, even-numbered houses can water on Saturday and Tuesday and odd-numbered houses can water on Sunday and Wednesday; and*
- *households with at least one resident aged 70 years or over, may water their gardens manually on specified watering days between 6am to 8am, or 8am or 10am.'*

To meet the need of future population growth, without costly changes to environment and infrastructure Melbourne needs to reduce their water consumption by 40% by 2020. This means reducing personal water usage from 296 l/pd to 178 l/pd. As of October 2007, Melbourne's residents are well on their way to reducing daily water consumption. Since 1999/2000 water use has fallen from 296 l/pd to just below 200 l/pd.

Melbourne's Water Strategy

Melbourne's 'Total Watermark 2004' strategy for managing water in the City of Melbourne, sets innovative policies and actions for managing the total water cycle, including[32]:

- water consumption
- stormwater
- wastewater; and
- groundwater

The City of Melbourne residents and business people are encouraged to take action and get involved in the following programs:

- water conservation – residential
- water conservation – commercial

[32] ***http://www.melbourne.vic.gov.au/info.cfm?top=120&pg=1638***

- Water Sensitive Urban Design guidelines
- Waterwatch
- Sustainability Street
- Savings in the City

The following summaries of the above water programs have been downloaded from the website: www.melbourne.vic.gov.au/info.

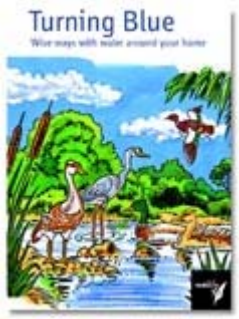
Water Conservation - residential

Residential water saving ideas around the home includes:

- install a AAA showerhead to save six litres a minute;
- reduce water pressure on taps and meters;
- install dual-flush toilets;
- sweep instead of hosing concrete;
- plant species that don't require as much water, mulch garden beds and install irrigation systems that use minimal water; and
- buy a AAA-rated front-loading washing machine. They use about 90 litres less water a load than the average top-loader machine. More handy hints on how to save water around the house are outlined in the publication, 'Turning Blue'.

Educational material

- Household water use calculator – 4 pages showing simple examples of how much each item/habit in the household uses water.
- Turning Blue – Wise ways with water around your home – 12 page public brochure focusing on water supply, stormwater, wastewater and ground water.



Rebates

- Rainwater tanks – as of 1 January 2007 rebates increased to $1,000.
  - 2,000 to 4,999 litre connected to toilet and/or laundry $500
  - 5,000 litre +, connected to toilet or laundry $900
  - 5,000 litre +, connected to toilet and laundry $1,000
  - Existing $150 rebate for tanks 600 litres or larger not connected for indoor use still applies.
- AAA shower roses, dual flush toilets, garden products, re-using household wastewater.

Water Conservation - commercial

Businesses are encouraged to carry out water audits to identify where and how much water is used so they can cut water consumption – and their running costs.

Commercial water-saving tips in the work place include:

- replace old toilets with dual-flush toilets to save an average of 4.5 litres a flush;
- install AAA dishwashers, upgrade appliances, install flow-control regulators, minimise the use of garbage disposal units and sweep floors instead of hosing them down to save water in commercial kitchens;
- install AAAA front-loading washing machines or ensure laundry items are washed with water-efficient appliances;
- use rainfall and reuse water by installing rainwater and grey-water systems. Reused water is best used for gardens and toilet flushing;
- install efficient air conditioning or use shading and smart design for buildings to reduce the need for air conditioning; and
- educate your employees about wise water use.

Additional industry-specific water-saving ideas include:

- do a water audit and review each industrial process to see where water and cost savings can be made;
- use sequential rinsing, where water used for one process is reused as rinse water in another compatible process;
- reuse outgoing water by channelling it to cooling towers and air pollution scrubbers; and
- replace water-based production systems with air-based systems where possible.

Business's can download a copy of the 'Is Your Business in the Blue' publication which gives useful tips on how they can reduce their water use.

Water Sensitive Urban Design Guidelines

The Water Sensitive Urban Design (WSUD) guidelines recognise that all water streams in the urban water cycle are a resource. It can assist to reduce water consumption, wastewater and the environmental impacts of stormwater on our waterways, while also maximising water reuse.

The WSUD outlines the following guiding principles:

- demand management – reducing the demand for water in our homes and businesses;
- 'Fit for Purpose' water use – using appropriate quality water for relevant purposes;

- the use of alternative urban water sources through rainwater harvesting, stormwater collection, greywater reuse and blackwater reuse; and
- applying stormwater best practice environmental management.

The guidelines have been created as:

- a handbook for residents, business and councils;
- a tool to help increase awareness and appreciation of Water Sensitive Urban Design;
- a way to inform and guide urban water management decision making processes;
- an educational document for Council staff and others involved in water management; and
- a demonstration of Water Sensitive Urban Design using innovative examples from within Council.

Waterwatch

Waterwatch is a national program in which residents, schools and community groups monitor and manage their local waterways. It is funded by the Federal Government's Natural Heritage Trust. In the City of Melbourne, Waterwatch is supported by the National Heritage Trust, Melbourne City Council and Melbourne Water.

The program aims to build community understanding of water-quality issues and encourage monitoring groups to take constructive action to rectify water-quality problems. Regular monitoring provides an awareness and increased knowledge of the impacts on waterways. It determines whether the quality is improving, declining or being maintained and can lead to positive initiatives for improving waterway quality.

Waterwatch coordinators help schools, individuals and community groups use water-quality monitoring equipment and assessment procedures. Participants monitor their waterways regularly through the year or take part in the twice-yearly "snapshot" of water quality held in April and October.

Sustainability Street

Sustainability Street is a community program that helps residents create a healthier, safer and more environmentally sustainable place in which to live. The program aims not only to develop environmentally sustainable ideas but create new social links between participants and strengthen existing community groups.

Residents, schools, businesses and community groups can all take part and work together to come up with aims and activities that will benefit your neighbourhood and improve the quality of your local area. The City of Melbourne, Vox Bandicoot and the Northern Alliance for

Greenhouse Action support the Sustainability Street groups through the provision of training, expert advice, program material, and assistance to form partnerships and apply for environmental grants.

For example, the North Melbourne Sustainability Street group's recent activities and highlights include organising a tour of the Visy – Banyule Material Recovery Facility (MRF) to learn about the recycling process; providing subsidised compost bins and worm farms to North and West Melbourne residents; and holding a community environment stall at North and West Melbourne's annual 'Spring Fling Festival 2006' where they handed out 200 calico bags and gave away a trolley full of 'green' household products.

Savings in the City

The City of Melbourne's **Savings in the City** is an innovative environmental program to help city hotels cut energy, water and waste consumption. The Savings in the City program provides leadership, support, recognition, toolkits and advice on environmental management.

Savings in the City offers the following components:

- Waste Wise
- Water Wise
- Energy Wise

Over 30 hotels and serviced apartments, large and small, are now participating in the pilot program. The Savings in the City program has resulted in significant savings:

- annually, close to 1200 tonnes of waste have been diverted from landfill, which is about 658 large skips of rubbish;
- more than 20 Olympic swimming pools of fresh water have been conserved in the first year of the program; and
- the total annual energy use by participating hotels has been reduced by more than 42,000GJ - this equates to about 11,200 tonnes of greenhouse gas, or the same amount of greenhouse gases generated by 933 average Victorian households each year.

Climate Neutral Water Saving Schemes

The City of Melbourne has produced an innovative discussion paper title 'Climate Neutral Water Saving Schemes'[33] on how to reuse water without increasing greenhouse gas emissions.

The discussion paper provides guidance for neutralizing greenhouse gas emissions from medium to large water saving schemes with a compendium to guide smaller domestic water saving schemes. The document outlines a 6 step process:

Step 1: Greenhouse gas audit – Undertake a water balance for the site and calculate baseline greenhouse gas emissions

Establish baseline for assessment from the embodied energy of the water consumed and wastewater generated (embodied energy is the energy consumed by all the processes associated with the production, transportation, use and disposal) and the biological degradation of wastewater (greenhouse gas emissions are produced by the biological treatment of wastewater).

For example, for Melbourne these have been worked out as:

GHG emissions (t CO_2-e) = PW x 0.173 + WW x 0.875

Water (ML/y)	Equivalent CO_2 generated (CO_2t/ML)
PW = Potable Water	0.173
WW = Wastewater	0.875

Step 2: Reduce Water Use (Demand management) – Reduce water demand and organic loading of wastewater

Greenhouse gas emissions associated with water treatment can be minimised by:

- Reducing water consumption and wastewater generation;
- Using alternative water supplies;
- Reducing organic material in wastewater (this can be achieved by educating commerce and industry about waste minimisation and cleaner production);
- Diverting organic waste from uncontrolled anaerobic conditions.

Step 3: Select an alternative water scheme and assess its greenhouse gas emissions

The greenhouse gas emissions are the sum of:

- The emissions from the energy consumption (treatment and pumping).
- Emission from biological degradation.
- Embodied energy for materials selection.

(Melbourne have calculated these factors)

[33] City of Melbourne, 'Climate Neutral Water saving Schemes, How to reuse water without increasing greenhouse gas emissions.'

Step 4: Consider on-site generation of renewable energy to service the water saving scheme, such as photovoltaics, wind, fuel cells and methane recovery & cogeneration

Step 5: Consider the purchase of accredited renewable energy. Victoria has electricity suppliers accredited Green Power^{TM} suppliers

Step 6: Consider offsetting emissions by purchasing carbon credits

Compendium – Simplified Process for Households

The document recommends a simplified process for households, comprising:

Step 1: Reduce Water Use
Step 2: Select an alternative water scheme and assess its greenhouse gas emissions
Step 3: Consider the purchase of accredited renewable energy

Example household calculation summary for a rainwater tank and harvesting system

Baseline assessment - Conventional	
	kg-CO_2e/y
Water	5.54
Wastewater	28.1
Sub-total	33.6
Water efficient option	
Water (mains supply)	0.41
Wastewater	28.1
Rainwater tank	24.8
Distribution (dual plumbing)	10.2
Sub-total	51
	kg-CO_2e/y
Net Increase	**18**

4.2.3 Sydney Water

The following information has been downloaded from the website: www.sydneywater.com.au, between August and October 2007.

Overview

Sydney Water has implemented demand management activities since the early 1990's. The first demand management strategy was developed in 1995 to meet a target of 329 l/pc/pd by 2011, a reduction of 35% from the 1990-91 baseline. The current average water use is around 340 l/pc/pd.[34]

Actual l/pc/pd are shown below in Figure 10. The impact of mandatory restrictions can be easily seen.

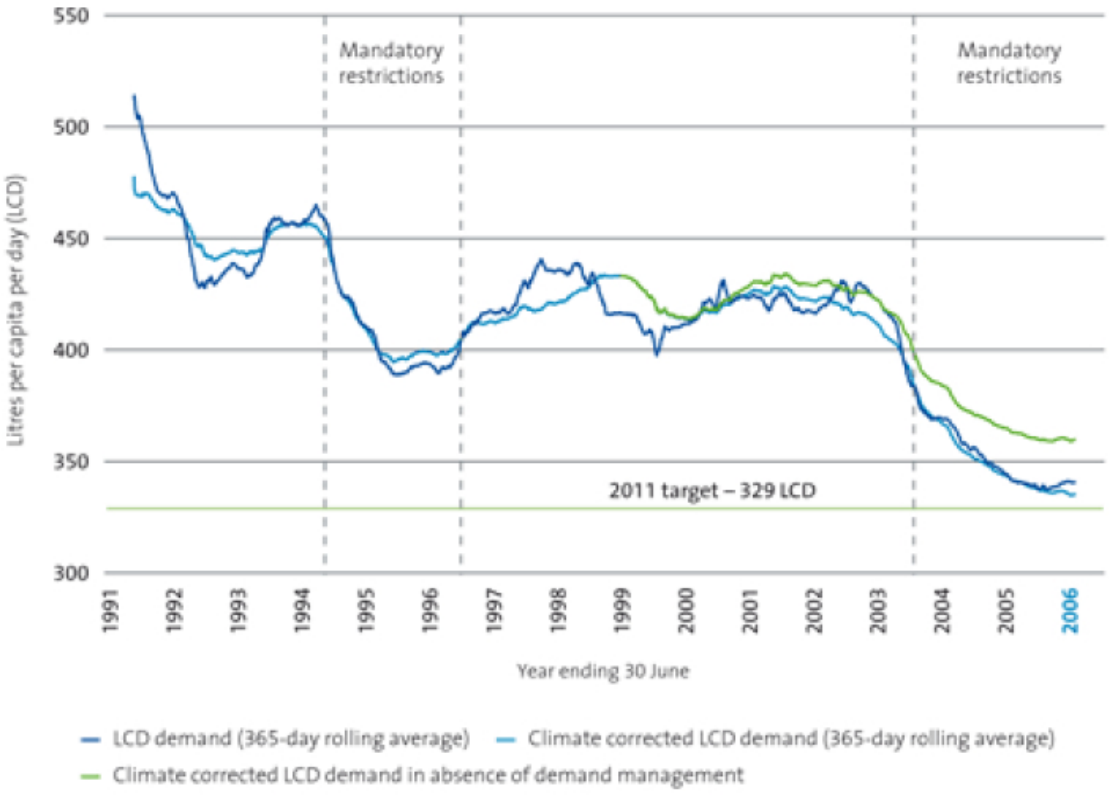


Fig 10: Litres per capita per day (LCD) from 1991 to 2006

Mandatory restrictions were put in place during 1995/96 and Level 3 water restrictions introduced in June 2005. Level 3 restrictions are:

> *'Hand-held hosing of lawns and gardens and **drip irrigation** is now allowed only on **Wednesdays** and **Sundays** before 10 am and after 4 pm.*

[34] ***http://www.sydneywater.com.au/AnnualReport/menu/performancesummary***

- *No other watering systems or sprinklers are to be used at any time.*
- *A permit from Sydney Water is required to fill new or renovated pools bigger than 10,000 litres.*
- *No hosing of hard surfaces including vehicles at any time.*
- *Fire hoses must only be used for fire fighting purposes – not for cleaning.*
- *No hoses or taps to be left running unattended, except when filling pools or containers.* ‘

The total volumes of water supplied versus population are given below in Figure11.

.

Fig 11: Total Water Supplied (GL) and Population, 1951 to 2006

In 2006, Sydney Water supplied approx 528,000 ML of water to 4.3 million customers, a per capita daily usage of 341 litres.

In 2005-06, estimated drinking water savings of more than 40,000 ML were achieved from the following areas:

- 18,500 ML in reduced leakage (3.5% of total water supplied)
- 8,000 ML with businesses, industry and governments to improve water efficiency and reduce water use (1.5% of total water supplied)
- 9,000 ML from residential programmes (1.7 % of total water supplied)
- 3,500 ML through water recycling (0.7 % of total water supplied)

A summary of Sydney Water's achievements are[35]:

- The people in Sydney Water are using the same amount of water now as in 1974. Even though there are an extra one million people living in greater Sydney.
- The average person has reduced their daily water use from 500 litres a day in 1991 to around 340 litres a day.
- 370,000 households have installed water efficient taps and fittings.
- 24,000 households have received rainwater tank rebates.
- 7,100 households received washing machine rebates.
- Since mandatory water restrictions were introduced in October 2003, customers have reduced their water use by more than 13%. This is equal to around six months water use.
- Over 360 of the biggest water users are in Sydney Water's Every Drop Counts Business Program. Together they are saving more than 12 billion litres of water a year.
- Sydney Water is spending $100 million a year to stop water leaks. This involves:
  - scanning 18,000 kilometres of water mains for hidden leaks
  - replacing around 75 kilometres of water mains a year in high priority areas
  - saving more than 56 million litres every day.
- Sydney Water has one of the best leak management programs in the world.

The water savings come from a mix of:

- Education
- Incentives and programs to increase recycling
- Increased water efficiency
- Water leakage

Education

The 'Every Drop Counts in Schools' program is a comprehensive 75 page teaching package with full lesson plans and documentation[36]. The 'Rainwater Tanks in Schools Water Audit' is a 55 page package with detailed worksheets and lessons for students. To date about 260 schools have signed up.

Residential Programs

[35] ***www.sydneywater.com.au/SavingWater***

[36] ***http://www.sydneywater.com.au/EnsuringtheFuture/WaterSchool***

Households use around 70% of water in greater Sydney. Sydney Water offers the following residential programs[37]:

- Free Water Saving Kit – Includes aerators, which are small devices that fit into your bathroom and kitchen taps and flow regulators, which are small devices that fit into your showerhead.
- WaterFix your home – From $22 a qualified plumber will visit your home to install water saving devices.
- Washing Machine Rebates – A $150 rebate to buy a water efficient washing machine.
- Rainwater Tank Rebate – Up to $1,500 for installing a rainwater tank in an existing home, and up to $2,500 for schools (see more details below).

Business Programmes

Sydney Water offers a formalised water saving process for business customers who spend more than $70,000 per year on water and related charges (equating to approx 100 kilo litres of water per day). The 'Every Drop Counts Business Program' consists of[38]:

- A voluntary business arrangement with Sydney Water
- Help with a 'diagnostic process' to evaluate business performance that examines 10 key areas of an effective water management system including
    - Identifying someone who will be responsible for water management within the business
    - Carrying out a water audit and identify key performance indicators and water reduction targets
    - Incorporating water efficiency and reduction targets into the environmental policy
    - Regularly monitoring and analyzing water use to identify trends or abnormal usage, such as leakage.

Water Leakage

Water leakage is the difference between the volume of bulk water supplied by water filtration plants and the volume of water delivered to customers. This figure is adjusted to include estimates for legitimate uses such as fire fighting and system maintenance, and the illegal use of water.

[37] ***http://www.sydneywater.com.au/SavingWater/InYourHome/***

[38] ***http://www.sydneywater.com.au/SavingWater/InYourBusiness***

According to the International Water Association's Water Loss Task Force (2005) "Australia's urban water utilities are world leaders in leakage management." Sydney's Leakage Reduction Program consists of:

- Active leak detection and repair
- Pressure management to reduce mains pressure in high pressure areas
- Improving response time to main breaks, and
- Additional flow metering.

Leakage is around 10% of total water drawn, see Figure 12 below.

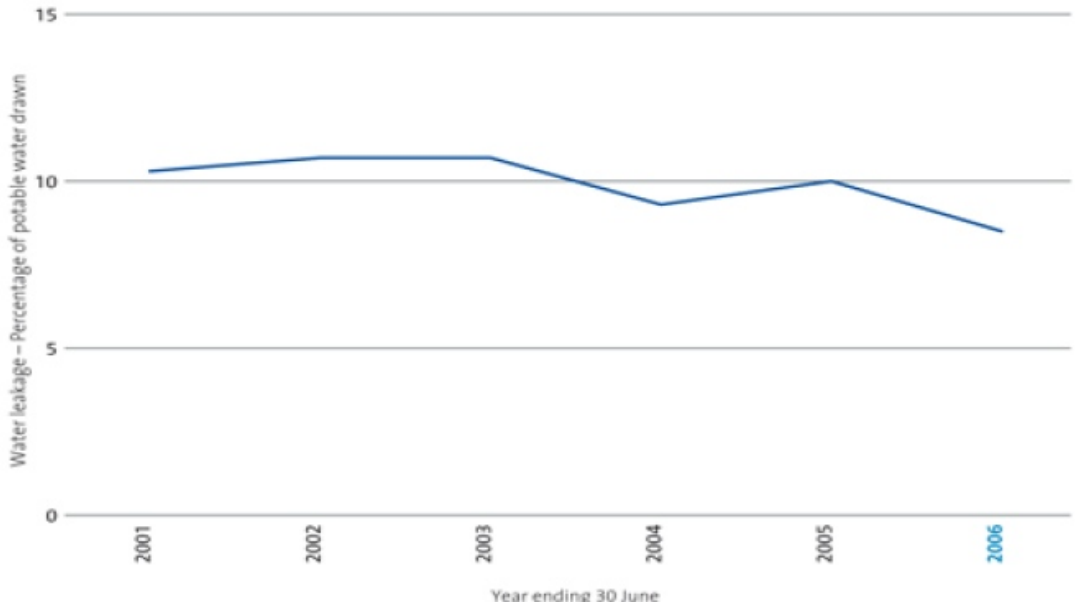


Fig 12: Percent Water Leakage, 2001 to 2006

Rainwater Tank Rebates

The maximum value for a residential rainwater tank rebate has recently increased from $800 to $1,500. This new rebate is for tanks bought and installed between 1 July 2007 and 30 June 2009. The rebate is made up of the following:

Tank capacity	
2,000 to 3,999 litres	$150
4,000 to 6,999 litres	$400
7,000 litres and above	$500
Internal connections	

- Tank connected by a plumber to toilet additional $500
- Tank connected by a plumber to washing machine additional $500

There is a separate rebate program for schools for up to $2,500. The minimum tank size is 10,000 litres with the following conditions:

- Complete a water conservation education program within 12 months of receiving the rebate or have done so in the last two years.
- Participate in or run eligible water conservation programs such as 'Every Drop Counts in Schools' and 'Rainwater Tanks in Schools Water Audit'.
- The tank connected to either a fixed irrigation system and/or frequently used student toilet block.

4.3. BASIX

Introduced by the NSW Government, BASIX is an online program that assesses a house or unit design, and compares it against energy and water reduction targets[39]. The design must meet these targets before a BASIX Certificate can be printed.

The BASIX tool is divided into three sections:

- Water
- Thermal Comfort
- Energy

For water, the reduction target ranges from 0 to 40% across NSW, depending on location. The target set depends on the differences in rainfall and evaporation rates as shown in Figure 13 for each area. 90% of new homes are covered by the 40% water target, and no new home built in NSW will use more water than the current state average. As of 1 October 2005 the BASIX applied to all new dwellings, including single dwellings, villas, townhouses and low rise, mid-rise and high rise developments in NSW. As of 1 October 2006, the BASIX applied to all residential alterations and additions throughout NSW.

[39] ***http://www.basix.nsw.gov.au/information/about.jsp***

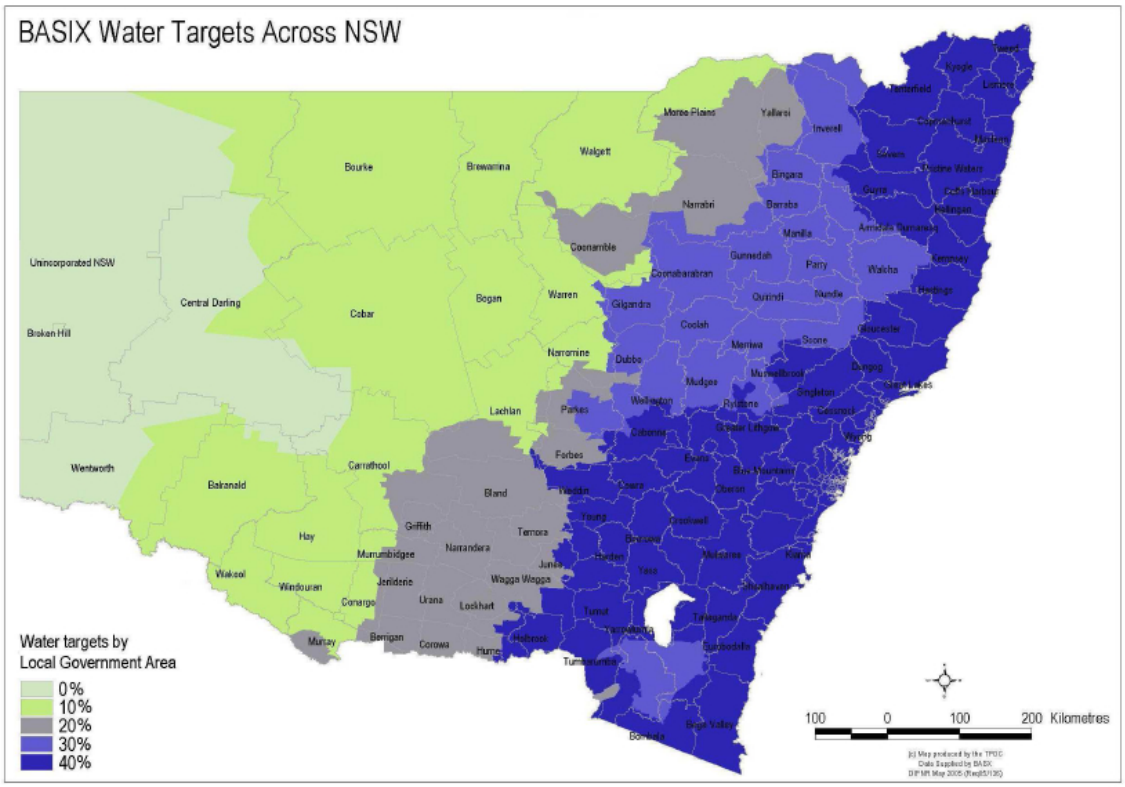


Fig 13: Percent Water Target Reductions across NSW

A typical single dwelling design will meet the target for water conservation if it includes:

- Showerheads, tap fittings and toilets with at least a 3A rating;
- Rainwater tank or alternative water supply for outdoor water use and toilet flushing and/or laundry. (In very dry areas of NSW, a typical single dwelling may not require a rainwater tank)

The water targets are based on a percentage of the average yearly water use in NSW of 90,340 litres of water (250l/pd).

Since implementation, the Department has conducted a monitoring program of 100 BASIX-compliant home designs that are now in the development approval and construction process. Items to note are that:

- Every home has a rainwater tank, the average size being 4,000 litres and the
- majority of which will be plumbed to the toilet and laundry, as well as providing water for the garden;
- 1 in 4 of these homes will have a solar hot water or heat pump system;
- Over 30% of the homes have included performance glass and double glazing;

- All homes are opting for efficient shower heads and tap fixtures, reducing water use and costs;
- Eaves, shading, insulation and other simple design features are making a welcome comeback.

5 Appendix 5: Council Questionnaire

Please mark the appropriate responses with an 'X' inside the text boxes.

1. What management model does your council use to provide water services?

a. Council Controlled Organisation ☐

b. Public Private Organisation ☐

c. In-house ☐

d. Other (please explain) ☐

2. What category best describes your water supply?

a. Fully reticulated ☐ b. Unreticulated ☐

b. Mostly reticulated ☐ d. Mostly unreticulated ☐

3. Are individual households metered?

a. Yes ☐ b. No. ☐

4. Do you have a water conservation programme?

a. Yes ☐ b. No. ☐

5. Which of the following techniques best describes how you implement your water conservation programme? ***(If more than one technique, please indicate most widely used from 1=always, 2=sometimes, 3=rarely, 4=never)***

a. Voluntary ☐

b. Incentives or subsidies ☐

c. Residential intensification (through resource consent processes) ☐

d. New Growth areas (ie. District Plan change) ☐

e. None ☐

f. Other

6. What are the 3 primary drivers for the water conservation programme?

(Please rate up to 3 where 1=greatest and 3=less important)

a. Supply constraints/source ☐

b. Political desire ☐

c. Infrastructure costs ☐

d. Environmental impacts (constraints ie. Climate, soil) ☐

e. Stormwater management ☐

f. Water quality ☐

7. If Beacon Pathway identified your council as a good candidate for a case study, would you be willing to participate?

a. Yes ☐ b. No. ☐

8. Do you have any general comments you would like to make about water conservation issues in your area / district?