ENVIRONMENT DESIGN GUIDE

SUSTAINABLE WATER USE – EFFICIENT THEN EFFECTIVE

Cynthia Mitchell, Andrea Turner and Stuart White

SUMMARY OF

ACTIONS TOWARDS SUSTAINABLE OUTCOMES

Environmental Issues/Principal Impacts

- Many of our large urban water systems now, or will soon, face a serious gap between projected demand and supply. The two key reasons for increasing demand are population growth and increasing recognition of the need to provide environmental flows. Predicted shifts in rainfall and evaporation patterns associated with climate change are likely to result in reduced inflow to existing water storages.
- Sustainable water systems are those which equitably meet society's water servicing needs, are cost effective for the whole of society and minimise the environmental impacts of water use. Sustainable water systems therefore maximise efficiency first, supplying the minimum volume required to meet the service need. Then, sustainable water systems maximise effectiveness, optimally matching the quality of demand and supply.
- From a cost perspective, efficiency is almost always cheaper than replacing or augmenting existing potable water systems with a new alternative supply.
- From an environmental perspective, efficiency is always preferable because fewer resources (energy, chemicals, materials) are required to treat and transport the water, regardless of its quality.
- New regulations and rating tools have emerged which seek to encourage sustainable water systems. These tools and regulations are constrained by their need to be widely applicable, whilst enabling appropriate contextual responses.

Basic Strategies

In many design situations, boundaries and constraints limit the application of cutting EDGe actions. In these circumstances, designers should at least consider the following:

- Water use is influenced by technology choices and behaviour. Designers can control and/or influence both, whereas regulations and design rating tools are limited to controlling just a subset of technology.
- Use the new national water efficiency labelling scheme to inform your choice of water efficient fixtures and appliances.
- Implement water efficient technology first, with a focus on greatest potential gain: specify water efficient fixtures throughout, starting with the shower and toilet.
- Specify water efficient landscapes and watering systems.
- Implement water effectiveness wisely: single lot scale responses of rainwater tanks and wastewater treatment and reuse are likely to be expensive, both to the individual and whole of society.
- Minimise water and energy losses through clever placement of hot water services and small bore piping.

Cutting EDGe Strategies

- Encourage water efficient technologies beyond regulations: encourage water efficient washing machines.
- Encourage water efficient behaviour in clients.
- Maximise the effectiveness of rainwater tanks by ensuring a sufficient roof area is connected to an appropriately sized tank. For south-east Australia, a reasonable starting point is 100 square metres of roof, and a two kilolitre tank for toilet flushing and laundry.
- To maximise cost and environmental effectiveness of alternative supplies, focus on precinct scale approaches, rather than lot scale.

Synergies and References

- BDP *Environment Design Guide*: GEN 56, PRO 25, NOT 6, DES 13, DES 14, DES 24, DES 43, TEC 11
- Related regulations: BASIX, 5 STAR
- Related rating tools: Green Building Council GreenStar; NABERS

ENVIRONMENT DESIGN GUIDE

SUSTAINABLE WATER USE – EFFICIENT THEN EFFECTIVE

Cynthia Mitchell, Andrea Turner and Stuart White

Sustainable water systems will meet water service needs at the lowest cost to society and with the lowest environmental impact through maximising water use efficiency first, then maximising water use effectiveness, optimally matching the quality of demand and supply. Recent regulations and tools can help, and are reviewed against these goals. Building design professionals can help more: they are uniquely positioned to influence technology and behaviour, the key water use factors. This note was written by the Institute for Sustainable Futures and replaces the original DES 27 Note which was written by Deni Green in June 1999 and reviewed by David Hood in January 2005.

1.0 INTRODUCTION

Water is a finite resource. Most of Australia's capital cities are facing potentially severe water shortages. Or are they? Certainly our cities are facing potentially large imbalances between demand and supply in conventional terms. In this Note, we look a little deeper, behind the alarm bells and quick-fix responses, to identify the issues and opportunities for restoring the waters, and the role that building design professionals can play.

2.0 URBAN WATER INFRASTRUCTURE AT THE CROSSROADS

Physical infrastructure is a necessity for all stationary communities – it is in part what enables us to congregate in ever-increasing numbers. Urban water infrastructure is now at a crossroads. In this section, we outline the nature of the looming gap between demand and supply, explain the reasons for the gap, and outline the conceptual shifts that are occurring in the water industry that enable qualitatively different responses in line with new sustainable water goals.

2.1 The supply demand gap

Many of our large urban water systems either now – or will soon – face a serious gap between projected demand and supply. There are two key factors: demand continues to grow, whilst climate change is likely to reduce the available supply. These are explored in more detail below.

Existing potable water supplies in Sydney, Perth, Adelaide, and the Gold Coast are reaching their limits in terms of supplying current dependent populations. As we look to the future, demand for water grows because of:

- increasing populations (e.g. NSW Department of Infrastructure Planning and Natural Resources (DIPNR) Metro Strategy [2004a] suggests 1000 new people each week in Sydney's urban area); and
- increasing recognition of the need to provide more environmental flows (e.g. NSW DIPNR [2004b], South East Queensland Regional Water Quality Management Strategy Team 2001).

Meanwhile, climate change may be influencing the reliability of the existing supply systems. Perth's experience of the last 20 years is that major reductions in inflows to water storages have already occurred, and have reduced on average by 50 per cent since 1975 (Water Corporation of WA, 2004). For south-eastern Australia, where most of our people reside, best guesses at present are that total rainfall will either stay the same or decrease; and changes in rainfall and evaporation patterns will lead to reduced runoff, further decreasing the reliability of existing water storages (AGO, 2002; Pittock, B [ed] 2003).

There are three qualitatively different responses to this highly constrained situation:

- increase water use efficiency (i.e. decrease demand, perhaps even to the point of moving to water-free services);
- substitute potable water with reclaimed wastewater or stormwater of adequate quality; or
- find new potable water sources (i.e. new dams, groundwater sources, or desalination plants).

All three of these (water conservation, source substitution, source augmentation) will be significant contributors to the solution. Some combination of all three will likely be necessary in the long term. Our interest is in where to focus in the short term, and in particular, where building designers can focus, to provide the best long term social, economic and environmental outcomes.

2.2 Conceptual shifts

There are three conceptual shifts occurring now that represent opportunities to rethink our responses: water supply has been thought of in terms of volume rather than service, water has taken a linear path through our society rather than a cycle, and water infrastructure has been highly centralised, rather than distributed. Also, according to some, it has also been inadequately maintained. These new ways of thinking about water (service, cyclical, and distributed) enable us to create new sustainable water concepts.

When people use water, they are interested in the task, or service, they want the water to achieve – clean clothes or a clean body. In other words, demand for water is a derived demand: the volume of water required to complete the task is secondary. Planners, however, have historically focused on supplying a volume. Focusing on the nature of the service opens the possibility of

The BDP Environment Design Guide is published by The Royal Australian Institute of Architects

achieving the same outcome with a smaller volume or a lower quality of water, consistent with increasing water use efficiency and/or substituting potable water for other sources (Mitchell and White, 2003). Toilets are a good example: in the last decade or so, mainstream toilet technology has moved from a single flush volume of 11 litres to dual flush volumes of between 3 to 4.5 litres, reducing the water used by around two-thirds.

The path of water through our cities and towns has tended to be linear. Linearity is encouraged by the highly centralised nature of the existing water infrastructure in Australia. Typically, for our major cities and towns, there are one or two major water storages and a complex water distribution network, followed by a similarly complex sewage collection system, leading to one or two major wastewater treatment plants, and, for the most part, disposal rather than reuse. This also means we invest heavily in transport of water and wastewater, rather than treatment and reuse.

There are varying views about the state of our major water infrastructures, but few, if any, suggest they are in good health overall. One independent review, Engineers Australia's national infrastructure report card (Institution of Engineers Australia, 2001) has for some time suggested that these vital investments are being inadequately maintained. The Business Council of Australia (2005) suggests "…the current state of Australia's most fundamental infrastructure… water supplies, and the basic facilities to support growing and spreading urban communities – is in urgent need of reform, repair and expansion." Sydney Water Corporation's recent tender for retrofitting water mains (Sydney Water Corporation, 2004) suggests that some are approaching the end of their useful life. That is to be expected of course. The issue is timing: some suggest that a large proportion of our underground water assets are at this point already, and that we are just beginning to realise the massive looming cost of maintaining and replacing our buried infrastructure. For water and wastewater infrastructure replacement in the USA, some estimates put the cost at USD$1 trillion over the next 20 years (American Water and Wastewater Association, 2001, p17). In addition, expenditure on repairs is expected to treble because ageing pipes are more prone to breakage.

Responding to these constraints presents an opportunity to rethink the highly centralised nature of current infrastructure, and to consider investing locally (Berry et al, 2004). For water, this means co-locating sources and end uses, investing in distributed generation and treatment, rather than transport and disposal. The latest national and international approaches to managing urban domestic wastewater begin with a growing acceptance of small single-lot and cluster systems as valid long-term alternatives to sewer and centralised systems. Decisions about the most appropriate scale system for sustainable urban domestic wastewater management for a given location are complex. Nonetheless, there is growing support for smaller scale systems due to their demonstrated advantages in closely matching capacity to need, flexibility to recycle water, qualitatively different risk profiles, and community involvement at a local level (Etnier et al, in press). In addition, distributed solutions can cost society less than the conventional centralised approach (Fane, 2005).

2.3 The new water goals

All this can be summed up in the new water goals, which clearly align with the reduce, reuse, recycle hierarchy:

- meet water service need at lowest cost to society;
- maximise water use efficiency first;
- then maximise water use effectiveness (i.e. minimise environmental impacts associated with water service provision and water cycle management through matching water quality demand and supplies); and
- recapture nutrients for reuse and close nutrient cycles. Global phosphorus deposits are expected to deplete in the next 50-80 years (Birch, 1976). The mass of phosphorus that leaves Sydney's sewage treatment plants each year is said to be roughly equivalent to the mass of phosphorus used annually in broad acre cropping in NSW, and therefore represents a significant potential resource.

In the following sections of this Note, we focus on the first three goals, demonstrating why efficiency measures should be implemented first, identifying low cost approaches, reviewing recent regulations and tools against these goals, and showing where designers can intervene to make a difference.

3.0 DEMONSTRATING THE DIFFERENCE

Publicly available information can be used to demonstrate the difference in costs and environmental impact between the popular options proposed to respond to demand supply imbalance. Typical current responses from Australian water utilities and government agencies include a desalination plant, effective rainwater tanks, efficient washing machines, efficiency retrofits in existing houses, and efficiency in new houses. We analyse each of these options below.

3.1 The cost difference

Since water services in Australia are supplied to the community by government owned businesses operating in monopoly situations, these services should be provided at the lowest cost to society as a whole. So, analysis of costs and benefits should be based on whole of society costs, that is, include all the costs and savings to society associated with making an extra kilolitre of water available for a new use. We are interested in the marginal cost to society (the water utility, the developer and the consumer) to make one more kilolitre available, and are also interested in the savings (the avoided costs) associated with producing less water from existing infrastructure. This is explained in more detail below.

3.1.1. Marginal costs

We are interested in what extra investment is required, above and beyond that which would already happen, to shift from water inefficient and/or water ineffective towards efficient and effective water use. For example, on average, Australian households purchase a new washing machine about every eight years. So, we are interested only in the additional cost associated with choosing a water efficient washing machine over a water inefficient machine. In the case of alterations/additions and new homes, new appliances will be specified and installed anyway. The cost included here is only the additional cost associated with specifying water efficient appliances over water inefficient appliances. This is the extra investment required to free up that extra volume of water at the source for new uses. Often, this extra investment is zero – that is, in many cases, efficient and inefficient appliances cost much the same.

3.1.2 Avoided costs

For the rainwater tank, front loading washing machine, retrofit, and efficient new house examples, there are operating and capital cost savings for the existing water treatment and distribution works. Operating cost savings occur because these initiatives 'save' water from needing to be treated and distributed. For water efficiency options associated with indoor uses, a similar effect occurs for the sewers, that is, there is a reduction in flow to the sewers, which means a smaller volume of sewage to be collected and treated, resulting in further cost savings. In contrast, the desalination plant represents new treatment capacity, and does not substitute for any existing treatment capacity, so it does not avoid any existing operating costs. Capital cost savings can occur when reductions in peak and average demand for water and wastewater allow new capital works to be deferred, downsized, or avoided altogether.

The costs for each option were analysed over a 25 year period, using a discount rate of seven per cent. The results are insensitive to significant changes in these parameters: increasing the time frame to 40 years to reflect longer infrastructure life or reducing the discount rate to five per cent to reflect lower costs of capital reduces all of the unit costs by around 10 per cent. Because avoided costs are highly specific, and linked to particular local contexts, they have been excluded from this general analysis. Including them will not materially change the rank order of the results in most cases. Figure 1 draws this analysis together, and demonstrates that rain water tanks are a costly option when used as an add-on to existing water infrastructure. In contrast, rain water tanks and distributed wastewater and stormwater reuse are germane to the cost-effectiveness of new integrated water service systems (Mitchell and White, 2003). Figure 1 shows desalination is also costly, relative to the efficiency options. The take-home message here is that efficiency options are by far the most cost effective, both for the whole of society and the customer, and that integrated approaches are necessary to ensure the cost-effectiveness of alternative supplies.

We explain and validate the assumptions for each of the following typical options.

The desalination plant is modelled on the information available for Perth's planned augmentation. We have assumed capital costs of $387 million (Watercorp, 2005b), annual operating costs of $24 million (Watercorp, 2005a), and a yield of 45 gigalitres per annum (Watercorp, 2005a).

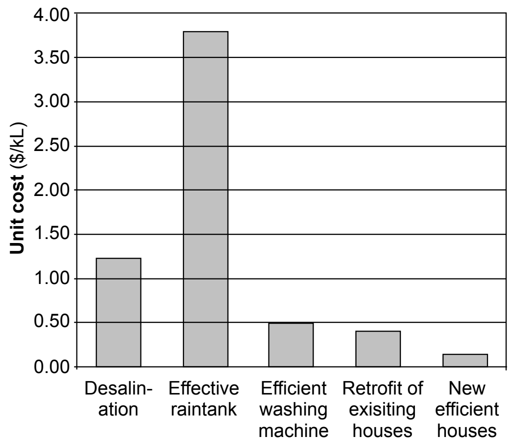

Figure 1. Relative unit costs for various water efficiency and source substitution examples

For the rain water tank case study, we assumed effective tank installation. This is achieved by connecting the tank to indoor water uses with a demand greater than the supply available, so that at all times there is maximum capacity available in the tank for capturing rainfall. With this approach, a two kilolitre rainwater tank connected to 100 square metres of roof area (roughly half the roof area of a new detached house) will capture all available rain (losses and first flushes notwithstanding), thereby maximising the effectiveness of the investment. When modelled as supplying water efficient toilet and laundry, using a daily timestep and 40 years of historical rainfall data for Melbourne (670mm/annum average), the available supply is 32 kilolitres per annum. We used recently published data for rain water tank installation costs in Melbourne (Grant and Hallman, 2003) at $1270 for installation, pump replacement after 15 years at $570, with electricity operating costs at three dollars each year.

The front loading washing machine example assumes that the average difference between the price of a water efficient front loader and a water inefficient top loader is $100 now, $50 in eight years, and zero thereafter, consistent with assumed trends at present. Recent evaluation studies (not yet released) show water savings around 24 kilolitres per household per annum.

For the retrofit program, we used Sydney Water's 'Every Drop Counts' as the model. This program involves retrofitting a new water efficient showerhead, toilet arrestor, and tap aerators. We know from evaluations of actual households (Turner et al, 2004) that the savings are on average 21 kilolitres per household per annum. Because this is an intervention that would not otherwise have happened, we need to include the whole cost of the new fittings and labour to install the fittings and run the program: $105, $80 for the water utility and $25 for the customer, encompassing the cost of new parts (showerhead etc) and labour. For comparison, if the 4.5 million existing residents in Sydney took up the retrofit program, the total water savings would be around 35 gigalitres per annum – in the same ball park as Perth's desalination option in volume terms, but at around one-fifth of the cost to society.

Finally, for new efficient houses, we assumed savings of around 35 per cent of current average in Sydney i.e. 85

kilolitres per household per annum. This is consistent with expectations for efficiency savings in forthcoming new developments of Aurora Melbourne (Melbourne Water, 2004) and Pimpama Coomera (Apostolidis, 2003). Both these developments plan to use source substitution also, taking their overall savings from existing potable supplies to much higher levels. Because these new houses would have had new fittings anyway, we include only the marginal cost associated with water efficient showers, toilets, taps, and garden watering, which we estimate to be $150 up front.

3.2 The environmental difference

When thinking about water efficiency, the focus is on quantity; for water effectiveness, the focus is quality. For both, the key is to match the demand and the supply. In environmental terms, water conservation is preferable to source substitution for the very simple reason that less water means less everything else: less energy and chemicals for water and sewage treatment, less energy for distribution and collection (even for a rain water tank), and less infrastructure.

Then, when we choose a different water source, the best environmental outcome is associated with matching the qualities demanded and supplied in order to minimise the treatment before re/use. The key is to focus on the particular constituents that characterise particular demands and supplies. For example, the level of dissolved salts in rainwater is particularly low. A water use that could benefit substantially from low salt concentrations is cooling towers. So, in commercial buildings, the rain water tank could be hooked up to cooling tower use with a conductivity meter to control cooling tower blowdown. Salt concentration is what limits the number of cooling tower cycles. So, starting with a lower salt concentration means potentially more cycles, and therefore less water demand overall, maximising efficiency first through clever matching of demand and supply.

In more general terms, there is rapidly increasing interest in treating and reusing water, from the single lot scale through to commercial buildings and whole subdivisions. A common approach is to collect sewage and treat it to a very high standard in order to minimise the microbial risks associated with reuse. The typical use for this recycled water is toilet flushing first, and then clothes washing or garden watering. Sewage is a very low quality used water, with significant microbial, organic, and chemical contamination. To bring this potential resource right back up to the top of the water quality scale on all three of these contaminant scales requires significant energy and chemical inputs; much more, in fact, than the potable source we are seeking to replace. Because stormwater is less contaminated than sewage, it may be a better starting point, but its availability is also less predictable than that of sewage. At any rate, the argument about 'less is more' takes on even more importance, and efficient use of recycled water becomes paramount.

A major issue confronting the move towards more sustainable water use is the difference in the opportunities between new and existing developments. Greenfield sites can support quite radical innovations, particularly in source substitution, that are either impractical and/or uneconomic in a retrofit context.

4.0 REGULATIONS AND RATING TOOLS

In this section we give a brief overview of recent regulations and rating tools, as they relate to achieving the new water goals. All the regulatory and rating tools discussed here shared the principle of focusing on the outcome (performance) and minimising prescriptive input. All regulations and rating tools suffer from a similar quandary: to be widely applicable and widely usable, they must simplify the assessment process. The challenge is to do so in a way that maintains the intent of encouraging movement towards more sustainable practice; in this case, efficient and effective and least cost water use.

4.1 Regulations

BASIX

On July 1 2004, BASIX, a web-based planning tool (NSW Department of Infrastructure, Planning and Natural Resources [2005]), became the lead development application consent mechanism for all new detached homes within the Sydney metropolitan region. Extensions of the concept to multi-residential and commercial buildings are expected in the near future. BASIX takes a life cycle approach to estimating and evaluating water and energy consumption over the life of the house. Because it takes effect at the point of development consent, it necessarily focuses on the water fixtures that once specified and installed, are likely to remain unchanged (e.g. showers, toilets, taps, some landscape elements). This makes it a rather blunt instrument in terms of achieving the key goal of maximising water efficiency, because, as a regulatory instrument, it ignores water efficiency opportunities beyond its control (e.g. washing machines and landscape compliance). That means both efficiency and source substitution are necessary to meet the target of a 40 per cent reduction in demand, relative to the Sydney-wide average, from potable sources. BASIX' point scoring system allows flexibility in how the target is met. However, because source substitution options cost significantly more (in both dollars and environmental impacts) than efficiency options, the savings from BASIX come at a premium.

5 STAR

Victoria introduced the '5 Star Energy Smart Homes Policy' in July 2004. Under this regulation, all new homes need to meet '5 Star' energy rating on the FirstRate tool, and should achieve 25 per cent water savings. The focus of this initiative is energy, which is well documented. In contrast, the benchmark for the water reductions is not clear, and there is little guidance about how to achieve or monitor the savings. Householders must choose between a solar hot water service and a rain water tank connected to toilet flushing. Currently, renewable energy credits are available for the solar hot water heaters, but not for rain water tanks attached to new houses, so the financial incentive for householders is to choose the solar hot water heaters. In fact, since Victoria's average electricity mix has the highest greenhouse gas emissions in the country, and hot water becomes an even larger component of the operating energy in '5 Star' homes, solar hot water services are likely to provide a better outcome in environmental sustainability terms than a rain water tank.

4.2 Rating tools

NABERS

The National Australian Built Environment Ratings Scheme (NABERS) is explained in the EDG Note, GEN56. It assesses operational environmental impacts of buildings, and therefore covers both technologies and behaviours. Originally developed under the auspices of the national Department of Environment and Heritage, it now rests with the NSW Department of Energy, Utilities, and Sustainability, which has responsibility for commercialising the tool. The status of this process is unclear at present. In the 2003 release, water is encompassed in four NABERS categories: water use, stormwater runoff, stormwater pollution, and sewage outfall volume. In the water use and sewage categories, NABERS prioritises efficiency over source substitution, in line with the new water goals (Department of Environment and Heritage, 2004).

GreenStar

The Green Building Council of Australia released its GreenStar Office Design Tool in 2003 (see http://www.gbcaus.org/). Since then, various other tools have been released, and more are planned. To date, the tools focus on commercial buildings, and the intent is to extend to residential buildings soon. As a design tool, it focuses on the technologies specified and installed, rather than on behaviour.

Water is dealt with in two ways in GreenStar: through the water credits category, and through the emissions category. In the water category, credits are available for indoor water use (efficiency and/or source substitution), cooling towers (either reduced energy demand or increased efficiency of operation or supplied with non-potable water), landscape (either efficiency or source substitution), firewater reuse, and installing additional water meters for all major water uses and/or water users. In the emissions category, credits are available for reductions in flow to sewer, either through efficient fixtures or onsite treatment and reuse.

So, GreenStar tends to treat efficiency gains and source substitution as interchangeable. In some categories, more points are awarded for source substitution than efficiency. Like BASIX, there is no opportunity to account for local context. That is, if the local water or sewage system is at the point of requiring augmentation, then investing in new distributed supplies (e.g. rain water tanks or effluent reuse) or treatment systems (e.g. blackwater treatment) can be good sense. For the most part though, investing in source substitution without considering this context can mean sub-optimal outcomes from both a cost and environmental perspective. Nonetheless, GreenStar has played a major part in the swing towards sustainability generally in the commercial building sector.

5.0 HOW CAN BUILDING DESIGN PROFESSIONALS HELP TO ACHIEVE THE NEW WATER GOALS?

In this section, we adapt Covey's concept of Circles of Control, Influence and Concern to identify concrete actions that building design professionals (BDPs) can take to help them and their clients meet the new water goals (Covey, 1990).

5.1 Factors influencing water use

The shift in thinking about water from a 'volume' to a 'service' requires a focus on how water is used, by whom, and for what purpose. That means, start by identifying all the uses of water in the home, office, or industry, and all of the factors that influence how much and what kind of water is used. Figure 2 shows the range of

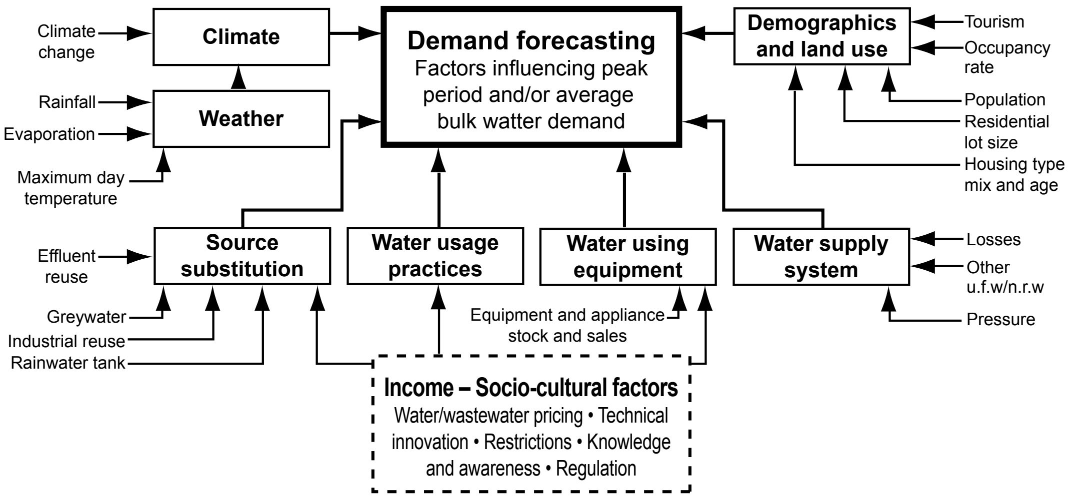

Figure 2. Factors which influence how much and what kind of water is used (White et al, 2003)

factors that influence how much and what kind of water is used (White et al, 2003). The factors are very wide ranging, from climate change to the water utility's losses (marked as u.f.w, (unaccounted for water) and n.r.w (non revenue water).

What we are interested in here is identifying the places where building design professionals can intervene to help to deliver more efficient and effective water use. So, to explain these ideas in another way, we focus on the two primary influences on water use: technology related (water using equipment, source substitution, water supply system, land use) and behaviour related (water usage practices, climate, demographics). In Figure 3, we show a sample spectrum of technology and behavioural shifts that would result in more efficient and effective water use in residential settings.

The idea here is that water efficient technologies and water efficient behaviours are *both* necessary to deliver water efficient outcomes overall. Technology is easier to control, so it is where we all should start, and it is where we should regulate to ensure water efficient outcomes. Behaviour is hard to control, but open to influence, and because it is a key factor, it needs to be part of any effort to arrive at efficient and effective water use.

5.2 Building design professionals' opportunity to affect water using factors

In Table 1, we overlay factors influencing water use, with building design professionals' potential to affect those factors. We do this using the idea, adapted from Covey, of building design professionals' circle of control, influence, or concern (Covey, 1990). According to Covey, factors which are within the circle of control are exactly that: we can determine the outcome. Within the circle of influence, we have a say in what happens, so we can affect but cannot determine the outcome. Within the circle of concern, we are certainly still interested in the outcome, but we have effectively no opportunity to affect the outcome.

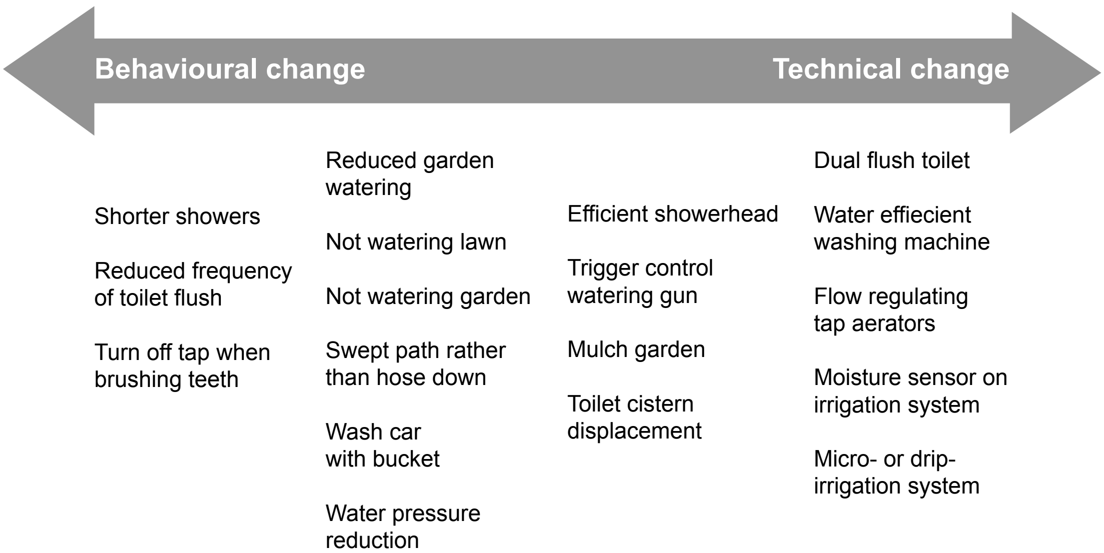

Figure 3. A sample of behavioural and technological changes associated with efficient and effective residential water use (White et al, 2003)

<table>
<tr><th rowspan="2">Factors</th><th colspan="3">Building Design Professionals' Circle of</th></tr>
<tr><th>Control</th><th>Influence</th><th>Concern</th></tr>
<tr><td>Water using equipment</td><td>Indoor: Showerheads, toilets, taps, sinks, dishwashers
Outdoor: Landscape design</td><td>Washing machines</td><td></td></tr>
<tr><td rowspan="2">Demography and land Use</td><td colspan="2">Housing type</td><td>Population, occupancy, tourism</td></tr>
<tr><td colspan="3">Lot size</td></tr>
<tr><td>Source substitution</td><td colspan="2">Rain water tanks, greywater reuse
Commercial – industrial reuse</td><td>Effluent reuse</td></tr>
<tr><td>Water using practices</td><td colspan="2">Knowledge and awareness</td><td>Pricing, regulation, restrictions, technology innovation</td></tr>
<tr><td rowspan="2">Water supply system</td><td colspan="3">Losses</td></tr>
<tr><td></td><td>Pressure</td><td>Other unaccounted-for-water</td></tr>
<tr><td>Climate</td><td></td><td></td><td>Weather
Climate change</td></tr>
</table>

Table 1. Mapping water use factors to building design professionals' circles of control, influence and concern

5.2.1 Specifying water efficient equipment

Specifying efficient water using equipment is a key opportunity for building design professionals. The Water Services Association of Australia has run a voluntary labelling program since 1997. However, the newly released national Water Efficiency Labelling Scheme (WELS), (Department of Environment and Heritage, 2005) will help greatly because it mandates efficiency labels on **all** water using equipment – for the first time, consumers and designers will have the information they need to make informed choices.

To make the greatest gain, we should first target the water uses with the greatest volume. For indoor water uses, a rough rule of thumb is that showers use around one-third of the total, toilets and washing machines use around one-quarter each, and the other uses (bath, bathroom basin, kitchen sink, dishwasher, laundry sink) together make up the remainder.

The most effective outcome then would be to ensure water efficient showers, toilets, and washing machines. Some water using fixtures are easier to regulate than others: that's why BASIX focuses on efficient showerheads, toilets, and taps. However, the development approvals process that BASIX oversees is an inappropriate point to regulate for potentially discretionary water using appliances, like washing machines. This is where the building design professional can step in, and seek to influence their client's choices in order to maximise their water efficiency. In other locations around Australia, they have the opportunity to take the lead, specifying the newest, high performing water saving technologies, such as the new 4.5/3 litres dual flush toilets. EDG Notes PRO 25 and NOT 6 have further detailed information about water efficient appliance specification and information.

Outdoor water use varies greatly according to climate: in Alice Springs, garden water use is around 65 per cent of total residential water use, or 450 litres per household per day, (Turner et al, 2003), whereas in Sydney, it is typically 35 per cent, or 100 litres per household per day (Turner et al, 2004). Within a given climatic region, there is also much variation, according to wide ranging factors including physical factors like lot size and garden type, but just as importantly, a range of socio-economic and cultural factors, like income, personal preferences, family status, and so forth. Regardless of all of these, the opportunity for the building design professional is to design in a water efficient landscape in collaboration with their clients. Water efficient landscaping approaches are described in detail in the Notes DES 13, DES 14 and DES 43. The new Smart Approved WaterMark (2005) scheme, a collaboration between the Water Services Association of Australia, the Nursery and Garden Industry Association, the Irrigation Association of Australia, and the Australian Water Association, specifically targets best practice outdoor water products and services.

5.2.2 Choosing new sources wisely

Once efficiency has been maximised, building design professionals can turn their attention to new water sources. For existing scenarios at the single lot scale, our analysis showed that rain water tanks are an expensive means of securing a new source. The unit costs for single residential greywater re-use schemes are similarly expensive (Mitchell et al, 2002). In addition, these costs are borne primarily by the individual household. In contrast, where new infrastructure is required, for example for a new subdivision, rainwater and reclaimed wastewater and stormwater are key components of cost-effective integrated sustainable water systems. The environmental impacts of rainwater tanks are lower than those associated with greywater or blackwater treatment and reuse.

The key thing the building design professional can either control or at least influence is the effectiveness of the investment. For rainwater tanks, this occurs when they are installed in locations where the annual rainfall is consistent and greater than around 500mm, and in a way that ensures maximum capture: sufficient roof area to a sufficiently large tank, plumbed to an indoor, non-seasonal demand that is greater than the rainwater source. The optimal roof area, tank size, and end uses vary for different climates, but a reasonable starting point for south eastern Australia is 100 square metres, connected to a two kilolitre tank, plumbed to toilet and laundry or shower. For greywater reuse, there is a similar opportunity: maximise the investment effectiveness by collecting the best quality wastewater from both showers and laundry, and supplying to garden uses.

For commercial and industrial reuse, the situation is similar: building design professionals can either control or influence the choice of matching sources to demands. In multi-level residential and commercial buildings, the roof area is small relative to the water use in the building. Precinct-scale approaches may provide better rainwater capture outcomes than individual building approaches. For example, collecting rain water and fire safety water from several buildings could provide sufficient volume to meet the cooling tower demands of one building, enabling greater water efficiency of the site overall.

Greywater and blackwater treatment and reuse are described in more detail in the EDG Notes TEC 11 and DES 24.

5.2.3 Water using practices – enabling knowledge and awareness

The two categories above focused on influencing technology: efficient appliances and effective supply water quality. In this category, we focus on influencing behaviour. Meadows (1998) explains 'people can't respond to information they don't have. They can't react effectively to information that is inadequate. They can't achieve goals or targets of which they are not aware. They cannot work towards sustainable development if they have no clear, timely, accurate, visible indicators of sustainable development' (p5). So, to change behaviours, water users need useful information that helps them decide on their own efficient and effective responses.

Unlike government agencies and water authorities, building design professionals are in direct contact with clients and residents. Therefore building design professionals have a responsibility and an opportunity to provide useful information that helps their clients and residents to change behaviours. Changing behaviour is about learning, and learning belongs to the realm of practice and experience (Wenger, p229, 1998). Because building design professionals are firmly ensconced in the practical world of their clients and residents, their role in influencing behaviours is key.

The role is simple too. It is about either supplying or helping clients to locate useful resources, pointing to and talking about real examples and demonstrations, naming actual water efficient products… anything that enables the building design professional's clients and residents to learn through experience what kind of efficient and effective water use makes sense for their lifestyle.

5.2.4 Water supply systems – losses

The final category where building design professionals can exercise influence is in minimising losses from the water supply system. There are two kinds of losses: water itself, and energy. There are two kinds of water losses – those associated with leaks and those associated with unused water. Building design professionals can minimise water leaks through smart specification, e.g. small bore smart sewers. More significant are the opportunities for building design professionals to design and specify the plumbing to minimise the volume of water wasted whilst users wait for hot water, which will also minimise energy losses. One solution is to locate the hot water service close to the most frequent point of hot water use, which is usually the kitchen. Another solution is to minimise the diameter of hot water lines, down to as little as 13mm, and then to plumb separate lines to major end uses, like the bathroom and kitchen, in order to ensure pressure is always maintained at the point of use.

6.0 CONCLUSIONS

In this Note we have demonstrated that:

- both water efficiency and water effectiveness are necessary for sustainable water use
- it makes good environmental and economic sense to invest in water efficiency first, before investing in new water sources, even if regulations and rating tools fail to support this principle
- new water sources should be appropriately matched with the quality of water required by the end use
- building design professionals have many varied opportunities to use their control and influence to help ensure sustainable water use in our built environment.

REFERENCES

AGO, 2002, *Living with Climate Change: An Overview of Potential Climate Change Impacts on Australia*, Australian Greenhouse Office, Canberra, available online at http://www.greenhouse.gov.au/impacts/overview/.

American Water Works Association, 2001, *Dawn of the Replacement Era – Reinvesting in Drinking Water Infrastructure*, Denver.

Apostolidis, N, 2003, *Integrated water management – Pushing the boundaries*. Paper presented at Institute of Public Works Engineering Australia, Queensland Division, State Conference, Mackay 2003.

Berry, T, Campbell, S, Riedy, C, and White, S, 2004, *A New Distributed Infrastructure Services Market – Assessing Australia's Future Market Potential*, a discussion paper prepared by the Institute for Sustainable Futures for the Australian Council for Infrastructure Development.

Birch, C, 1976, Confronting the Future. *Australia and the world: the next hundred years*, Penguin Books, England.

Business Council of Australia, 2005, *Infrastructure Action Plan for Future Prosperity*, available online at http://www.bca.com.au/upload/BCA_Infrastructure_Action_Plan_for_Future_Prosperity.pdf.

Covey, S, 1990, *The seven habits of highly effective people*. New York, Simon and Schuster.

Department of Environment and Heritage, 2005, *Water efficiency labelling scheme*, http://www.waterrating.gov.au/index.html. Accessed 19 June 2005.

Department of Environment and Heritage, 2004, *National Australian Built Environment Ratings Scheme,* http://www.deh.gov.au/settlements/industry/construction/nabers/index.html. Accessed 19 June 2005.

Etnier C, Willetts J, Mitchell C, and Johnstone S (in press) *Decentralised wastewater system reliability analysis handbook*, National Decentralised Water Resources Capacity Development Project, United States Environment Protection Agency

Fane S, 2005, *PhD Thesis*, University of Technology Sydney.

Grant T and Hallmann, M, 2003, *Urban domestic water tanks: life cycle assessment*, Water Vol 30 No 5 August 2003.

Green Building Council of Australia, 2005, http://www. gbcaus.org/ accessed 24 June 2005.

Institution of Engineers Australia, 2001, *2001 Australian Infrastructure Report Card*, Alliance Partners, available on-line at http://www.ieaust.org.au/library/institution_pubs.html.

Meadows ,D, 1998, *Indicators and Information Systems for Sustainable Development: A Report to the Balaton Group.*

Melbourne Water, 2004, *The Source*, a magazine by Melbourne Water, Issue 31, August 2004, available online at http://www.melbournewater.com.au/content/library/publications/the_source/the_source_issue_31.pdf.

Mitchell, C, Mitchell, G, Shipton, R, Speers, A, Turner, A and White, S, 2002, *Edmondson Park Feasibility Report*, a report prepared by the Institute for Sustainable Futures and CSIRO for Sydney Water Corporation.

Mitchell, C and White, S, 2003, *Forecasting and Backcasting for Sustainable Urban Water Futures*, Water Vol 30 No 5, August 2003.

Mitchell, C A, Turner A, Cordell D, Fane S, and White S, 2004, *Water conservation is dead: long live water conservation*, 2nd IWA Leading-Edge Conference on Sustainability in Water-Limited Environments. Sydney, 8-10 November.

NSW Department of Infrastructure, Planning and Natural Resources, 2004a, *Metropolitan Strategy Discussion Paper.*

NSW Department of Infrastructure, Planning and Natural Resources, 2004b, *Water and Sydney's Future: Balancing the values of our rivers and economy*, final report of the Hawkesbury-Nepean River Management Forum.

NSW Department of Infrastructure, Planning and Natural Resources, 2005, BASIX, http://www.basix.nsw.gov.au/information/index.jsp Accessed 24 June 2005.

Pittock, B (ed), 2003, *Climate Change: An Australian Guide to the Science and Potential Impacts*, Australian Greenhouse Office, Canberra, http://www.greenhouse.gov.au/science/guide/index.html.

Smart Approved WaterMark, 2005, http://www.smartapprovedwatermark.info/ accessed 24 June 2005.

South East Queensland Regional Water Quality Management Strategy Team, 2001, *Discover the Waterways of South-East Queensland: Waterways health and catchment management in South-east Queensland, Australia,* South East Queensland Regional Water Quality Management Strategy.

Sydney Water Corporation, 2004, *Tender 510021867* Water and Sewer Mains Renewal Program (WSRP) Request for Proposals.

Turner, A, Campbell, S, White, S, 2003, *End use modelling and water efficiency programs for Arid Zones – The Alice Springs Experience*, Efficient 2003: 2nd IWA Conference on Water Efficiency, Tenerife, Spain.

Turner, A, Beatty, K, White, S and Tarlo, K, 2004, *Sydney Water Corporation 'Every Drop Counts' residential retrofits – Analysis of Water Savings*, prepared by ISF for Sydney Water Corporation.

Water Corporation of WA, 2004, *Annual Report 2003/04, New Solutions for a Changing World.*

Watercorp, 2005a, http://www.watercorporation.com.au/media/media_detail.cfm?id=310, Media Release 21 February 2005, accessed 10 May 2005.

Watercorp, 2005b, http://www.watercorporation.com.au/media/media_detail.cfm?id=353 Media Release 14 April 2005, accessed 10 May 2005.

Wenger, E, 1998, *Communities of Practice: Learning, Meaning, and Identity*, Cambridge University Press.

White, S, Robinson J, Cordell, D, Jha, M and Milne, G, 2003, *Urban water demand forecasting and demand management: Research needs review and recommendations*, WSAA Occasional Paper No 9.

BIOGRAPHY

Cynthia Mitchell PhD (UNSW) BE Chem (UQ) is an Associate Professor and Research Director at the Institute for Sustainable Futures, University of Technology Sydney. She has 12 years of research experience at the cutting edge of strategic planning, design and evaluation of water systems that promote the ideals of efficiency and effectiveness. At the Institute, Cynthia has focused on projects that create change towards sustainability in the water and building sectors, including developing and delivering highly successful professional development programs. Cynthia is also responsible for the Institute's transdisciplinary postgraduate research program.

Andrea Turner BEng (Hons) DIC MSc CEng is a Research Principal at the Institute for Sustainable Futures. She is a chartered civil engineer with a post graduate degree in environmental engineering from Imperial College, London. Andrea has over fourteen years engineering and research experience in water, wastewater, stormwater and environmental assessment projects having worked in the UK, Hong Kong and Australia. Over the last four years she has worked with many water service providers across Australia on all stages of water efficiency and integrated resource planning from end use analysis, modelling, option design and costing to measurement of water savings.

Professor Stuart White is Director of the Institute for Sustainable Futures. He has worked and undertaken research in sustainability for over twenty years, specialising in the use of least cost planning for utilities and the advocacy, design, implementation and evaluation of programs for improving resource use efficiency. Stuart has been instrumental in designing and implementing three of Australia's largest water efficiency programs, in Kalgoorlie Boulder in Western Australia, in northern New South Wales and in Sydney. Stuart has written and presented widely on sustainable futures including taxation, participatory decision-making and public policy in the areas of waste minimisation, energy conservation and sustainable urban transport.