DEMONSTRATION PROJECTS:
CASE STUDIES FROM PERTH, AUSTRALIA.

- Kwinana Water Reclamation Plant
- Liege Street Wetland
- The Green at Brighton Estate
- Wungong Urban Water Project

Caitlin Davis and Megan Farrelly
www.urbanwatergovernance.com

PERTH

National Urban Water Governance Program

MONASH University

Demonstration Projects: Case Studies from Perth, Australia. Kwinana Water Reclamation Plant; Liege Street Wetland; The Green at Brighton Estate; Wungong Urban Water Project

Davis, Caitlin
Farrelly, Megan

June 2009

DISCLAIMER:

This research was funded by the Australian Research Council, the Water Corporation (WA), the Western Australian Planning Commission, the Department of Water (WA), City of Armadale (WA), the Smart Water Fund (established and operated by City West Water, Melbourne Water, South East Water, Yarra Valley Water and the Department of Sustainability and Environment, VIC), South East Queensland Healthy Waterways Partnership, and Maroochy Shire Council (now Sunshine Coast Regional Council, QLD). The opinions expressed in this report are those of the authors and do not necessarily represent those of the funding partners.

ACKNOWLEDGEMENTS

Our appreciation goes to steering committee members for their support and guidance in selecting specific demonstration projects. Thank you to all the interview participants who generously contributed towards this research project. Finally, thank you to all those who agreed to review the case studies, your input strengthened the report.

Photo image of Kwinana Water Reclamation Plant courtesy of the Water Corporation, Western Australia.

Photo images of The Green at Brighton Estate and Liege Street Wetland courtesy of Megan Farrelly.

CONTACT DETAILS:

Dr Megan Farrelly – Research Fellow
Dr Rebekah Brown – Program Leader

nuwgp@arts.monash.edu.au

National Urban Water Governance Program
School of Geography and Environmental Science
Faculty of Arts
Monash University
Clayton VIC 3800

www.urbanwatergovernance.com

National Urban Water Governance Program

The *National Urban Water Governance Program* (the Program) is located at Monash University, Melbourne. The Program comprises a group of social science research projects investigating the changing governance of traditional urban water management in Australia.

The Program is intended to facilitate progress towards achieving 'Water Sensitive Cities', a long-term aim of Australia's National Water Initiative, by drawing from a number of social theories concerning institutional and technological change processes, and by undertaking comprehensive social research across three Australian cities: Brisbane, Melbourne and Perth.

Three key questions guiding the overall Program's research agenda are:

1. What institutional factors are most important for enabling change towards a Water Sensitive City?
2. How can current reform processes be effectively informed and adapted to advance a Water Sensitive City?
3. What are the implications, and future roles, for professionals in the urban water sector?

The metropolitan regions of Brisbane, Melbourne and Perth were selected as broad case studies because they share similar drivers for re-examining their water management options (drought, waterway degradation, increasing populations). Collectively, the cities also represent a broad range of differing urban water governance structures and systems across Australian cities. This is in addition to differences in traditional water supply sources. For example, Perth's supply is predominantly sourced from groundwater aquifers, whereas Melbourne and Brisbane's are sourced primarily from surface, freshwater systems.

Introduction

It is widely recognised that conventional approaches to urban water management are unable to respond and adapt to the emerging challenges of ageing infrastructure (Engineers Australia, 2005); increased demand from growing populations (Birrell *et al.*, 2005), and climate change and sustainability (Marsalek *et al.*, 2001; Brandes and Kriwoken, 2006; Wong, 2006). These challenges introduce great complexity and uncertainty to urban water management; thus, many sustainability commentators are calling for transformative change towards adopting more sustainable practices. Such an approach would emphasise adaptable, inclusive and collaborative practices operating within supportive organisational cultures that embrace learning-by-doing (e.g. Maksimovic and Tejada-Guibert, 2001; Pahl-Wostl, 2007; Wong and Brown, 2009). As van der Brugge and Rotmans (2007: 259) point out: "because the road is unclear, experimentation is essential in order to learn". In Australia, demonstration projects are used as a mechanism to introduce, test and promote (experiment with) new technologies and practices in support of sustainable urban water management.

Demonstration projects act as bounded experiments, trialling the application of structural innovations such as technology, infrastructure or science, as well as non-structural innovations such as education or policy programs. They can occur at a range of scales, and trial any number of innovations. Each project may offer new insights into how a policy or new piece of technology can contribute to change or enhance current practice, and help shift towards more sustainable urban water practices.

In a review of demonstration projects across eastern Australia, Mitchell (2006) determined that while significant progress had been made in integrated water management, there was room to improve on the 'progressive learning experience' of demonstration projects. She concluded that (Mitchell, 2006: 602):

> In order to allow people to build on the experience of others and enable knowledge gaps to be filled, improved dissemination of knowledge gained and lessons learnt, including pitfalls to be avoided and processes followed is required.

In response to this call, these case study reports have been designed to:

a) raise the profile of projects involving new water supply and treatment technologies amongst urban water professionals, and

b) share the key lessons and insights gained from these projects.

The case studies aim to provide a holistic overview of the selected projects, including not just technical aspects, but also the processes undertaken, the challenges encountered and methods for overcoming these challenges during the course of project development and implementation. This set of case study reports contributes towards a larger research project investigating how demonstration projects can assist in the diffusion of sustainable urban water management technologies and practices in the Australian urban water sector. This research also supports the broad research agenda of the National Urban Water Governance Program.

Publicly available literature, alongside interview notes, form the basis of these reviews. Sixty-five individuals were interviewed across Perth between April and May 2008 to determine the quality and diffusion of information among urban water professionals in relation to technical and process innovations. Interview participants included representatives from Local Government, State Government agencies, the water utility, leading consultants, land developers and researchers. Interviewees who had detailed experience with specific demonstration projects were also asked a series of questions tailored to capture their experiential insights to help reveal the drivers for initiating the project and to identify the enabling and/or constraining factors involved in undertaking the process of design, construction, and implementation. Implications for future adoption of new water supply and treatment technologies and practices arising from these case studies are also reported.

CASE STUDY OF
KWINANA WATER RECLAMATION PLANT
KWINANA, PERTH

Introduction

The Kwinana Water Reclamation Plant provides recycled water for non-potable (industrial) uses in the Kwinana Industrial Area, located within the broader Perth Metropolitan region. The Water Corporation, in association with several industry partners, undertook to reduce potable water demand amongst industrial users by providing the option of purchasing non-potable recycled water. This case study highlights how the recycling plant came to exist, the past and current challenges involved in the process of securing the project (and its planned extension) and the implications arising from the project.

Project Overview: Kwinana Water Reclamation Plant

The Kwinana Water Reclamation Plant (KWRP) is located 35km south of Perth on the site of the BP refinery in Western Australia's largest industrial area, the Kwinana Industrial Area (KIA) (see Figure 1). The KIA covers an area of approximately 16km², and is home to many of Western Australia's most economically significant heavy industries. These include chemical, petroleum and mineral processing industries such as alumina, nickel and oil refineries, as well as smaller service, infrastructure and utilities industries such as port facilities, a power station and construction businesses (SKM, 2007).

Figure 1: KWRP Location (Water Corporation, 2003a).

KWINANA WATER RECLAMATION PLANT - SNAPSHOT

- Kwinana Industrial Area, Kwinana
- **Driver:** Increasing water demand vs. drought and water scarcity crisis.
- **Purpose:** to provide an alternative to potable water supply for industry.
- Owned and operated by the Water Corporation.
- Developed in partnership with the Kwinana Industries Council.
- Microfiltration and Reverse Osmosis treatment process.
- Replaces up to 6GL potable water per year.
- Reduces wastewater discharge into the ocean by 11ML per day.

Issues of environment, industry and community in the KIA are overseen by the Kwinana Industries Council (KIC). The KIC was established in 1991, and is an incorporated business association. Membership consists of 12 full members, representing the major industries, along with 28 associate members drawn from the support and service sectors (KIC website, 2008). Although initially established for the collective organisation of air and water quality monitoring in the local environment, the KIC now deals with a wider variety of issues common to the various stakeholders in the KIA, and provides a communicative link between industry, government and the community (van Beers *et al.*, 2007).

The KIA is internationally recognised as a leading example of industrial symbiosis, where by-product materials, waste, energy and water are recovered and reused between businesses operating in close proximity (van Beers *et al.*, 2006; Harris *et al.*, 2006; Harris, 2007). The KWRP is considered an important example of industrial synergy in the KIA, an area that exhibits a number of industrial symbiosis projects with particular emphasis on water synergies (van Beers *et al.*, 2008).

The KWRP was designed and built through a joint venture between Veolia Water Systems and John Holland at a cost of approximately A$28 million. Owned and operated by the Water Corporation, the plant receives secondary treated wastewater from the nearby Woodman Point Wastewater Treatment Plant (WWTP) (Figure 1). This water is treated to produce a high quality industrial-grade water which is supplied to industries such

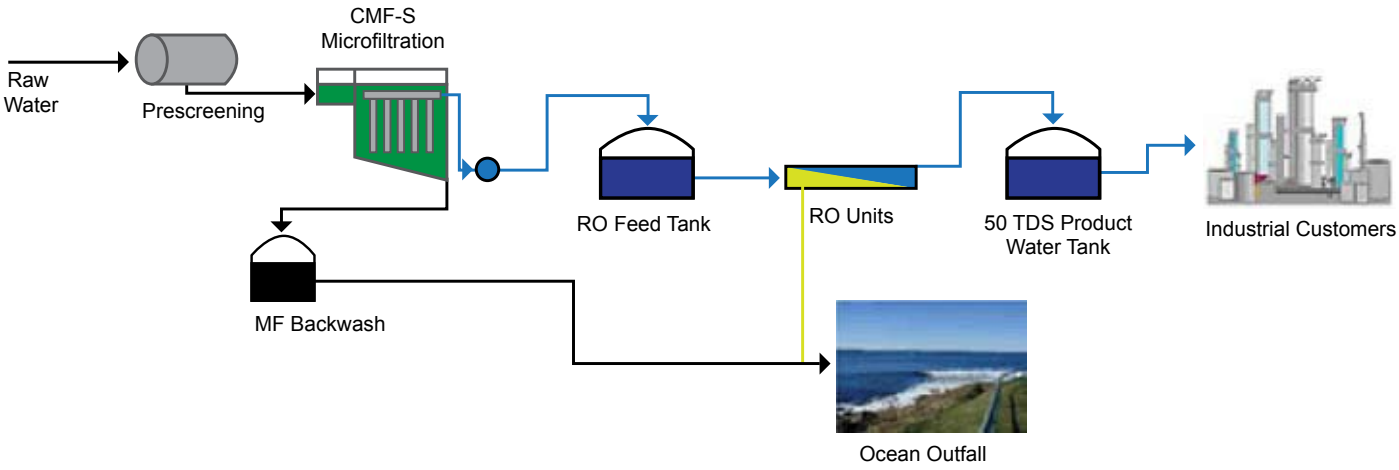

Figure 2: KWRP Wastewater Treatment and Supply Process in the Kwinana Industrial Area (SPG Media Limited, 2008)

as CSBP, Tiwest, Kwinana Cogeneration Plant, BP and HIsmelt (Rio Tinto) to replace potable water (Harris, 2007). The Plant is capable of producing 6 giga-litres (GL) of treated wastewater per year through a micro-filtration and reverse osmosis (RO) process (Water Corporation, 2003a) (see Figure 2). This will replace approximately 2-3% of total potable water use in metropolitan Perth (Harris, 2007). Through the treatment of 24 mega-litres (ML) of wastewater per day, approximately 17 ML of water is produced to be used for functions such as steam production and cooling towers (Water Corporation, 2003a). The low level of Total Dissolved Solids (50 TDS) in the treated water is ideal for such processes, as it cuts down chemical use in cooling towers and other procedures, therefore reducing metal loads in the business' wastewater discharge (Harris, 2007).

A further aspect of the project has been the reduction of industrial discharge into the adjacent sensitive marine environment of Cockburn Sound (see Figure 1). Treated industry effluent previously discharged into the Sound is now returned to the Water Corporation pipeline to be disposed via the Sepia Depression Ocean Outlet, 4kms offshore (see Figure 1). The Sepia Depression is believed to have a greater capacity than the Cockburn Sound to receive the waste without harming the environment (Water Corporation, 2003a). Overall discharge to the Sepia Depression will decrease by approximately 11 ML a day due to the recycling scheme (Water Corporation, 2003a).

Drivers and Purpose of KWRP

Many types of industrial processes found in the KIA, such as oil refinement or chemical fertiliser manufacturing, are identified as high users of water. In the late nineties, the KIA was using approximately 3% of Perth's total water demand; however, demand was forecast to increase significantly with further development and expansion in the area. At present, Kwinana industries require around 30 billion litres of water per year.

In the mid-late nineties, Western Australia was facing increased water scarcity which was further compounded by rapid population growth and a minerals boom which led authorities to seek alternative water supply options for the State. Thus, any increase in the use of potable water for industrial purposes was viewed as impracticable and unsustainable. In response to these pressures, the Water Corporation, Kwinana Industries Council and other government agencies jointly undertook the Kwinana WaterLink study to investigate water efficiency and environmental management improvements in the area. The development of the KWRP was a key initiative arising from this study to address water supply options for industry. Further supporting this important initiative, in 2003 the Gallop Government released the State Water Strategy, setting a treated wastewater reuse target of 20% by 2012 (Government of Western Australia, 2003). While regional Western Australia has been reusing over 40% of its municipal wastewater for park, sporting field and agricultural irrigation for some time, only 3% of the Perth metropolitan region's wastewater was recycled (Government of Western Australia, 2003; Water Corporation, 2003a). Therefore, the industrial sector was identified as a key area for reuse opportunities in the Perth region, and the KWRP was nominated as the government's flagship project to contribute to achieving the reuse target (Government of Western Australia, 2003).

Furthermore, from the commercial perspective of the Water Corporation, the project provided the space to foster closer relationships with some of their largest and most significant industrial customers. This enabled them to search for business options that were mutually beneficial. At the time of planning for the KWRP project, mutual social, environmental and financial benefits were identified by the WaterLink study participants.

Process and Timeline for Project Implementation

The Kwinana WaterLink study was created during the late nineties to foster collaboration between peak industrial bodies in the KIA, the Kwinana Industries Council, the Water Corporation and government, to explore the options for substituting potable water for industrial uses. Task groups were formed around different issues in the area, such as wastewater reuse opportunities or the commercial aspects regarding water supply options. One of the key outcomes of the task-groups process and WaterLink study was the recommendation to move forward with a wastewater recycling plant.

In 2000 the Water Corporation and BP formed an alliance to begin preliminary studies required to get the project up and running. It was intended that BP be a 50% equity partner in the project. However, due to concerns with the commercial viability of the project, the alliance process fell over within 12 months. The Water Corporation decided to continue alone, and in early 2001 the project team began the process of making the necessary adjustments to the project specifications in order to get the approvals through the Water Corporation Board. Once the project was accepted 'in principle' by Board members, a general canvassing of the market for treated water within the KIA was undertaken. This process was complicated by one of the key requirements of the Board, which included drawing up "take-or-pay contracts" to be signed by industries receiving the recycled water. These documents constituted a non-legally binding agreement, much like a Memorandum of Understanding, and sought the commitment of business to pay for 15 years supply of their estimated water-use requirements, whether or not they ended up using the water. Many businesses, however, had the contract term reduced to 5 years before signing. The process of getting these agreements signed by the various industries involved lasted more than two years, and was further assisted by various external factors such as declining water resources and industrial expansion. The last customer signed on in early 2008, ensuring the full capacity of water produced by the plant was allocated.

Key to the project's success was the construction of a HIsmelt iron plant by Rio Tinto in 2003. Part of the environmental approval requirements included sourcing the projected water needs (approximately 8 ML/day) from non-potable sources. With no available groundwater licences or opportunity to buy from other industries, the KWRP provided HIsmelt with an ideal alternative water source option. It was reported in HIsmelt's Social and Environmental Report (2003) that "HIsmelt's involvement in the KWRP Project provided the critical mass (approximately 50% of the KWRP production will be used by HIsmelt) that enabled the KWRP project to achieve Water Corporation Board approval" (HIsmelt, 2003: 5).

In 2002, a $150 million project to upgrade the Woodman Point WWTP commenced (to reach advanced secondary level wastewater treatment) (Water Corporation, 2003c). This ensured the quality of wastewater required for reuse could be provided. The contract to design and construct the KWRP was awarded to a Veolia Water Systems/John Holland consortium in 2003, and the plant was officially commissioned on 4 November 2004 (Water Corporation website, 2008).

The Environmental Protection Authority (EPA) requested a Public Environmental Review be undertaken, and the results were released in November 2003 (Water Corporation, 2003b). Much of the concern related to the industrial wastewater discharge into the Sepia Depression Ocean Outfall. The project was ultimately delayed for approximately six months while the issues raised in the public environmental review were addressed.

Recycling water on such a large scale was considered something exceptional from a health regulation perspective, and a cautious approach to the project approval was adopted by the Department of Health. This reportedly had some impact on decisions regarding the type of treatment processes and water quality requirements for the KWRP, however, it should also be noted that the Water Corporation's own internal water quality branch was also considered strict on such issues.

Monitoring the environmental impacts resulting from the plant's operation is primarily the responsibility of the Water Corporation, with contribution from industry through the Kwinana Industries Council. Monitoring occurs primarily at the Sepia Depression Ocean Outlet and the Stakeholder Liaison Group assists the Water Corporation to manage any issues arising from the discharge of wastewater into the Sepia Depression, to review its environmental performance and to ensure effective communication of the social and environmental impacts of effluents on the marine environment (Water Corporation, 2008). The group includes representatives from the Water Corporation, various environmental groups and recreational user groups, community members as well as local and state government organisations (Water Corporation, 2008).

The KWRP's current production capacity is approximately 17 ML/day, however, with the addition of extra reverse osmosis modules, as well as upgrading storage and pumping infrastructure, the plant can be expanded to a 27 ML/day capacity. With the ever-increasing demand for water in the region, talks are currently underway for the extension of the KWRP to produce 9.6GL of water per year. The Western Australian State Government has asserted its support for the Plant's second stage of development in the *State Water Recycling Strategy*, released in June 2008 (Department

of Water; Department of the Premier and Cabinet, 2008). Furthermore, in May 2008, the Federal Government announced a $5 million contribution to the upgrade (Wong, 2008).

AWARDS WON

- **Australian Water Association Environment Merit Award 2005**
- **Highly Commended in the Global Water Awards**

Challenges and Opportunities within the Project

One of the biggest challenges currently facing the KWRP project relates to the high quality of water produced by the reclamation plant. While the low total dissolved solids levels in the treated water are beneficial for certain industrial uses, the same effect or better could be achieved with a slightly lower quality of water. The current water quality is considered to be "too good" for some uses. The demand for lower quality water raises concern for the Water Corporation regarding the proposed upgrade for the KWRP. The first stage of the plant was constructed with the option for expansion. As a result, the Corporation is technologically committed to producing high quality water. According to interviewees, supplying water of a lower quality requires the construction of new infrastructure; this is considered an impractical and unacceptable expense by the Water Corporation. However, a further challenge may emerge when attempting to secure industry commitment to receiving recycled water in the future. Tension remains as to whether industry will continue to source their water from the KWRP, or pursue other alternatives if they arise.

The need for ensuring the development or adjustment of pricing structures for water at a state-wide level was nominated as a key consideration to be explored prior to a new source coming online. The high price of the water currently produced by the plant, in comparison to scheme and ground water in Perth, has contributed towards many customers' reluctance to pay for water they consider to be of an unnecessarily high quality. The price for the reclaimed water is projected at $1-2/kL (Water Corporation, 2008 Website), well above the current price of potable water (approximately $0.80/kL). However, the *State Water Recycling Strategy 2008* outlines the Government's intention to investigate the potential for an industrial tariff "to promote the efficient use of water and the use of recycled water by industry" (Government of Western Australia 2008: 6). On 7 July 2008, the Economic Regulation Authority (ERA) of Western Australia launched an inquiry into the pricing of recycled water in the State, and the final report was released in February 2009 (ERA, 2009). This was an opportunity to provide recycled water to industry at a cost-competitive price, thus reducing the demand risk liability for the Water Corporation in the KIA, and also providing incentive(s) for industry to use recycled water, rather than potable water, in a fit-for-purpose manner.

The final ERA report acknowledges the need for transitioning industrial and metropolitan customers to cost-reflective usage charges; however, finds that the price of recycled water is to remain "a commercial matter between the service provider and its recycled water customers" (ERA, 2009: 57). Of note, the Economic Regulatory Authority has stated in its concluding pricing principles that "the price of wastewater from wastewater treatment plants should not be adjusted to reflect environmental objectives or to achieve social objectives" (ERA, 2009:49). The Report further points out that "in relation to whether there are any substitutes for KWRP water, it is clear that the industrial customers have the option of using scheme water." (ERA, 2009: 55). Without restrictions on using potable water for certain industrial purpose, the high price of recycled water may continue to be a challenge, as it does not provide incentive for industry to move away from using potable water.

The targets set by the Water Corporation Board with respect to the 'take-or-pay' contracts with industry for the treated water have been a contested issue due to tension between the needs and interests of the Water Corporation and its customers. The agreements are in place to ensure asset security for the Water Corporation. Indeed, the importance of the agreements for the Water Corporation in terms of cost recovery is illuminated in light of the recent closure of the HIsmelt plant in March 2009, due to a global drop in iron demand caused by the economic downturn (The West Australian, 26 March, 2009). As the plant is now in "care and maintenance" mode until April 2010 the water will not be used, despite the business having signed up for 50% of the KWRP's water production. Without the 'take-or-pay' obligation on HIsmelt, the HIsmelt plant closure would have posed a significant (financial) risk to the Water Corporation asset.

However, in combination with the water price and quality issues, the inflexibility of the 'take-or-pay' arrangement may eventually constitute a demand-risk for the Water Corporation in itself, as future customers may not recognise business incentives for signing on. In a submission to the Inquiry into Pricing of Recycled Water, the Kwinana Industries Council points out that the "highly restrictive" take-or-pay agreements provide a disincentive for industry to take the water, as this "limits the use of the water as Industry only signs up for the water they will definitely use and then can't take more even if it is available."

(KIC, 2008b: 2). On the other hand, the take-or-pay agreements have also caused issues for one business, which was only using half the water it paid for due to technical difficulties with their plant's operation (the operational difficulties experienced by the company's plant were not associated with the use of recycled water). Due to the availability of the cheaper potable water option, such restrictions could be perceived as disincentives for other businesses to sign on to receive the water in the future.

The diverse customer base of the KWRP provided both challenges and opportunities in the planning and implementation of the project. One interviewee noted that the KWRP was unique, as the average water reclamation plant generally serves a single customer; for example, Sydney Water and BlueScope Steel's reclamation plant at the Port Kembla and Springhill Steelworks (Hird, 2006). Thus, there remains a challenge to identifying a suitable quality of water that is able to support multiple industrial uses. In addition, the interviewee suggested that while including a variety of customers had its successes, this also led to delays as there were significant issues regarding some industries waiting to see if others committed first.

From a technical perspective, difficulties were experienced when retrofitting infrastructure to suit the receiving industries. For example, connection for one business was delayed due to the difficulties associated with laying the pipe-work through their plant.

From the outset, the KWRP project was conceived as an opportunity to partner with industry, and considered outside the Water Corporation's core business. This reportedly led to the project being initially regarded as a low priority in terms of funding and support. The relative success of the plant's operation has provided an opportunity to challenge the traditional core business of the Water Corporation, and the attitudes supporting that traditional focus. The partnership and ongoing engagement with industry has yielded encouraging results, with numerous interviewees highlighting that despite any challenges encountered during the project, the relationship between industry and the Water Corporation has been positive and mutually beneficial. Overall, the KWRP constitutes a positive example of water efficiency, alternative supply options and cooperation in industry. Its significant role in the KIA's industrial ecosystem has been highlighted numerous times (see, for example: Corder *et al.*, 2006; Harris *et al.*, 2006; van Beers *et al.*, 2006; Harris, 2007; van Beers *et al.*, 2007; van Beers *et al.*, 2008). Such benefits need to be made explicit when considering how to reduce the impact of industry and managing water demands during future industrial expansion.

Case Study Implications

The KWRP project has many positive implications for recycled water use for industry State-wide. The project has contributed significantly to the State's targets of 20% wastewater reuse by 2012, helping WA reach 12.5% by 2007 (Department of Water; Department of the Premier and Cabinet, 2008). The success of the KWRP project has contributed to building the confidence within the Government to set higher wastewater recycling goals for the State. In the 2007 State Water Plan new targets for recycling water were set at 30% of wastewater by 2030, in which the extension of the KWRP project plays an important role (Government of Western Australia, 2007).

Interviewees' opinions on the changes occurring within the Water Corporation as a result of the project identified both positive and negative reactions within the organisation. On the one hand, the cost overruns of the project were considered to have contributed to further internal reticence and a reluctance to advocate recycled water as a preferred alternative water source option. On the other hand, it was noted that the relative overall success of the project had led to changes in the attitudes of some of the project's early critics. Beyond existing rural-regional reuse schemes, the KWRP represents a marked shift in direction for the Water Corporation, whose traditional core business approach to urban water provision has centred on extending potable water supply options. Ultimately, interviewees considered there to be general understanding within Water Corporation and the government that recycled water for industry occupies a significant role in both Perth and Western Australia's futures.

However, it remains to be seen how the HIsmelt plant closure will affect the success of the KWRP operation, and the planned extension. The significant drop in demand due to the plant's closure has resulted in a 50% production surplus of recycled water. While the Water Corporation has undertaken efforts to re-sell the water on HIsmelt's behalf, industry interest has been limited in light of the economic downturn. As the reclaimed water is solely for use in the industrial area, it cannot be diverted for other potential non-potable uses (i.e. sporting field irrigation) in the broader community as part of the State's Integrated Water Supply Scheme. Therefore, the reduction in overall demand in the industrial area may have implications for future viability and expansion of the existing plant (and potentially, the attitude within the Water Corporation towards such a scheme).

References and Further Information

Economic Regulation Authority (ERA) (2008) *Issues Paper: Inquiry into Pricing of Recycled Water in Western Australia*: 1 August 2008.

Economic Regulation Authority (ERA) (2009) *Final Report: Inquiry into Pricing of Recycled Water in Western Australia*: 6 February 2009.

Government of Western Australia (2003) *State Water Strategy 2003*.

Government of Western Australia (2007) *State Water Plan 2007.*

Government of Western Australia (2008) *State Water Recycling Strategy: An Overview,* June 2008.

Harris, S., R. van Berkel; and B. Kurup (2006) "Fostering Industrial Symbiosis for Regional Sustainable Development Outcomes." Paper presented at the Corporate Responsibility Research Conference , 4-5 September 2006, Dublin, Ireland.

Harris, S. (2007) "Industrial Symbiosis in the Kwinana Industrial Area (Western Australia)" *Transactions for the Institute for Measurement and Control*, Vol. 29, October 2007.

Hird, W (2006) "Recycled water — case study: BlueScope Steel, Port Kembla Steelworks" *Desalination*, 188: 97-103.

HIsmelt (2003) *Social and Environmental Report 2003*, Rio Tinto Group.

Kwinana Industries Council (KIC) (2008a) Website, accessible at http://www.kic.org.au

Kwinana Industries Council (KIC) (2008b) Submission to the Inquiry into Pricing of Recycled Water in WA. Available at: http://www.era.wa.gov.au/3/773/46/public_submissi.pm

Kwinana Industries Council (KIC) (2006) *Kwinana Industrial Area Water Planning Study 2006*.

Sinclair Knight Merz (SKM) (2007) *Kwinana Industrial Area Integrated Impact Assessment 2007*, Sinclair Knight Merz Pty Ltd, Kwinana Industries Council.

SPG Media Limited (2008) "Kwinana Water Reclamation Plant: Microfiltration and Reverse Osmosis Technology, Australia". Accessible at http://www.water-technology.net/projects/Kwinana Last accessed 20 August 2008.

Van Beers, D., A, Bossilkov; and R. van Berkel (2006) "Enhancing Water Efficiency Through Regional Cooperation – The Case of Kwinana". Paper presented at Water In Mining conference, 14-16 November 2006, Brisbane, Australia.

Van Beers, D., C. Oughton; and D. Cooling (2007) "Update on Regional Synergy Development in the Kwinana Industrial Area". Paper presented at the SSEE International Conference on Engineering Sustainability, 1 November 2007, Perth, Australia.

Van Beers, D., A. Bossilkov; and R. van Berkel (2008) "A regional synergy approach to advance sustainable water use: a case study using Kwinana (Western Australia)" *Australasian Journal of Environmental Management* 15(3) September, 2008: 149-158.

Water Corporation (2003a) *Kwinana Water Reclamation Plant*.

Water Corporation (2003b) *Kwinana Water Reclamation Plant (KWRP): Expanding Perth's Water Options. Public Environmental Review.* November 2003.

Water Corporation (2003c) *Annual Report 2002-2003*.

Water Corporation (2008) Website, accessible at http://www.watercorporation.com.au

The West Australian (2009) "HIsmelt plant is 'deeply uneconomic': Rio", 26 March, 2009.

Wong, P. (2008) *Media Release: "$254.8 million in water security for cities and towns"*, Commonwealth Government of Australia, 13 May 2008.

CASE STUDY OF
LIEGE STREET WETLAND
CANNINGTON, PERTH

Introduction

The Swan and Canning Rivers regularly receive large nutrient loads which often lead to algal blooms and occasionally fish kills. It is the mandate of the Swan River Trust to improve and protect the health of the two river systems. Through the support of a range of stakeholders, the Liege Street demonstration wetland was created with the aim of improving stormwater quality through the reduction of nutrient loads before entering the Canning River. This case study highlights the processes involved, the challenges faced throughout the project and finally highlights some key implications arising from this case study.

Liege Street Demonstration Wetland

Located in the Canning River Regional Park in Cannington, south-east Perth, the Liege Street Wetland has been constructed to assist in reducing nutrient loads entering the nearby Canning River via the Liege Street and Cockram Street main drains. The original 350 metres of linear drainage was identified as a major contributor of nitrogen and phosphorous to the Canning River. Thus, this was an important site to demonstrate the benefits of transforming the area into a 3 hectare wetland which incorporates multiple design features, such as clay-lined pools, floodplains, a sedimentation forebay, gross pollutant traps, islands and vegetated sump-lands (Torre *et al*., 2006; GHD, 2007).

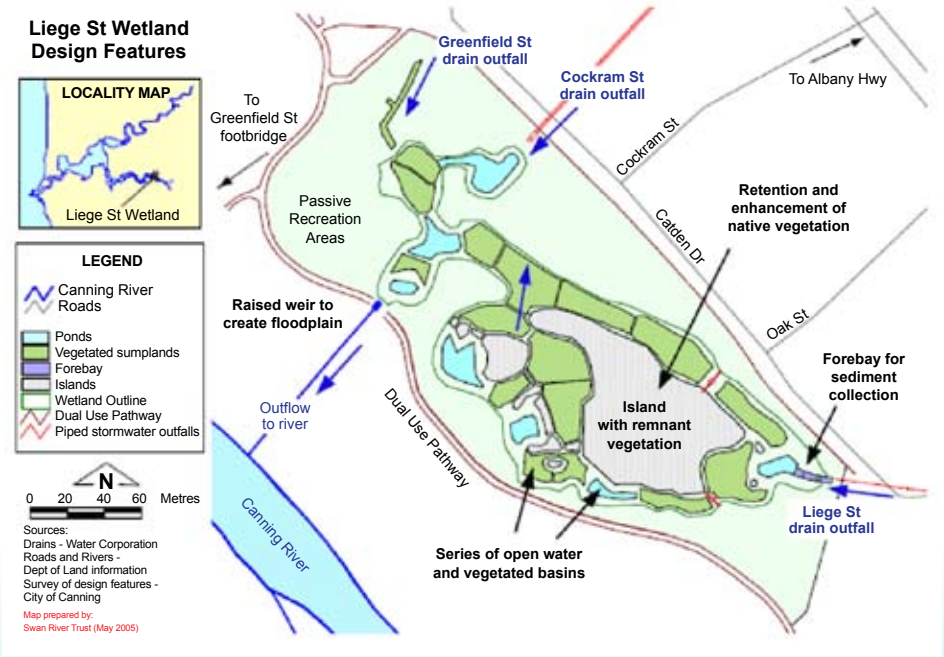

Figure 1: **Design features and water flow, Liege Street Wetlands (GHD, 2007)**

The catchment area for the wetland covers just under 530ha, about half of which is impervious (Syrinx Environmental, 2004). The upper area of the catchment is predominantly residential land use, while the lower area is mainly commercial, including the Westfield Carousel Shopping Complex and car park.

The wetland was developed via a partnership between the Swan River Trust, the City of Canning, the South East Regional Centre for Urban Landcare (SERCUL), Department of Environment and Conservation (previously Department of Environment and Department of Conservation and Land Management), Water Corporation, and the Two Rivers Catchment Group, and was designed by Syrinx Environmental Pty Ltd. The key objectives of the wetland are outlined as (GHD, 2007:1):

- reduce summer baseflows and autumn first flush nutrient loads from the urban catchment when the risk of algal blooms is high in the lower Canning River and estuary;
- reduce other pollutants (i.e. metals and suspended sediment); and
- improve the habitat and amenity values of the area, while maintaining hydraulic capacity during flood flows.

The total cost of the project has so far exceeded $700 000, including site investigations, design, earthworks and plants (Kimber, 2007). The majority of funding has been provided by the State Government through the Swan River Trust, and the City of Canning has contributed $300 000 towards drain sediment disposal costs, council drain restoration and works supervision. There has also been significant in-kind contribution from representatives of council and State Government staff, as well as many volunteers from the community and organisations involved in the project.

Figure 2: **Liege Street Wetland**

Drivers and Purpose of the Liege Street Wetland

Throughout the 1990s, frequent algal blooms, fish kills and further deterioration of water quality in the Swan and Canning River systems, along with rising community concern, led the State Government to establish the Swan-Canning Cleanup Program (SCCP) in 1994. Led by the Swan River Trust, the aim was to develop an Action Plan to guide the restoration of Perth's degraded urban river systems. This was released in 1999 (Swan River Trust, 1999). Building on the original initiative, the Drainage Nutrient Intervention Program (DNIP) was developed in 2003 to deal with the issue of nutrient removal from drains discharging into the river systems.

The Liege Street Wetland was the first major project undertaken as part of the DNIP initiative. Water quality monitoring since 1999 had identified the Liege Street and Cockram Street drains as significant contributors of phosphorous, nitrogen and sediment loads to the Canning River, with the outfall discharging into the Kent Street Weir Pool (Torre *et al.*, 2006). This section of the river was identified as an area of significant social and environmental value; however, it was regularly experiencing algal blooms during summer and autumn (Syrinx Environmental, 2004). Furthermore, the area around the drains was infested with exotic plant species which impacted negatively on the aesthetic and recreational value of the park (Torre *et al*., 2006). The project provided an opportunity to reduce nutrient loads entering the river system and restore native flora and fauna to the region, as well as provide a passive recreational area for park visitors (Syrinx Environmental, 2004). The Park location also ensured the availability of space for the project, as a wetland requires comparatively more area than a linear drain. These factors contributed to making the Liege Street Wetland location an ideal area for an artificial wetland and stormwater treatment project. As very few projects of its kind existed in Perth at the time, the Liege Street Wetland was able to provide a model for future stormwater treatment and management in Western Australia.

AWARDS RECEIVED

- **Stormwater Industry Association of Australia**
  – National Award for Excellence in Stormwater Management 2006
- **Western Australian Environment Awards**
  – Bush, Land and Waterways Award 2006

Key Aspects of Implementation

With the establishment of the DNIP in 2003, the Swan River Trust was awarded $750 000 to fund stormwater treatment works in the Canning Plain region. Consequently, the Liege Street Wetland site was identified as the ideal location for the trial of an artificial wetland.

On 3 November 2003, the then Department of Environment facilitated a workshop to discuss the design concepts and objectives for the project, and incorporate the vision of the various stakeholders. The consulting group Syrinx Environmental Pty Ltd was engaged to design the wetland in consultation with these stakeholders (Syrinx Environmental, 2004). Stakeholder involvement was further achieved through the Project Steering Committee, established in early 2004 to oversee project management, design, construction and maintenance (Torre *et al.*, 2006). Local indigenous and heritage issues were also required to be considered and approved as a part of the planning and design process.

Construction and earthworks began in April 2004, with revegetation underway by June 2004. By late 2004, over 50 000 plants had been planted in the area (Torre *et al.*, 2006). However, there were reported delays during construction as aspects of the wetland design were questioned by project partners and the design was reassessed to accommodate the various project partners' expectations (Torre *et al.*, 2006).

Volunteers have contributed significantly throughout the project, particularly through community organisations such as SERCUL, the Two Rivers Catchment Group and Conservation Volunteers Australia. Community members and local school children have assisted in planting and weeding throughout the project's existence, along with Corporate Care days hosted by the Swan River Trust (Kimber, 2007).

The Department of Water began monitoring water quality from November 2004 (GHD, 2007). Primary responsibility for monitoring lies with the SRT, who have committed $65 000 for 2004-05, as well as $40 000 for the following 3 years, and an additional $15 000 per year for maintenance (Kimber, 2007). GHD Pty Ltd was engaged by the SRT in 2007 to undertake a detailed performance review of the wetland (GHD, 2007).

Challenges and Achievements within the Project

The Liege Street Wetland case study, featured in the Stormwater Management Manual for Western Australia, highlights construction delays as a significant challenge for the project due to attempts to accommodate the diverse interests of the various stakeholders (Torre *et al.*, 2006). A number of interviewees linked the delays to the failure to involve all stakeholders in the early planning stages. It was suggested that mistakes were made during the implementation phase that were a result of the lack of participation in the design process by those with technical and on-ground expertise and experience, particularly the construction crews responsible for building the project. Consequently, delays during construction resulted in higher costs for the project.

On the other hand, stakeholder engagement was also highlighted as a positive outcome of the project. Responsibility for, and ownership of, land and assets within the project scope are shared across the boundaries of many organisations, and therefore the project required significant cooperation between many different authorities to ensure successful implementation. For example, the drains conveying stormwater to the area are owned by the Water Corporation and the City of Canning; the Canning River Regional Park is managed by the former Department of Conservation and Land Management (now the Department of Environment and Conservation); the Park land is owned by the Western Australian Planning Commission (WAPC); and project site is within the SRT Development Control area and Riverpark. Together these organisations produced the Liege Street Wetland project.

Although there were successes related to the engagement of various stakeholders, a number of interviewees commented on the lack of organisational commitment expressed by the Water Corporation. The Water Corporation's involvement was essential to the project's success as the Corporation owns the stormwater assets (main drain). However, while the Water Corporation was represented on the steering committee and provided technical advice on their own assets, interviewees commented that, although certain individuals were committed, as an organisation, the Water Corporation did not appear to value the project or the expected environmental and water quality benefits.

Concerns were also raised in relation to funding, particularly in terms of on-going monitoring and evaluation. It was noted that while the project is receiving attention due to its reputation as an award winning project, its continued success and survival was not ensured without sufficient planning and budgeting for on-going, long-term monitoring and maintenance. Furthermore, there was some criticism expressed regarding the role of the wetland as an 'end-of-pipe' solution. It was suggested that perhaps the money could have been better spent on 'point source' projects instead.

In terms of the primary aim of nutrient removal and water quality improvement, the Liege Street Wetland has had relative success. While it was suggested the wetland was not performing to ideal standards, there has been an improvement in water and habitat quality compared to the former state of the environment. The project has also been recognised as a significant learning opportunity for multiple organisations and the public. By 2007, over 70 000 native plant species had been restored to the area, representing 64 different species, which has promoted the return of various native birds and animals as a result of the improved habitat (GHD, 2007). For the period of 2005-06, GHD Pty Ltd reported Total Nitrogen (TN) concentration reductions of 27%, while Total Phosphorous (TP) levels were reduced by 45% based on mean inlet and outlet concentrations during summer baseflow conditions (GHD, 2007). This did not quite meet the SRT's catchment targets, however, levels generally lay somewhere between the short and long term targets (GHD, 2007).

Figure 3: Monitoring Gauge

The Liege Street Wetland exhibits the significant benefits of a multi-functional stormwater solution when compared with the pre-existing trapezoidal drains, which had the sole function of stormwater conveyance. Along with improved habitat, biodiversity and water quality, the Liege Street Wetland also provides social benefits in the form of aesthetic quality, amenity, and recreation, as well as learning and participation opportunities.

Case Study Implications

Many interviewees expressed distrust in the concept of artificial water bodies, based on negative experiences within the last decade with ornamental lakes in a number of housing developments. Unfortunately, this sentiment was also at times extended to artificial treatment wetlands, along with scepticism of the viability of stormwater sensitive design in the Western Australian geographical context, compared to the eastern Australian states. Also, the case study highlights that without support from the major stormwater asset owner (main drains), then there is a significantly reduced prospect of effective stormwater quality management from a whole-of-catchment perspective. This relates more broadly to the issue of stormwater quality management responsibility in Western Australia, for which accountability has generally been poorly defined (EPA, 2004). Thus, the Liege Street project's success was underpinned by their extensive stakeholder engagement processes to gain commitment from all involved.

Drainage quality and management responsibility is currently fragmented between local governments, State government departments (i.e. Department of Water, Swan River Trust, Department of Planning and Infrastructure, Western Australian Planning Commission, Environmental Protection Authority), and the Water Corporation. Recently, collaborative effort at the State Government level has been undertaken to reform drainage and waterway management approaches, link land and water planning, and integrate stormwater into a "total water cycle" management approach. This has been supported through documents such as *Drainage Management, Swan-Canning Catchment* (EPA, 2004); the *Stormwater Management Manual for Western Australia* (Department of Water, 2004-2007); *Better Managing the Urban Water Cycle: the Urban Drainage Initiative* (Department of Water, 2007); *Better Urban Water Management* (WAPC, 2008); and *Towards a Water Sensitive City: the Urban Drainage Initiative Phase 2* (Department of Water, 2009). While the outcomes of such programs are yet to be evaluated, their presence indicates potential opportunities for the future application of stormwater sensitive design features in Western Australia, and will hopefully contribute to improved stormwater quality outcomes for the Perth metropolitan region.

Their implementation will rely heavily on the co-operation and commitment of the local governments and the Water Corporation as the drainage asset managers.

Projects such as the Liege Street Wetland have important implications for contributing to stormwater quality targets in Western Australia, by providing a local example of a functioning artificial wetland and stormwater treatment system. Furthermore, the project has successfully demonstrated that through collaborative practices (planning and management) stormwater quality improvements can be made, particularly in reducing the levels of phosphorous and nitrogen entering the Swan-Canning River Estuary. Liege Street joins other stormwater sensitive design projects in Perth, such as Ascot Waters in the City of Belmont, and the more numerous projects that exist in regions beyond the Perth metropolitan boundary such as Mandurah and Bunbury. Importantly, key organisations involved in the Liege Street Wetland, along with elements of the project's process and design have been replicated (and improved) in a more recent demonstration project called the Wharf Street Wetlands and Civic Parklands which also contributes towards the Drainage and Nutrient Intervention Program (see Adkins and Sylva, 2009).

References and Further Information

Adkins, P.W. and Sylva, K.M. (2009) Wharf Street Wetlands and Civic Parklands: a solution to multiple objectives. *Proceedings of the 6th International Water Sensitive Urban Design Conference and Hydropolis 3#, 5-8th May, 2009*, Perth, Western Australia.

Environmental Protection Authority (EPA) (2004) *Drainage Management: Swan-Canning Catchment*, Section 16(e) report and recommendations of the Environmental Protection Authority, Perth, Western Australia, Bulletin 1131, April 2004.

GHD Pty Ltd (2007) *Liege Street Wetland Performance Report 2005-2006 – Community Summary Report*, Swan River Trust, August 2005.

Kimber, A. (2007), "Perth Tackles Nutrients the Natural Way", *Wetlands Australia*, No.15: 40-41.

Department of Water (previously Department of Environment) (2004-2007) *Stormwater Management Manual for Western Australia*, Government of Western Australia.

Department of Water (2007) *Better Managing the Urban Water Cycle: the Urban Drainage Initiative*, Government of Western Australia, June 2007.

Department of Water (2009) *Towards a water sensitive city: the Urban Drainage Initiative, Phase 2*, Government of Western Australia, May 2009.

South East Regional Centre for Urban Landcare (SERCUL) (2009) http://www.sercul.org.au/

Syrinx Environmental Pty Ltd (2004) *Liege Street Demonstration Wetland Concept Design: Technical Report*, Department of Environment, January 2004.

Torre, A., Monk, E., Chalmers, L. and Spencer, R. (2006) "Chapter 6: Retrofitting", *Stormwater Management Manual for Western Australia 2004-2007*, Department of Environment, February 2006.

Western Australian Planning Commission (WAPC) (2008) *Better Urban Water Management*, Government of Western Australia, October 2008.

CASE STUDY OF
THE GREEN AT BRIGHTON ESTATE
BUTLER, PERTH

Introduction

This case study provides an overview of the processes, challenges and implications involved in the implementation of a third-pipe network to supply untreated groundwater for outdoor household use and public open space irrigation. The greenfield residential development is located in the north-western corridor of Perth, in the suburb of Butler.

Overview: The Green at Brighton Estate

The Green is the fourth village to be built in the Brighton Estate development owned by the Satterley Property Group. The Green was highlighted by many interviewees as a landmark demonstration project for the Perth metropolitan region, described as "the first cab off the rank."

Built around the idea of "drinking water for people, not plants" (Satterley Property Group, nd, a), The Green features a third-pipe system which supplies untreated groundwater for irrigating private property and public open space. Five communal bores draw water from a shallow groundwater aquifer (30-65m below the surface) feeding into a ring main that services properties, verges and parks throughout the development. To ensure efficient delivery and to reduce household risk of misuse, the scheme is controlled via an automated, central system connected to a weather station, with moisture sensors determining whether soil conditions necessitate watering. Under dry conditions, water will be delivered to domestic lots on alternate days, and public open space watering will occur at 8mls per night for five nights per week (City of Wanneroo, 2006a). The system is only pressurised between 10pm and 6am, therefore reducing water loss through evaporation, and decreasing the potential for cross-connection. Landowners in the area are obligated to connect to the scheme as outlined in each land title. Residents are charged a fixed rate annually, whether or not they use the water.

It is predicted that the scheme will reduce drinking water consumption by 56% (Satterley Property Group, nd, a), representing total potable water savings of around 30-40% (Water Corporation, 2007a). The Green's alternative water supply was developed through a partnership between Satterley, the Water Corporation and the City of Wanneroo, and is currently in the construction phase of development. To date, around two hundred properties are connected to the system.

While this case study will focus of the third-pipe scheme, it is important to note that in addition to the water saving measures, The Green and the broader Brighton Estate have been some of the first developments in the City of Wanneroo to include elements of stormwater sensitive landscape design in the place of traditional sump-based drainage, in order to improve the quality of stormwater run-off in the region (see Figure 2). The subdivision also incorporates other sustainable features including sourcing "green" energy, energy efficient housing design, and is a "transport-oriented development", aiming to reduce reliance on private vehicle use (Satterley Property Group, nd., b).

THE GREEN AT BRIGHTON ESTATE - SNAPSHOT

- The fourth village of the Satterley Property Group's Brighton Estate in the suburb of Butler.
- Third-pipe scheme, sourced from groundwater, for public open space and private garden irrigation.
- 30-40% total water savings expected.

Drivers and Purpose of The Green

The Green provided an opportunity to trial an alternative water supply option in a Perth residential area on a small scale, with the potential for expansion in appropriate areas if the project is considered successful. For the Water Corporation, this project presented an ideal opportunity to reduce potable water demand through an alternative supply scheme with minimal health risk to customers, while also providing the chance to investigate a potential future role for the Water Corporation in alternative household water supply.

For the City of Wanneroo, the primary purpose of the demonstration project is to (City of Wanneroo, 2006a):

1. investigate the effectiveness and viability of a centrally controlled groundwater supply system to meet the community's external garden watering needs;
2. determine if a centrally controlled groundwater scheme will reduce demand for drinking water, and
3. investigate the feasibility of a centrally supplied water service to irrigate public open space and streetscapes.

Many interviewees identified the project as "developer-driven". Recognising several opportunities to address issues of sustainability in housing developments, the Satterley Property Group aimed to create The Green as an example of "environmental friendliness" (Satterley Property Group, nd., b). The opportunity to implement an alternative water supply option was considered a marketing edge for the new development in Perth, a city with little experience in developing alternative water supply schemes comparative to other Australian cities. In addition, the project assisted in meeting water saving and sustainable development targets in the *City of*

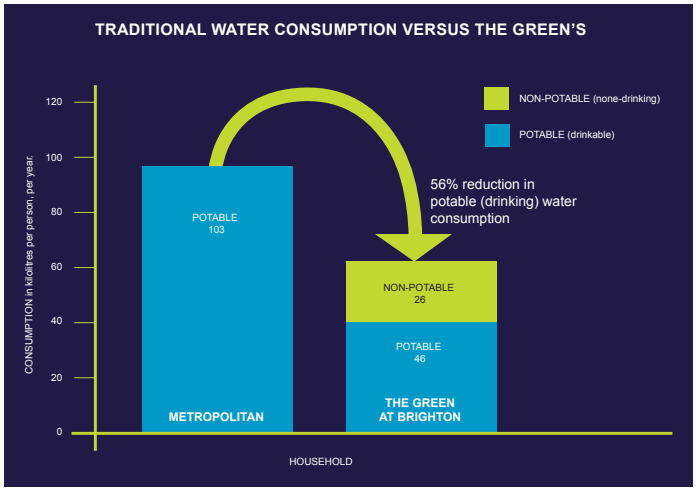

Figure 1: Potential Water Savings at The Green (Satterley Property group, undated 2)

Wanneroo Smart Growth Strategy 2005, and the *City of Wanneroo Strategic Plan 2006-2021* (City of Wanneroo, 2005; 2006b).

Another important driver for The Green, as identified by interviewees, was the small number of individuals who were key to the project's success and implementation. It was often stated that without these 'champions' driving the project forward, the trial would not have proceeded to the implementation stages. One particular project champion from Satterley Property Group was repeatedly identified as crucial in the initiation and implementation of the project. The project champion appealed to the Board of Satterley Property Group to make a serious attempt at a "green" development, rather than a "green wash" approach. As a former Water Corporation employee, the project champion enjoyed considerable support from the (now former) Chief Operating Officer of the Water Corporation, who was known to interviewees as an innovative thinker, and keen to trial an alternative approach to household water supply. This high level support secured the participation of the Water Corporation in the project, which was facilitated through the internal Water Efficiency Branch. Again, individuals working in the Water Efficiency Branch played key roles in the project by tackling the appropriate regulatory requirements and generating internal organisational support.

Key Aspects of the Implementation Process

The process undertaken to achieve on ground implementation of The Green's alternative water supply project involved both proactive and reactive elements. The design of the project was proactive as it attempted to reduce potable water consumption and investigated the potential role of alternative water supplies for household use. However, with no prior examples, the process for undertaking such a project was unclear.

Furthermore, as the developer initiated the project, much of the process was undertaken to accommodate the developer's requirements and timelines. This contributed to policies being developed as they were required, typically within short timeframes.

Discussions among the Water Corporation, Satterley Property Group and the City of Wanneroo began officially in late 2005. By mid-2006 a Memorandum of Understanding was signed by the parties, outlining the responsibilities of each member organisation, including water supply, maintenance and access agreements. Total Eden Watering Systems, an irrigation and reticulation specialist company, was responsible for installing the bores and reticulation, while the Water Corporation holds the operating licence. In addition, it was agreed that the Water Corporation would disconnect the irrigation system and hand control of the bores to the City of Wanneroo should the project be deemed a failure.

From the beginning, the project reportedly encountered a lot of resistance both internal and external to the organisations involved. Patient and committed individuals were required at all stages to keep the project moving forward. For example, the project champion was required to present multiple times to the Satterley Property Group's Board on the financial requirements of the project, which were causing resistance among certain Board members, to convince them to spend approximately $5-6 million to get the project off the ground.

Figure 2: Grassed swale area, Brighton Estate.

A lack of regulation and guidelines for alternative water supply schemes to residential lots reportedly led to resistance and conservatism within the Water Corporation and key regulatory bodies. Members of the Water Efficiency Branch, often with the assistance of the project champion, also had the challenging task of identifying the regulatory gaps and establishing a regulatory process to facilitate project approval. This included a number of round-table discussions among the Water Corporation, Satterley Property Group and regulatory agencies such as the Department of Health. While executive-level support existed within the City of Wanneroo, middle management and officer-level employees

reportedly approached the project with less confidence. Informal meetings were often required to convince council employees on the benefits of the alternative approach. As a result, navigating the approvals process was largely a process of trial and error that relied on dedicated and persistent individuals who asked many questions and pushed for responses and action.

Much of the resistance experienced by regulatory bodies was associated with perceived risks to health, and the uncertainty surrounding the "first time" nature of the project. As a result, addressing project risk was a key area of the approvals process. Risk assessment sessions were organised by the project facilitators between the key organisations to determine the significant aspects of risk management. Furthermore, a large, comprehensive health risk management plan was required by the Department of Health to address the potential risks posed to human health by the irrigation system.

As the Department of Water is responsible for issuing licences to extract groundwater in Western Australia, the Water Corporation and Satterley Property Group were required to apply for an extraction licence. Interviewees reported very few problems with the Department of Water as this remains a standard administrative process. Further, the location and access requirements for the groundwater at site of The Green worked in the project's favour as it is difficult to access this particular groundwater source. When issuing the licence, one condition was placed on its approval, which required that the system was able to demonstrate the scheme would provide 30-40% of potable water savings.

Monitoring and evaluation of the scheme was undertaken by the developer for a period of two years, to provide evidence of successful operation before the Water Corporation agreed to take over as the licence holder. Monitoring has focused on demand and cost, water quality, and consumer behaviour, perceptions and satisfaction. Funding from the Premier's Water Foundation (Department of Premier and Cabinet) was awarded to assist with the monitoring of customer expectations and water quality. The Water Corporation monitors water quality, and, as part of the Health Risk Management Plan, is required to check approximately 10% of houses every year for cross-connection, and in the event of house re-sale. Monitoring will continue for a period of five years after the last house is built, after which the Water Corporation will assess the business and community benefits of the scheme, and decide whether to continue (and possibly expand) the system.

Satterley Property Group place a strong emphasis on community building, and due to the perceived risks of the non-potable water supply, providing opportunities for community consultation regarding the alternative water supply scheme was considered extremely important by the project's participating organisations. Prior to project implementation, Satterley undertook market research to ascertain community expectations from such a scheme. A number of community information sessions were also held where community members had the opportunity to ask questions of the Water Corporation project team. The Water Corporation developed a Customer Charter in consultation with its Customer Advisory Council, to demonstrate commitment to conditions such as water quality, water pressure, and entry to property, unplanned interruptions, service standards, and account communication (City of Wanneroo, 2006a). Further, to assist in risk minimisation and improve customer understanding, community information packages have also been developed for residents and homeowners in The Green. In addition, to support the trial, several demonstration and interpretive sites have been incorporated throughout The Green to provide interactive opportunities for community and visitor education (See Figure 3).

The cost of the project was jointly covered by the Water Corporation and the Satterley Property Group. Satterley was responsible for the total cost of the third-pipe asset construction, to be handed over to the Water Corporation once finalised. According to interviewees, the willingness of the developer to pay for the initial establishment of the infrastructure substantially assisted in securing the Water Corporation's participation in the project. The Water Corporation financed the standardised internal systems, project management costs,

Figure 3: Examples of demonstration and interpretive sites at The Green, Brighton Estate.

1) A perspex box revealing the different pipe configuration for school children
2) Interpretative signage regarding the demonstration of porous pavement
3) An example of how the subsurface irrigation system is configured.

annual operating costs, any subsequent asset replacements and a 30% tax liability on asset handover (City of Wanneroo, 2006a). At present, the third-pipe infrastructure is in the ground, and approximately 200 houses are connected to the system.

In the scheme information brochure produced for residents, the Satterley Property Group has indicated that opportunities for further innovation will be investigated, including "plumbing non-potable water supply inside the home to facilitate toilet flushing which doesn't use drinking water" (Satterley Property Group, nd., a:9). This is also acknowledged as an option by the City of Wanneroo, "should the use of non-drinking water become acceptable within the house" by the community and regulatory authorities (City of Wanneroo, 2006a: 2).

Challenges and Opportunities within the Project

When challenging the status quo, regulatory barriers are commonly identified as a significant hurdle to overcome and The Green project was no exception. Although alternative water source projects have been undertaken for uses such as public open space irrigation (i.e. McGillivray Sporting Ovals) or industrial supply (Kwinana Water Reclamation Plant), the Perth metropolitan region has had relatively limited exposure to alternative water supply to households. Consequently, rather than attempting to introduce a greywater or wastewater recycling scheme, or to plumb houses to untreated groundwater, it was considered more appropriate to begin by providing untreated groundwater for outdoor household use only.

However, despite the decision to trial what was considered by some to be the least "challenging" of Perth's alternative water source options, interviewees still reported encountering significant barriers in the form of conservatism, risk aversion and lack of regulation, leading to overly complicated approvals requirements and processes. There are an estimated 164, 000 private bores across Western Australia (90% of those in the metropolitan region) that use groundwater for irrigation purposes (Government of Western Australia, 2007), yet the requirements for approval of the communal scheme, from a health and operational perspective, were comparatively strict. One project participant stated: "…it was really hard. It took two and a half years over something so simple….something the industry has been doing for decades…all we were doing was sinking bores."

A large number of the requirements were established by the Department of Health, who were largely concerned about the possibility of reducing current public health standards, thus requiring a 'Health Risk Management Plan' to be developed. While protection of public health was recognised by interviewees as essential, the level of in-depth investigation required by the Department of Health was considered by many project participants to be excessive. It is possible that this requirement is the result of the communal asset management arrangements, in comparison to the requirements for the operation of a private bore. For example, the construction of a typical, privately maintained garden bore requires the approval of the respective local government authority, and any risk is the responsibility of the individual. However, as the licence and therefore the responsibility for The Green scheme was held by the Water Corporation, and delivered at a larger scale, more in-depth analysis of the risks at the State level was required.

Figure 4: "Green" marketing

The majority of health concerns focused on the possibility of plumbing groundwater into the home for toilet-flushing and washing machine use, and the capacity of the community to manage the alternate water supply in an appropriate manner. While these concerns have limited the project's scope, they have also provided a positive opportunity to innovate around the concept of third-pipe groundwater schemes for outdoor household use. As the system is only pressurised between 10pm and 6am, the Health Department's fears about cross-connection were allayed, while also ensuring reduced evaporation due to night time watering. Furthermore, by emphasising a technological solution and limiting homeowner control of the system (residents can only switch off the water flow), the system could go ahead. The central operating system, controlled by a weather station, seeks to ensure efficient use of water for outdoor purposes. As over 47% of water used in a typical Western Australian household is used outdoors (Government of Western Australia, 2007), incorporating these measures are significant steps towards reducing water usage in Perth.

Although there was some high level support within the Water Corporation, securing commitment throughout the various levels of the organisation proved challenging for members of the Water Efficiency Branch, who were charged with getting the project off the ground. Risk adversity related to health and economic issues, combined with a reluctance to change current "efficient", "core business" practices, were identified as some of the more common attitudes and perceptions encountered at varying levels across departments within the business. This reluctance and conservatism contributed to making the planning and approvals process difficult to navigate.

AWARDS WON

- **Water Awards 2007**
  - Waterwise Development Award
  - Water Conservation and Efficiency for a Commercial Project
  - Water Innovation Award
  - Minister's Award for Excellence
- **UDIA Awards 2007**
  - Award for Water Sensitive Development
  - Award for Masterplanned Development

Cost was also considered a barrier to indoor plumbing of the third-pipe scheme, and certainly a challenge for the scheme in general. Several factors contributed to this limitation, including the project's role as a demonstration and the risk and uncertainty surrounding a new approach, as well as the lack of standards and guidelines for such a scheme. This contributed to outcomes such as having to use drinking water-standard pipes for water conveyance, and the provision of traditional infrastructure in case the scheme was deemed a failure. Limiting the scheme to outdoor household use reduced the cost to both the home-buyer and developer. On the other hand, cost has been seen by the Water Corporation as an opportunity for prospective residents, who are only charged a flat fee per year for the groundwater based on lot size ($65.15 for lots <400m² and $130.30 for lots >400m² (ERA, 2009)). In comparison to the cost of watering the garden with drinking water, customer savings are expected as a result of the scheme (Water Corporation, nd.).

However, more recently, the pricing scheme for the third-pipe system has been challenged in an Economic Regulation Authority (ERA) *Inquiry into the Pricing of Recycled Water in Western Australia* (2009). The ERA have raised concerns in relation to the scheme, regarding the Water Corporation rate-of-return on the scheme (28% real pre-tax), and the fact that customers do not have the option to disconnect from the outdoor system, and are therefore charged whether they use the water or not (ERA, 2009). The Water Corporation maintains that if scheme participation were optional, this would result in the need for a higher rate of return in order to reflect the risk of non-participation (Water Corporation, 2008a). They argue that without the mandatory charges, project viability would be at risk, as customers would be required to pay proportionately higher costs (Water Corporation, 2008a). The ERA however, states that "this is a commercial project, not a social project" and that pricing should adequately reflect the risk of the project (presumably even if that results in higher costs to the customer) (ERA, 2009: 61).

Indeed, the ERA's position is that the scheme revenue is too high relative to the system risk (ERA, 2009). However, the Water Corporation has justified the prices stating the corporation's need to recoup the costs incurred through the asset handover (ERA, 2009). While the developer paid for the construction of the third-pipe infrastructure, the consequent operational handover has resulted in additional costs to the Water Corporation. As the system handover legally constituted "gifted assets", the Water Corporation was required to pay tax on the assets, which are considered revenue (ERA, 2009). The tax is in addition to costs such as the intensive monitoring required for the scheme, which is not necessary for conventional developments. The Water Corporation has sought to recoup the incurred costs through customer charges (ERA, 2009). The ERA, however, would prefer that the Water Corporation's rate of return was based on the "capital and operating costs incurred by the service provider" and that tax cost recovery should be negotiated with the developer at asset handover, as is the case with other large scale infrastructure projects (ERA, 2009: 61). The ERA has concluded that for third-pipe schemes such as The Green at Brighton Estate, "where services are provided by a monopoly provider and customers do not have an alternative supply option, some light-handed regulatory oversight is required to check that the rate of return is not unreasonably high." (ERA, 2009: 63). At this stage there is no requirement to change customer charges for The Green.

Figure 5: **Weather Station**

The project has also provided a useful opportunity to engage and interact with the community. The information packages and demonstration sites (see Figure 3) promote awareness and improve the level of understanding within the community in relation to outdoor water conservation and the alternative water scheme. Sites within the estate demonstrate water sensitive garden ideas, including the irrigation system, purple pipe explanations, landscaping methods such as porous pavement to reduce lawn areas, and plant varieties requiring minimal water (Figure 3). Furthermore, the weather station (Figure 5) controlling the system is situated adjacent to the local school

grounds, providing an opportunity to generate student awareness of the project. These measures offer excellent opportunities to generate community interest and to improve the general understanding of water pressures and climate change facing the Perth metropolitan region, as well as receptivity to water supply alternatives.

Finally, although the third-pipe systems were not allowed to connect to indoor household uses at the time (i.e. toilet flushing and laundry), having the infrastructure there means there is greater flexibility into the future when alternative supply sources are allowed to be plumbed into homes.

Case Study Implications

There are a number of key implications for the future of demonstration projects in Perth arising from the third-pipe trial, particularly due to the identification of The Green development at Brighton Estate as "the first cab off the rank" in the metropolitan region regarding alternative water supplies for outdoor household use.

A number of specific conditions have contributed to the successful implementation of this project. Many interviewees highlighted that the geographical conditions were unique to the area, particularly in terms of groundwater access. For instance, the possibility of individual households tapping the aquifer was low, due to the depth and location of the aquifer below the surface and the restrictions and expenses this placed on drilling. Furthermore, the quality of the water in this aquifer was extremely high, particularly in terms of iron levels and colour, which meant that no treatment of the water was required before it was supplied to homes. This contributed to the trial being accepted and considered a "safe project" by the Water Corporation, as it reduced the levels of risk and the potential for failure.

Such unique conditions, however, limit the possibilities for replication of the alternative water supply approach. As a result of the trial, a number of other land developers began laying third-pipe infrastructure in their developments, assuming that since it was occurring at Brighton Estate, they could also get approval for a community groundwater supply system. However, as the location of the developments and groundwater access conditions were different in these cases, none of the developers were able to secure groundwater licences from the Department of Water due to concerns of over-allocation of groundwater resources in many areas of the Perth metropolitan region. Laying the third-pipe has come at a great cost to the developers and may act as a disincentive to introduce innovations in future developments. However, although these pipes may currently be stranded assets (to the developers), the pipes represent flexible infrastructure, which can allow future connections to alternative water servicing.

This project has been important in establishing a process and precedent for the involvement of the Water Corporation in such demonstration projects/trials. As a result of the ground work undertaken by the Water Efficiency Branch, the planning, contractual, regulatory and approvals documents and strategies developed for The Green can now be used as models for future (demonstration) projects. The Brighton experience, combined with the volume of requests for advice around alternative water servicing and the problems encountered with developers acting before securing development approvals, led the Water Corporation to producing a developer's guide to alternative water supplies in the Perth metropolitan area ("H2Options", now known as "Alternative water supplies: a 7 step guide for developers", Water Corporation, 2008b). The purpose of the guide is to delineate the considerations land developers need to take in order to involve the Water Corporation as the service provider for a third-pipe asset. Addressing the lack of a clear process for incorporating alternative water sources into new developments, the guide directs developers through the procedures involved, from developing an 'alternative water supply plan' through to securing approvals, design and finally implementation (Water Corporation, 2008b). Ultimately, however, the project has not convinced the Water Corporation to enhance its role in, nor encourage the uptake of, alternative household water supplies. Rather, the Water Corporation's preferred focus remains on efficiency gains and demand management measures.

The conservatism regarding public health implications surrounding communal bore systems is not unexpected when dealing with unconventional water sources (Brown *et al.*, 2009). However, this led to a more conservative project and consequently a lost opportunity to gain much greater potable water savings from inside household use (e.g. toilet flushing). Importantly, the Satterley Property Group has built on their experiences from The Green and included third-pipes in another project called Evermore Heights. This development incorporates a similar groundwater-sourced third-pipe for garden and public open space irrigation, but has also recently gained approval from the Department of Health for the provision of 3000L rainwater tanks to be plumbed into the house for toilet flushing and laundry purposes (Satterley Property Group, 2009).

While The Green was hailed as a landmark project in Perth, a number of projects using or investigating alternative water supplies such as rainwater tanks, wastewater or greywater recycling were identified by interviewees outside the Perth metropolitan boundary. For example the Bridgewater Lifestyle Village near Mandurah (south of Perth) incorporates a suite of sustainability initiatives, including recycling greywater for garden irrigation (National Lifestyle Villages, 2006). The same

developer (National Lifestyle Villages) has also established a dormant company, Moama Lifestyle Village Pty Ltd, in order to apply for a water operating license to manage a decentralised wastewater recycling scheme, treating effluent from a new development in North Baldivis for irrigation purposes.

Furthermore, the Water Corporation's reluctance and deferral to investigate the supply of recycled water to households (in comparison to water utilities in other Australian States) has provided the opportunity for other service providers to undertake the role. One example is a current project to up-grade water supply services for the small but growing town of Gracetown, roughly 250km south of Perth. New development occurring in the small coastal town is expected to double the number of homes in the area; however, Gracetown is not connected to any centralised water supply or sewerage networks at present. Water is currently supplied through rainwater tanks, while septic tanks provide sewage treatment. Over the past few years, the state-owned developer LandCorp has investigated expanding the water supply options for the area, placing emphasis on the need for sustainable solutions. United Utilities Australia recently won the tender to become the service provider for a third-pipe scheme, which will recycle wastewater from homes to a Class A+ standard, and re-deliver it for non-potable use (toilet flushing, cold-water laundry use, fire-fighting and garden watering) (LandCorp, 2009). The scheme has the potential to reduce household water demand by about 50%, therefore enabling drinking water to continue being sourced from roof-runoff, with extra supply being trucked in if required (LandCorp, 2009). Furthermore, a recycling scheme allows for the decommissioning of septic tanks in the area, currently contributing to groundwater pollution (LandCorp, 2009). United Utilities Australia is now in the process of seeking a license from the Economic Regulation Authority in Western Australia, and construction is expected to begin (subject to license approval) in August 2009 (United Utilities Australia, 2009).

To date, there is not yet an operational third-pipe scheme using recycled water in Western Australia. More recently, the Water Corporation has sought to refine its position on the supply of recycled water to households, through the consideration of involvement in third-pipe schemes using recycled wastewater in the Wungong Urban Water Project (WUWP) (see WUWP Case Study; Devenish and Ellis, 2009) and the town of Denmark, approximately 450km south of Perth (Kayaalp, 2009). However, the implementation of both proposed dual-reticulation schemes is still subject to feasibility studies being undertaken by the Corporation (see WUWP Case Study; Kayaalp, 2009).

Within the last year, the Department of Health has put considerable work into determining and clarifying Western Australia's position on health and alternative household water supplies. In April 2009, the Department of Health released the *Draft Guidelines for the Use of Recycled Water in Western Australia*, based on the 2006 *Australian Guidelines on the Use of Recycled Water: Managing Health and Environmental Risks (Phase 1)* (Department of Health, 2009). Such steps certainly play a significant role in supporting future opportunities for the development of sustainable alternative water supply options.

However, the issue of responsibility and accountability remains a concern for the operation and maintenance of third-pipe schemes, as there is little clarification around the roles and responsibilities of stakeholders involved. This is particularly in relation to the infrastructure cost contributions, completion and hand-over (from the developer), long term system management, responsibility and accountability within the property boundaries, as well as cost and pricing of the water service (see Kayaalp, 2009). These issues will need to be resolved over time, and potentially on a case-contextual basis.

While the lack of a formal process for undertaking an alternative household water supply project was often noted by interviewees, this is largely to be expected in a project that challenges the current status quo. Demonstration projects such as The Green are by their very nature undertaking something that has never been done before in Western Australia, and therefore the levels of inter- and intra-organisational collaboration required, as well as the regulatory and approvals processes to support such initiatives, often do not yet exist. However, the engagement in such a process as part of a demonstration project offers significant opportunities to establish inter-and intra-agency links and networks, and to learn about what types of formal process will be required in future projects through such interaction. The drivers of various projects and how they overcame the significant regulatory barriers identified by participants in The Green project, as well as other interview respondents, requires further investigation. It can already be seen that as a result of such projects, regulatory changes are beginning to occur in response to innovation (i.e. Department of Health). With the recent emergence of several alternative water supply projects in Western Australia, there are significant opportunities for information sharing and learning between organisations and projects occurring in- and outside the Perth area, particularly in terms of regulation and approvals processes. This would help build the foundations of the formal process called for by many interviewees.

References and further information

Brown, R., Keath, N. and Wong, T.H.F. (2009) "Urban Water Management in Cities: historical, current and future regimes." *Water Science and Technology*, 59(5): 847-855.

City of Wanneroo (2005) *Smart Growth Strategy 2005*.

City of Wanneroo (2006a) "Proposed Demonstration Project in the Delivery of Non Drinking Water Supplies to the Community – Brighton Village", *City of Wanneroo Agenda of Ordinary Council Meeting*, 27 June, 2006 (pers. comm).

City of Wanneroo (2006b) *Strategic Plan 2006-2021.*

Department of Health (2009) *Draft Guidelines for the Use of Recycled Water in Western Australia*, Government of Western Australia. Available at: http://www.public.health.wa.gov.au/2/643/2/recycled_water.pm

Devenish, S and Ellis, J. (2009) Water Sensitive Urban Design: A Tool for Viable Urban Development. *Proceedings of the 6th International Water Sensitive urban Design Conference and Hydrolpolis 3#, Perth, Western Australia, 5-8th May 2009.*

Economic Regulation Authority (ERA) (2009) *Final Report: Inquiry into Pricing of Recycled Water in Western Australia*: 6 February 2009.

Government of Western Australia (2007) *State Water Plan 2007.*

Kayaalp, N.M. (2009) "Challenges Associated with Implementing a Dual Reticulation System within the Western Australian Context." *Proceedings of the 6th International Water Sensitive urban Design Conference and Hydrolpolis 3#, Perth, Western Australia, 5-8th May 2009.*

LandCorp (2009) Gracetown Development, available at: http://internet.landcorp.com.au/portal/page/portal/grace

National Lifestyle Villages (2006) *Environmental Innovations – National Lifestyle Villages*.

Satterley Property Group (2009) http://www.satterley.com.au

Satterley Property Group (no date (nd.), a) "The End to the Waste of Precious Water Starts Here: Smartwater Initiative: A partnership between Satterley Property Group, Water Corporation and The City of Wanneroo", *Customer Information Booklet – The Green*.

Satterley Property Group (no date, b) The Green *Fact Sheet.*

Total Eden (2009) http://www.totaleden.com.au

United Utilities Australia (2009) http://www.unitedutilities.com.au

Water Corporation (2006) "Non-drinking water use facts for developers", *Mainstream*, No 3, September 2006.

Water Corporation (2007a) *Annual Report*.

Water Corporation (2007b) "Brighton trial to reduce household water use" *Mainstream*, No 5, September 2007.

Water Corporation (2008a) *Submission to the Economic Regulation Authority's Inquiry into Pricing of Recycled Water in Western Australia, Response to the Draft Report.* 12 December 2008, available at: http://www.era.wa.gov.au/3/773/46/public_submissi.pm

Water Corporation (2008b) *H2Options: A Seven Step Guide for Developers*. (CD-ROM), also available at: http://www.watercorporation.com.au/P/publications_alternative_water_supply.cfm

Water Corporation (no date) *Customer Information Package – Brighton Non-Drinking Water Supply.*

CASE STUDY OF
WUNGONG URBAN WATER PROJECT
ARMADALE, PERTH

Introduction

While the project is not yet in the final development stages, the Wungong Urban Water Project was selected because of the innovative planning process undertaken, the project's focus on issues of water management and sustainability, and its potential implications for future development in the Perth region. This document aims to provide a holistic overview of the selected project, including not just technical aspects, but also the processes undertaken, the challenges encountered and methods for overcoming these challenges during the course of project development and implementation.

Project Overview: Wungong Urban Water Project

The Wungong Urban Water Project (WUWP) provides a unique example of innovation in planning and process within the Perth metropolitan region. An environmentally sensitive and culturally significant area, the WUWP will provide medium-density and rural-residential housing for up to 40, 000 people. Planning for the WUWP has aimed to incorporate the environmental, social and economic considerations of the region, and is being undertaken via a process, and at a scale, never before attempted in Western Australia.

Covering 1580ha, the WUWP is located approximately 25km south-west of Perth within the City of Armadale and is one of Australia's largest urban renewal projects. Lying within the designated area of the Southern River/Forrestdale/Brookdale/ Wungong District Structure Plan (WAPC, 2001), the project is situated in the Southern River catchment of the Swan and Canning rivers system, with a small section in the south west draining to the Peel-Harvey Catchment (Grace *et al*., 2006; EPA, 2007) (See Figure 1). The project falls under the planning and development powers of the Armadale Redevelopment Authority (ARA).

There are currently 330 properties and approximately 205 landowners in the area, including Peet & Co, Stockland and the Western Australian Department of Housing and Works (ARA, 2008a). The presence of a high water table, extensive wetlands and degraded waterways present significant challenges to any development occurring in the region.

Over four years the Wungong Urban Water Master Plan team developed a 15-20 year Master Plan (released in 2007 and gazetted in 2008) to guide future growth in the area. The aim of the Master Plan is to create "a diverse and vibrant residential area that showcases best practice in sustainable urban development incorporating natural resource management, water sensitive urban design and energy-efficient housing" (ARA website, 2008). The innovations contained within the WUWP are not only technical, but extend well into the design and planning realms. Some of the key innovations within WUWP process highlighted by the ARA include (ARA, 2008a):

WUNGONG URBAN WATER PROJECT - SNAPSHOT

- Located 25km South-west of Perth.
- 1580ha, Master-planned development.
- **Driver:** Sustainable development: recognising the issues of population growth, urban expansion, water scarcity, and the ecological, cultural and historical significance of the region.
- **Purpose:** to provide an example for future development within a similar environmental context in the Perth region.
- **Features:** Extensive, collaborative planning approach, total water cycle management.

- the collaborative planning process;
- creating a Landscape Master Plan based on the area's natural landscape to initiate design;
- identification and preservation of Indigenous sites;
- Park Avenues designed for public open space, wildlife corridors and stormwater treatment and conveyance;
- an interconnected matrix of all Open Space;
- Wungong Urban Water Place Codes;
- Total Water Cycle Management; and
- District Solar Orientation.

The innovative process of the WUWP significantly challenges traditional planning for urban developments. While developing the Master Plan the focus on water shifted from an encumbrance to a major selling point of the project (Devenish and Eillis, 2009). Lessons learned throughout the project's planning stages, as well as it's on-ground implementation will provide important opportunities for guiding future development in Western Australia and beyond.

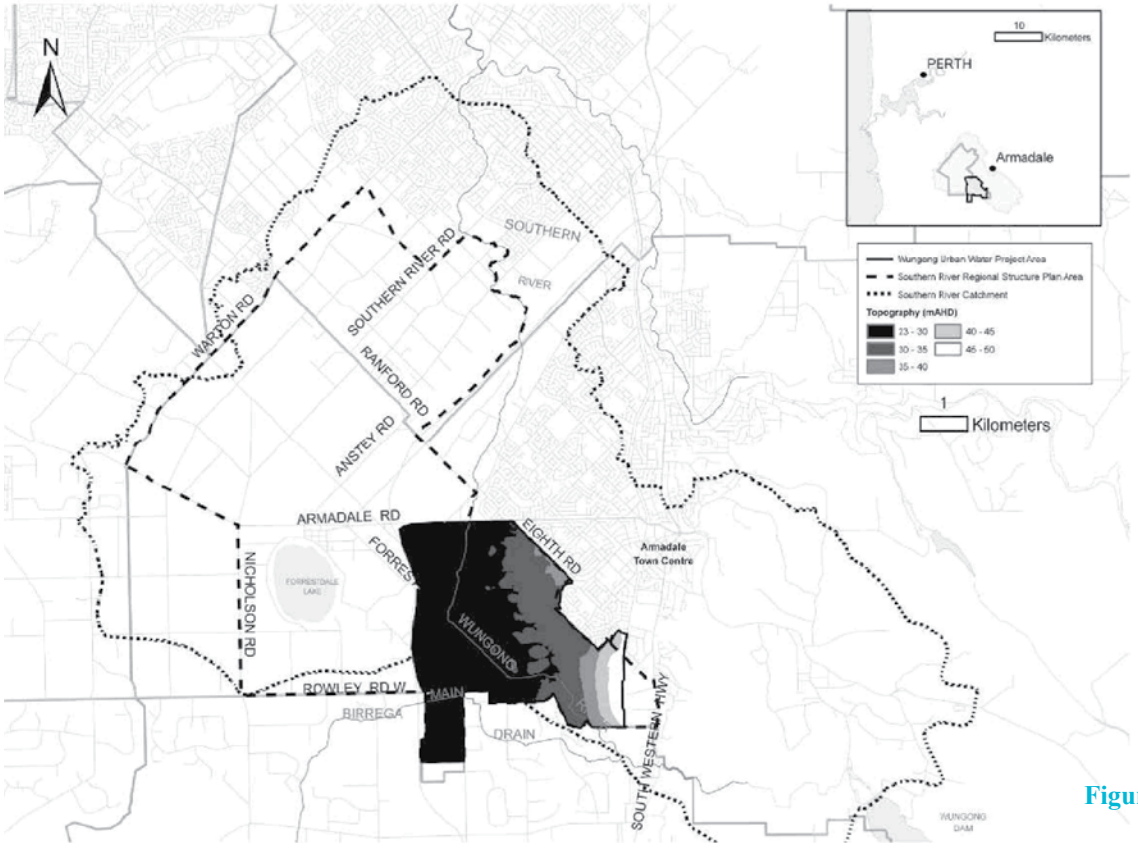

Figure 1: **Location plan (Grace *et al.*, 2006)**

Drivers and Purpose of the Wungong Urban Water Project

The WUWP has emerged from the culmination of many different drivers. The primary driver for the project was to approach development from a sustainability perspective and an attempt to build resilience to future climate change. While water is highlighted as the central aspect of sustainability for the project, other environmental, social and economic factors are also included. This resulted in the incorporation of innovative, best-practice planning tools to ensure any future development is undertaken in an ecologically, socially and economically responsible manner.

The sustainability focus of the project is underpinned and challenged by a number of factors which have contributed to driving the scheme. Perth is one of the fastest growing regions in Australia, growing by 2.3% during 2006-07 (Australian Bureau of Statistics, 2008). Thus, population growth is a key driver for increasing development in the WUWP area. This has posed a significant challenge to government planning institutions which have been required to open up new areas for development, many which were previously considered difficult to develop and have very little value in the property market (Devenish and Ellis, 2009). A number of interviewees noted that the easily developed areas in the Perth region are already utilised, therefore land previously deemed "undevelopable" or "uneconomic to develop" was now being released to developers. Residential development in Perth has traditionally occurred on sandy soils, and involved levelling the intended area for development, often resulting in significant loss of vegetation and natural form (Wood-Gush, 2008). However, such practices are neither considered feasible, nor sustainable, for many new, environmentally sensitive development areas, such as the WUWP area. For example, development in the WUWP area will be constrained due to its high water table, clay (plastic) soils, extensive wetlands and other significant ecological and cultural factors. Consequently, alternative approaches to development of the area needed to be considered.

In addition, a number of interviewees indicated that the total water cycle management emphasis within the WUWP project was the result of a combination of factors including the increasing demand for water (directed by population growth) and the need to address regional implications of climate change. For example, since the 1970s, Perth has experienced significantly reduced inflows to surface water catchment dams;

AWARDS WON

- **Planning Institute Australia 2007 West Australian Division Awards for Planning Excellence:**
  - President's Award for Planning Excellence
  - Award for Excellence in Environmental Conservation or Planning.

thus to support an increasing population alternative water supplies will be important.

A further purpose of the WUWP was to assist in revitalising the area, through creating a point of difference for the region and a pleasant, healthy environment to live in. This social objective was important to overcome the perceived negative reputation of the area, as established by CSIRO research, and largely attributed to the area's lower socio-economic history among other factors (see Green *et al.*, 2004; Devenish and Ellis, 2009). This issue was compounded by low-quality land development that had previously occurred in the area, contributing to the low economic value of the land (Devenish and Ellis, 2009).

Finally, many interviewees also noted the significant political support for the project from the then Planning and Infrastructure Minister, Alannah MacTiernan. As the Member for Armadale, Minister MacTiernan was highlighted as a key driving force behind the project's continuing momentum and sustainability focus.

Overall, the WUWP intends to provide a best practice model for future development in Western Australia, particularly in the realms of total water cycle management and integrated land and water development. The specific aim and vision of the ARA is to "establish a physical, social and environmental framework that will enable Armadale to build on its existing strengths and assets and develop the vibrant, multi-dimensional place of civic, cultural and economic significance that a strategic regional centre should be" (ARA, web 2008).

Process of Implementation: Wungong Urban Water Project

To date, the process of implementing the WUWP has been a complicated and carefully managed process influenced from many directions, including policy, government, industry and the community. Some of the key processes, both external and internal to the WUWP are outlined below. These include planning developments within the broader regional context; the establishment of the ARA and the inception of the project; the master planning process; and the process envisaged for on-ground implementation. Many of these processes have occurred simultaneously and interdependently, and significant emphasis has been placed on the need for stakeholder collaboration to resolve issues and work towards sustainability-focussed outcomes.

Figure 2 provides a basic overview of the implementation framework established for the WUWP.

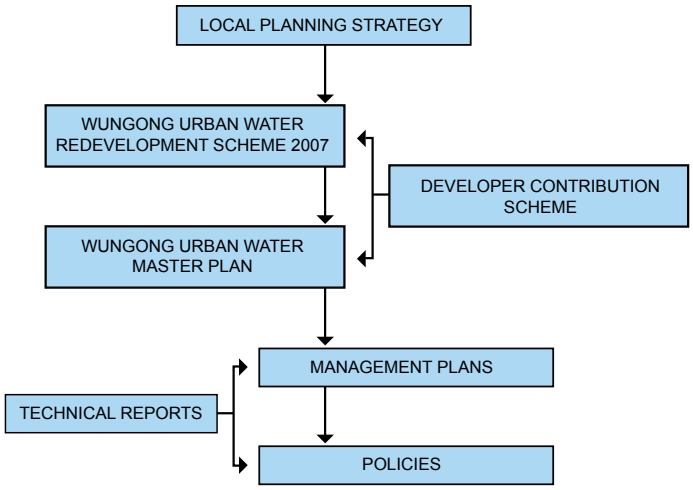

Figure 2: Wungong Urban Water Implementation Framework (Devenish and Ellis, 2009: 573).

The broader regional context

During the late 1990s, increasing pressure to develop land in the areas of Southern River in the City of Gosnells, and Forrestdale, Brookdale and Wungong in the City of Armadale, led the Western Australian Planning Commission (WAPC) to address the significant environmental constraints in the region before any development could take place (WAPC, 2001). Released in January 2001, the aim of the Southern River/Forrestdale/Brookdale/Wungong District Structure Plan was to guide future development and manage environmental issues in the area. This included the identification of potential areas for development, road networks, major community facilities, neighbourhood structure, conservation and Bush Forever sites, as well as providing recommendations for the Plan's implementation (WAPC, 2001). The WUWP area is encompassed within the District Structure Plan.

Following a review of a draft District Structure Plan, the Environmental Protection Authority (EPA) raised concerns regarding potential land use legacies and changes, particularly in relation to drainage constraints, hydrological impacts and nutrient management. This led to the development of the Southern River/Forrestdale/Brookdale/Wungong Urban Water Management Strategy (UWMS), released in April 2002. The document "embraces a stormwater vision of protecting water resources, ensuring an enhanced living environment for its community, and providing protection from flooding" (JDA, 2002:iv). The document was designed to highlight strategies to mitigate any negative impacts on the wetlands, hydrology or regional river systems that may arise from future development (JDA, 2002).

To facilitate and ensure the implementation of the UWMS, the EPA requested a Memorandum of Understanding (MOU) be signed by the then Water and Rivers Commission (now two organisations: Department of Environment and Conservation/ Department of Water), the City of Armadale, City of Gosnells,

Water Corporation, WAPC and the ARA (this was completed in October 2003). As part of the MOU, the Water Corporation was to coordinate the development of a Total Water Cycle Plan for the region (which involved best management practices), in collaboration with the other MOU signatory organisations. However, in recognition of the need to integrate land use and development planning with a total water cycle management approach, the MOU group changed the Total Water Cycle Plan to the Southern River Interim Integrated Land and Water Management Plan (Water Corporation, 2007). This plan was released in July 2007 and outlines the water management requirements at the regional, local and lot scale, with the inclusion of specific design targets for managing potable water use as well as surface and groundwater quantity and quality (Water Corporation, 2007). These documents have underpinned and guided planning in the WUWP region.

Armadale Redevelopment Authority and project foundations

In late 1999 an 'Inquiry By Design' workshop was held by the City of Armadale and the then Ministry for Planning's Urban Design and Major Places unit in order to discuss the future direction of the Armadale region and examine the development concerns facing the city (ATA Environmental Services, 2006a). The region was long considered a key strategic centre for the Perth metropolitan region by State planning authorities (ATA Environmental Services, 2006a).

The ARA was established under the Armadale Redevelopment Act 2001, to oversee revitalisation of the area. Removing the responsibility from the local government authority, the Act provides the State Government, through the ARA, with the power to directly control development and redevelopment within the specified area. The Act includes the unique requirement that the ARA provide for social as well as economic development within the region (ARA Sustainability Audit 2008). When the ARA began in March 2002, its jurisdiction included a number of development sites within the Armadale area. However, the WUWP area was not officially included in the Armadale Redevelopment Zone until 2004.

Initially titled the Brookdale Water Cycle Project, the Brookdale Redevelopment Scheme was adopted in 2005. However, in December 2005 the name of the project was changed to the Wungong Urban Water Project in recognition of the Wungong River traversing the site, and also, as suggested by interviewees, to disassociate the new development from the perceived negative connotations of "Brookdale", related to the region's reputation. The Scheme was later amended in 2006 to become the Wungong Urban Water Redevelopment Scheme which places a moratorium on subdivision and development until a Master Plan and Structure Plan are completed for the area (ATA Environmental Services, 2006a), ensuring any planning and development within the area is in accordance with the finalised Master Plan.

In February 2005, the EPA agreed to undertake an environmental assessment of the redevelopment area at the level of Strategic Environmental Assessment (SEA) (EPA, 2007). As this process was considered relatively new, the EPA agreed to assist the ARA to undertake the necessary requirements. However, the SEA process required any further planning for the project to be undertaken sequentially to the assessment, rather than concurrently. This did not suit the timeline objectives of the ARA, who were keen to advance the project as soon as possible by initiating the necessary changes to the Scheme in order to further develop the framework for project implementation. As a result, in August 2006, the EPA advised that an Environmental Review was the preferred method of assessment for the amended Wungong Urban Water Scheme 2006 (EPA, 2007).

The ARA submitted a grant application to the National Water Commission's Water Smart Australia (WSA) program in 2006, to assist in the implementation of the WUWP Master Plan (see below)(ARA, 2006). The only urban development project to win program funding, the WUWP received $6.19 million from the Australian Government, approximately half the amount they applied for. In 2008, the ARA announced a Western Australian State Government commitment of $12.5 million, half of which was intended to match the WSA funding. The combined sum of approximately $12.4 million was specifically intended to assist in funding the non-potable water supply, urban stormwater management, the re-establishment of living streams, and the creation of Park Avenues (Government of Western Australia, 2008). The 2009 State Budget has given approval for the ARA to expend $59.5 million up to June 2013 on scheme costs, much of which will be recouped from developers through a Developer Contribution Scheme as they subdivide their land. Scheme costs involve some third pipe costs in addition to living streams and district road works.

Wungong Urban Water Master Plan

The inclusion of the WUWP area into the Armadale Redevelopment zone in 2004 was no surprise to the ARA, who had initiated discussions regarding the future of the 1580ha site by organising the Brookdale Water Symposium, "From Catchment to Consumer", in 2003. The conference was designed to focus thinking around water issues and future development in the area, and was attended by land development and water professionals from around Australia. This process heralded the beginnings of the Wungong Urban Water Master Plan (ARA, 2008a).

The entire WUWP area was master planned as a single entity "to ensure integration and appropriate physical, environmental and visual connections exist between proposed residential development, community facilities and areas of public open space" (ATA Environmental Services, 2006a: 11). In an application to the National Water Commission for a Water Smart Australia Programme Grant, the key objectives of the master planning process for the project were outlined, including (ARA, 2006):

- Develop a new model to provide a benchmark for urban planning;
- Adopt a total water cycle approach to urban water management from rainfall to river;
- Preserve and enhance ecological function and conserve natural assets;
- Minimise import of scheme water via provision of both potable and non potable water supply;
- Identify, protect and recognise indigenous sites;
- Establish a revolutionary interconnected district network of contemporary open space;
- Minimise cut to fill earthworks to assist in affordability and retention of existing character;
- Provide climate responsive housing design across the neighbourhood;
- Provide diversity in sustainable housing choice; and
- Raise the community's awareness of the environment in which they live and their impacts upon it.

The Master Plan incorporates various aspects of sustainability, including minimising traffic impact, as well as heating, cooling, lighting and energy requirements. However, issues around the integration of land and water planning and total water cycle management have been central to the development of the Master Plan. Key elements of the Master Plan in relation to urban water management include (ATA Environmental Services, 2006a: 12):

- Park Avenues for detention, retention, conveyance, and treatment of stormwater;
- Converting existing trapezoidal drains within the WUWP area to 'Living Streams';
- Provision of appropriate buffer zones to ensure protection of the Wungong River, its associated tributaries, and significant wetlands;
- Maintenance of flow paths through the WUWP area for upstream catchments;
- Provision of a treatment train approach to stormwater management including both structural and non-structural controls, consistent with DEC requirements;
- Implementation of a controlled groundwater level in identified areas to minimise large scale trucking of fill consistent with sustainability principles;
- Implementation of water efficiency and demand management measures to reduce both inside and outside household domestic water use; and
- Minimising scheme water use by providing non-potable, fit-for-purpose supply for domestic and POS irrigation, toilet flushing, laundry use (cold water inlet) and potentially hot water system.

The Master Plan was developed via a unique, collaborative process that took more than four years to complete, and involved a core team of 64 people from 38 organisations (Devenish and Ellis, 2009). Members included representatives from organisations such as the ARA, City of Armadale, CSIRO, Department of Environment and Conservation, Department of Planning and Infrastructure, Department of Water, Water Corporation, Department of Housing and Works and the University of Western Australia (ARA, 2008a).

In December 2003 the ARA established the Wungong Urban Water Steering Committee, which included representatives from a variety of stakeholder organisations (ARA, 2008a). The Steering Committee has the responsibility for decision-making and outcomes of the master planning process. To provide a foundation of technical expertise to assist in this process, a multi-disciplinary Consultants Group was created by the ARA-appointed Project Director in collaboration with the Project Manager (ARA, 2008a). Members of this group remained constant throughout the planning process, and came from a variety of consulting agencies operating within the region (ARA, 2008a). The Consultants Group were responsible for the majority of outputs from the WUWP Master Plan team, such as reports on the environmental and hydrological constraints and opportunities in the region (ATA Environmental, 2004; JDA, 2004), regional flora and fauna assessments (i.e., ATA Environmental, 2006b; 2006c), and investigations into Aboriginal heritage (i.e., Tempus Archaeology, 2007).

Other working groups were also formed throughout the planning stages, to undertake and examine large and highly specialised tasks. A member of the Consultants Group was typically involved, along with additional key stakeholders and experts in the required disciplines. The flow of information was facilitated by the Project Director, who was a member of all groups (ARA, 2008a). Group members were encouraged to consider themselves both as experts with relevant knowledge to contribute, as well as neutral community members (ARA, 2008a).

Examples of these groups include:

- The Implementation Plans for Sustainability Group: made up of members of industry, community and government agencies, was assigned the role of collating all the master planning elements into a final report (ARA, 2008a).
- The Built Form Group: chaired by the State Architect. Members of this group included various technical experts from organisations such as CSIRO, the Department for Planning and Infrastructure, the Sustainable Energy Office, the Master Builders Association, the Housing Industry Association, ARA and the City of Armadale as well as local builders and architects (ARA, 2008a). Their mandate was to make recommendations regarding building guidelines and policies to encourage innovative and sustainable building performance standards (ARA web 2008).

- The Water Group: tasked with investigating water issues and options, including assisting in the development of the Wungong Urban Water District Water Management Strategy (JDA et al, 2006) as well as developing an implementation plan and business case for non-potable water supply (ATA Environmental Services, 2006a).
- A Peer Review Group and Major Landowners Group were created to review the progress of the Master Plan at various points throughout the process (ARA, 2008a).

The collaborative master planning process allowed for the inclusion of participants with relevant expertise to present best practice options and assist in problem resolution. Representatives had a variety of backgrounds, including landscape architecture, urban planning, hydrology, environmental science, social science, engineering, transport planning, architecture, building, archaeology and heritage (ARA, 2008a). This process was supported and facilitated by open dialogue around problems and opportunities encountered within the project, ensuring any conclusions drawn were done so with a wide support base (ARA, 2008a). Decisions were determined by casting a vote (one vote per member) and this was done only after all the relevant information and various options had been examined (ARA, 2008a). Any recommendations were agreed upon within the group before being presented to the Steering Committee for final approval (ARA, 2008a).

The initial design for the WUWP area was developed through the commission of a Landscape Structure Plan, produced by landscape architects from the University of Western Australia in 2004. This unique approach was undertaken in order to explore the possibilities for incorporating the natural characteristics of the landscape into a suburban development. One of the most significant outcomes from this approach was the design of Park Avenues, a series of corridors providing the multiple functions of public open space (POS), stormwater detention and conveyance, as well as wildlife and indigenous vegetation corridors (see Figure X). The Avenues connect the matrix of POS in the development, as well as treat stormwater before entering the Wungong River and surrounding wetlands (Grace *et al*., 2006). Furthermore, where possible, the alignment of the Avenues has played a role in determining the orientation of housing lots to encourage solar energy efficiency (Grace *et al.*, 2006). Additional stormwater management initiatives will include the reconversion of existing trapezoidal drains into Living Streams. The stormwater treatment focus of the Master Plan has arisen largely from the outcomes of the Landscape Structure Plan.

In addition to stormwater management, there are two other significant urban water issues addressed by the Master Plan: water conservation and non-potable water supply options. Recently, the State Government has emphasised the need to conserve water and find suitable replacements for scheme water use where possible (e.g. State Water Strategy 2003; State Water Plan 2007). To achieve the goals set by the State Government, the Water Corporation developed the Waterwise Land Development Criteria (one of many Waterwise programs), which were finalised in 2008 (Water Corporation, 2008). The Criteria have been used as a guide in the development of the WUWP Master Plan, and include water efficiency measures for inside (i.e. water efficient taps and showerheads) and outside homes (i.e. subsurface irrigation, soil conditioning) (ARA (WSA), 2006). These measures, in combination with the use of non-potable water for specified functions, have contributed to a potable water consumption target in the WUWP area at 50kL per person, per year (ARA, 2006), significantly lower than the household targets set in the State Water Plan at less that 100kL per person, per year by 2012 (Government of Western Australia, 2007).

Supplementing potable water with alternative water sources (for uses where drinking water quality is non-essential) has been a key objective of the WUWP from the outset. In applying for the WSA program grant, potential non-potable supply options were identified as roof run-off, groundwater, stormwater (predominantly road run-off), greywater and wastewater (ARA, 2006). Following feasibility evaluations of each source, two integrated options for the WUWP were identified (see Table 1). These options assumed scheme water for potable uses, conventional sewerage systems for wastewater conveyance and treatment, and that non-potable sources will supply domestic and POS irrigation, toilet-flushing, laundry use (cold water only), and possibly the hot water system (via roof run-off only), along with water efficiency and demand management measures (ARA, 2006). These options were assessed using conceptual water balances to determine the impacts on the WUWP area (ARA, 2006). Based on the assessments, it is estimated that both options would more than halve the volume of water reaching drains, waterways and groundwater compared to conventional methods (from 4700ML/year to 2100ML/year) (ARA, 2006).

Figure 3: Cross-section example of a proposed Park Avenue (ARA, 2008a)

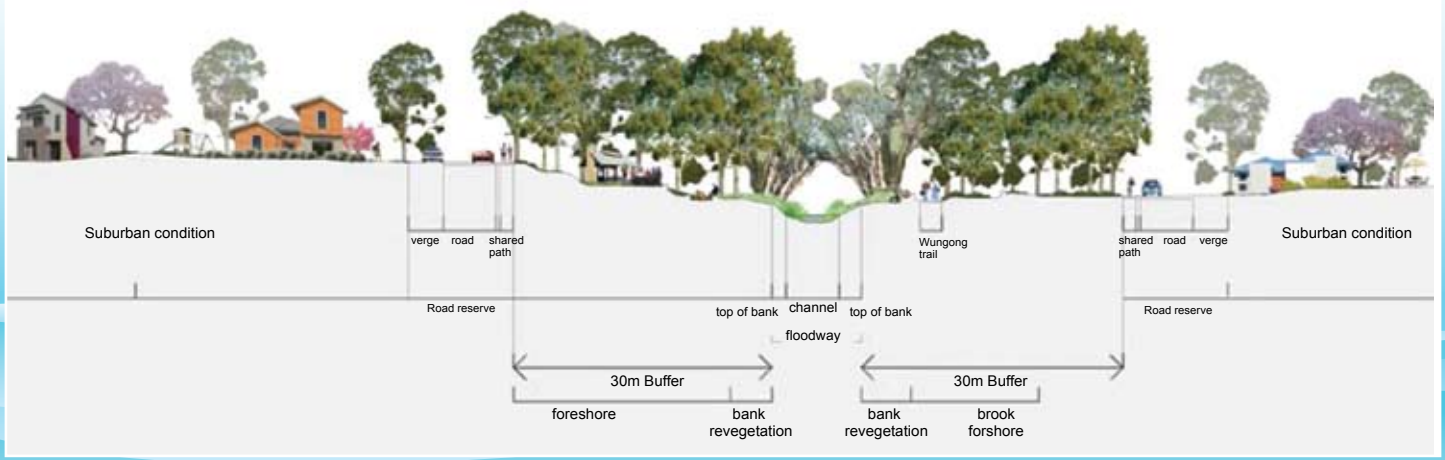

Table 1: Feasible Household Water Supply Options (adapted from ARA, 2006; Grace *et al.*, 2006).

OPTIONS	Kitchen	Bathroom	Laundry	Toilet	HWS	Yard	POS
	Cold Water				Hot Water	Cold Water	
	Potable (P)		Non-potable (N-P)			N-P	
Option A							
Scheme	✓	✓			✓		
Roof Run-off			✓	✓	✓ (Alt)*		
Groundwater						✓	✓
Treated Greywater				✓(Alt)		✓ (Alt)	
Treated Wastewater							
Option B							
Scheme	✓	✓			✓		
Roof Run-off							
Groundwater			✓	✓	✓ (Alt)	✓	✓
Treated Greywater				✓(Alt)		✓(Alt)	
Treated Wastewater							
*(Alt) = Alternative option							

Both Perth's superficial, unconfined aquifer and the deeper, confined Leederville aquifer underlay the WUWP area. However, use of this groundwater is constrained by a number of factors, including: high clay content of the superficial aquifer and declining pressure issues related the Leederville aquifer (Grace *et al.,* 2006). Based on outcomes from monitoring and groundwater modelling undertaken by the CSIRO (Grace *et al*., 2006), initial plans included the supply of groundwater sourced from the Leederville aquifer through a series (network) of community bores (similar to those of The Green at Brighton Estate north of Perth, further supplemented by rainwater from roof run-off). However, the community bore approach has recently been discounted due to the unconfined nature of the aquifer underlying the majority of the project area.

Current proposals include aquifer storage and recovery (ASR) schemes (stormwater or treated wastewater) and sewer mining (Devenish and Ellis, 2009). For the stormwater ASR scheme, drainage water from the WUWP area would treated and injected into the aquifer for later recovery (ARA, 2007b; Grace *et al*., 2006; Devenish and Ellis, 2009). Feasibility testing for this option continues and is being carried out by the ARA in conjunction with the Water Corporation, and with the support of Water Smart Australia funding. Although not included in the original feasibility options (Table 1), the close proximity of a Water Corporation sewage pumping station to the north-west of the WUWP area provides an alternative opportunity for the third-pipe scheme to source water through sewer mining, if the groundwater-recharge option fails to gain traction. Treated water sourced through sewer mining could be delivered directly to homes via a third pipe, or first injected into the ground and then delivered to homes as part of a treated wastewater ASR option (Devenish and Ellis, 2009). In addition, the option of a recycled water treatment plant is also being explored, with the potential to incorporate further greenfield residential and industrial development adjacent to the WUWP area.

Certainly, one confirmed option for 'alternative' household water supply includes rainwater. The Department of Health has recently given approval for using rainwater in hot water systems, provided it is not mixed with the non-potable water supply. The use of alternative water supplies has the potential to reduce potable water use by 75% in the Wungong area - a saving of 5GL of drinking water per year (Devenish and Ellis, 2009).

Monitoring of the region has been an integral part in the development of the total water cycle management approach of the WUWP Master Plan. Following the initial Brookdale Water Symposium, there was recognition that monitoring of the region needed to begin immediately in order to establish baseline data that could guide future development, and feed into documents such as the Landscape Structure Plan and, ultimately, the Master Plan. The CSIRO has played a large role in this respect, joining the project in late 2003 and formalising their commitment through a Memorandum of Understanding with the ARA in February 2004 (ARA, 2008a). Through the Water for a Healthy Country Flagship program, the CSIRO has undertaken an ongoing surface and groundwater monitoring program, looking at water quality and quantity of the area, as well as locating the areas with a high water table and acid sulphate soils which complicate development. The hydrological data collected by the CSIRO has also informed the Wungong Urban Water District Water Management Strategy, developed as a part of the master planning process to recommend an approach to total water cycle management in the project area (JDA *et al*., 2006).

In 2004, the CSIRO's Australian Research Centre for Water in Society undertook research to identify elements contributing to an "identity" for the Wungong area (Green *et al*., 2004; Johnston *et al*., 2004). To begin, researchers interviewed a number of community members from different social and cultural backgrounds in relation to aspects of the area's history, current perceptions of the area, current and future concerns for the area, and future aspirations for the region (Green *et al*., 2004). Having identified a number of key impressions, a survey was developed to further investigate those aspects. This phase, however, focussed more specifically on preferences for design features for the WUWP development, as well as gauging interest about living in the area once the WUWP is completed (Johnston *et al*., 2004). The purpose of this research was to ensure that the Master Plan was developed in a way that incorporated the historical and cultural values placed on the region by local residents, assisted in over coming or mitigating some of the current and future concerns interviewees held for the region and contributed to building an "identity" for the project area.

Indigenous heritage sites have also been identified within the WUWP area, and incorporated into the Master Plan via POS, environmental buffers and other suitable land uses to ensure their protection and to "provide a unique framework for developing on-country interpretation and promote broader scientific and public understanding of Aboriginal culture" (ARA, 2008d: 3). Non-indigenous sites, such as the John Haynes Dairy, have also been identified as significant cultural landmarks worthy of conservation (ARA, 2008d).

Towards on-ground implementation of the WUWP

In February 2008, the Wungong Urban Water Master Plan was gazetted, with the first development lots to be created in 2010 (Devenish and Ellis, 2009). Landowners are now able to begin work on Structure Plans for the area, which will outline the design features and planning for their area, required before any development or subdivision can begin.

The WUWP Master Plan is divided into 13 Structure Plan cells, with the boundaries of the cells developed in consideration of factors such as infrastructure needs, land ownership, water sub-catchments, and physical, geographical boundaries (ATA Environmental Services, 2006a). Landowners within a particular cell are required to work together to produce a Structure Plan for the area, demonstrating the process and timeframes for development and subdivision. In August 2008, the ARA released several policy documents relating to specific requirements in order to facilitate the development of the Structure Plans and Subdivision approvals (ARA, 2008a). Requirements of the Structure Plans include demonstrating the planning context of the area (including integration with other cells), advise on expected land uses, location and density of buildings, propose plans for provision of key infrastructure, services, and road networks. The Structure Plan is developed in accordance with the goals of the Master Plan and relevant State policy, and must relate to a list of twelve environmental management plans (i.e. District Water Management Strategy; Fauna Relocation and Management Strategy; Acid Sulfate Soils Management Plan etc.), with justification required if a particular plan is not included (ARA, 2007a). Furthermore, the Urban Water Management Policy requires the development of a Local Water Management Strategy consistent with the Wungong Urban Water District Water Management Strategy for each cell within the WUWP area (ARA, 2008b).

Figure 4: Perspective drawing illustrating the intended character of the Town Activity Centre (ARA, 2008c)

To ensure development remains consistent with the WUWP Master Plan's intentions for the future character and aesthetics of the region, and to assist in guiding the development of the Structure Plans to achieve these goals, the WUWP Master Plan team have undertaken a place-based planning approach. This innovative approach aims to reshape existing planning and design policy to move away from a "one code fits all" approach, and leave room for planning that is relevant to a specific place (ARA, 2007b). This type of planning allows for site responsive design and planning and variety in built form and land use, while ensuring the overall objectives of the Master Plan are met (ARA, 2007b; ARA, 2008c). While traditional standards are typically applied to lots in isolation, the WUWP Place Codes integrate the public and private realms, in recognition of the interrelated nature of elements such as built form, building setbacks and frontages, streetscapes, public open space and landscaping (ARA, 2008a). Eight Place Codes have been developed, six of which are detailed in a Wungong Place Code document to assist decision-making for future planning and implementation. The document outlines the intended character for places such as the "Town Activity Centre" or "Suburban Areas", including the key elements that will contribute to the area as well as providing examples of how such an area might look (see Figure 4). The WUWP will be "the first large scale fully integrated, place based, mixed use development in Western Australia" (ARA, 2007b: 3).

To assist in early infrastructure delivery to the region, a Developer Contribution Scheme has been developed in order to equitably share the cost of common infrastructure among landowners. This is divided into two components: Scheme Costs, which are considered to serve the whole project area; and Cell Costs, which relate to works undertaken within a particular cell (ARA, 2007b). This Scheme relates to the infrastructure costs of works such as roads, living streams, non-potable water supply headworks, gas and water mains extensions, service infrastructure and Aboriginal heritage sites for example (ARA, 2007b). With the likely inclusion of POS acquisition and development as part of the Contribution Scheme, the total cost of the Scheme is now approaching $300 million over 15 to 20 years. These works are undertaken by the ARA with expenditure recovered from developers at time of subdivision. This Developer Contribution Scheme is possibly the largest of its kind undertaken in Australia.

Challenges and Opportunities: the Wungong Urban Water Project

One of the most significant challenges facing the WUWP is the biophysical constraints of the development area. The WUWP area is characterised by a high water table and extensive palusplain wetlands, including the RAMSAR-listed Forrestdale Lake 1.5km to the west (ATA Environmental Services, 2006a; Grace, *et al*., 2006) (See figure 1). A sensitive and highly modified hydrologic environment, most of the WUWP area's watercourses, including the Wungong River, have become trapezoidal drains that are recognised as major contributors of nutrients to the Swan and Canning River system (Grace *et al*., 2006; ATA Environmental Services, 2006a). The Wungong River is also highly regulated by the Wungong dam, located upstream of the project area (Grace *et al*., 2006). Some current and previous land uses have been of high impact to the area, including the recently closed Brookdale liquid waste disposal facility, grazing, piggery and poultry farms, market gardens, a Water Corporation pumping station, and the Tonkin highway extension (ATA Environmental Services, 2006a). As a result, conventional approaches to development are not considered physically, ecologically or economically viable. In order to ensure the protection of the sensitive local environment, as well as ensure the practical and successful development of the site, an extensive, robust and on-going monitoring and evaluation process is required. Furthermore, it was noted during interviews that due to the challenging location of the development, in the case of project failure, recovery would be near to impossible, particularly in relation to the high water table in the area. At the same time, however, it was also pointed out that due to the fifteen to twenty year development timeframe for the project, there may be opportunities to mitigate problems as they arise.

A significant challenge encountered during the planning stages of the WUWP was associated with the environmental approvals process. Much time and effort was required to change the documentation and evaluation from a strategic environmental assessment to an environmental review process. In addition, a significant period of time was also lost during an appeal against the EPA's Environmental Review report and recommendations on the Wungong Urban Water Redevelopment Scheme 2006. The appeal focused on recommendations that set Total Phosphorous reduction targets for nutrients entering the receiving waterways at a level of 80%, a target both the ARA and developers Stockland felt was unrealistic in terms of measurement and proving compliance (Office of the Appeals Convenor, 2007). After some time, all relevant authorities (Swan River Trust, the Department of Water, Water Corporation, EPA, ARA and Stockland) were brought together in December 2007 by the Office of the Appeals Convenor to discuss the issue. This resulted in the amendment of the target to 60% reduction in the average annual load of total phosphorous in comparison to traditional stormwater design, recognising that although 80% was a 'desirable' target, it was an unreasonable expectation in terms of compliance measurement (Minister for the Environment, 2008). This process took over 9 months to be resolved, with the approvals coming through in February 2008.

Water supply options for the proposed third-pipe scheme have also proven more challenging than expected. While a diverse range of potential sources were identified for the scheme, securing the commitment of the Water Corporation as the preferred service provider has been difficult. Groundwater through ASR had previously been seen as the preferred source option; however, the Water Corporation pumping station on the WUWP site also means wastewater is a potential alternative future resource. However, interviewees suggested the Water Corporation had been reluctant to participate in developing either water source as it was considered to deviate from their core business; they remain undecided as to whether to expand on their role as suppliers of drinking water and wastewater disposal. However, interviewees did also report "positive gains" had been made in recent discussions with an agreement to cooperate in undertaking a feasibility study with relation to the sewer mining and managed aquifer recharge. Furthermore, the Water Corporation's support of the living streams component of the WUWP has been highlighted as a significant step outside the Corporation's traditional direction.

Another significant result of the project relates to the Department of Health's approval of rainwater plumbed to hot water services. While it has been suggested that the project's

location on the urban fringe has enabled this to occur, the approval provides a new benchmark for urban development in Perth and an opportunity to reduce current potable water demand.

The extended powers and direct control of the Armadale Redevelopment Authority of the WUWP planning process, in comparison to development overseen by a local government authority have certainly played a significant role in allowing for innovative planning and design concepts to be included in the project. The ARA's power has facilitated changes to current approaches to land development, for example, the introduction of Place Codes to guide the character of the development and encourage diversity in planning through the integration of the private and public design realms. This approach has operated outside of the normal state planning framework, which uses Residential Codes to guide individual lot development, in conjunction with the Liveable Neighbourhoods operational policy to cover the public realm. The WAPC has recently positioned more emphasis on place-based planning, and a number of small-scale developments have subsequently taken up the opportunity; although these are generally for projects with a specific focus (ARA, 2007b). The WUWP will be the first project to incorporate Place Code planning into a mixed-use development in Western Australia (ARA, 2007b).

Ultimately, the biggest challenge facing the WUWP is getting the project on the ground and achieving the ambitious goals set through the project's vision for sustainable development. This planning process has provided a great opportunity to set the future standards of land and water management and urban development in Perth.

Case Study Implications

Despite the size and significance of the project, the WUWP's profile in the Western Australia is relatively small. At the time of interviewing, many respondents who were not directly involved with the project had rarely, if at all, heard the name. Similarly, urban designer Brett Wood-Gush points out that "5 years into its planning Wungong is still a little known project somewhere out the back of Perth" (Wood-Gush, 2008: 8). While this may be symptomatic of changing the project's name throughout the process, the profile of the project is expected to increase as on-ground implementation commences. However, despite its current low profile, the ARA has made a wealth of information on the planning and design processes of the WUWP available for further reference. Technical reports, management plans and planning policies, along with information on the project planning and development process are available for download from the WUWP website (http://internet.landcorp.com.au/portal/page/portal/wungong/strategy). The willingness of the ARA to share information has positive implications for similar projects and the future of the development and planning processes. Regardless of the current lack of profile, the WUWP has considerable implications for the future of planning, design and urban development in Western Australia.

The extensive and early stakeholder engaging in the collaborative planning process, as overseen by the ARA, has contributed significantly to addressing the challenges of a complicated location, as well as highlighting the limitations of many traditional planning and design procedures. The multi-disciplinary, collaborative approach resulted in a robust and comprehensive product to help ensure responsible development of an environmentally and culturally sensitive area. Furthermore, as the ARA points out, "…cross-discipline interaction – such as having a hydrologist assess transport planning or a landscape architect to comment on civil engineering – was the key to real learning and innovation" (ARA, 2008a). Similarly, Grace *et al*. (2006: 4) highlight that the process "fostered a closer and earlier than usual integration between disciplines such as water sensitive urban design, landscape architecture, water resources planning, heritage and environmental protection." The comprehensive approach holds significant lessons for planners of future developments in the Perth region and the Australian development industry in general. Although the planning process was undertaken over a long time period, such processes are potentially required when working with multiple organisations and with individuals from a range of different professional backgrounds.

Given the challenging biophysical characteristics of Perth's remaining potential land development areas, any substandard or poorly planned implementation could have serious environmental, economic and social consequences (such as raised water tables, loss of species and habitat, flooding, property damage or loss, as well as significant implications for the well-being of individuals and communities). This case study has highlighted the importance of and benefits from establishing a comprehensive baseline understanding of the broad environmental characteristics undergoing development and how, through an appreciation of the existing environment, the development can be shaped by the site's natural characteristics.

Furthermore, the WUWP also demonstrates that such careful, comprehensive and ecologically considerate planning can also contribute to an increase in market value of a development area. A development feasibility study undertaken in 2002 investigated the value of 250ha of undeveloped land in the area, and concluded values of $0-$30,000 per hectare (Devenish and Ellis, 2009). Following the release of the Wungong Urban Water Redevelopment Scheme in 2007, land value had jumped between 800-1,500%, with land being sold at over $750,000 per hectare in 2007-2008 (Devenish and Ellis, 2009). Market receptivity is considered an important element for securing future replication of innovative approaches to water management (Brown and Clarke, 2007).

A degree of uncertainty regarding the form, establishment and management of a third-pipe scheme remains. Such a decision may have significant implications for the future of alternative water supplies to households in Perth. At present, the Water Corporation remains uncertain of their role beyond their traditional core business of drinking water supply and sewage conveyance. The decision to support a third-pipe network in the WUWP area has the potential to shape a future pathway for the introduction of third-pipe schemes in greenfield developments of Western Australia. Furthermore, the water source decided upon for the third-pipe intake will also hold significance for the water sector in Perth, as health authorities have been reluctant to authorise the use of recycled water within residential areas in the Perth metropolitan region to date. In view of this, their recent decision to allow the use of rainwater in hot water services in the WUWP area has been a major step forward in terms of alternative water supply for Perth.

Further implications will be revealed as on-ground development commences and much of the theory behind the planning is put into practice. The first lots are expected to created in 2010.

References and Further Information

Australian Bureau of Statistics (ABS) (2008), Regional Population Growth, 2006-2007, accessed at http://www.abs.gov.au

Armadale Redevelopment Authority (ARA) (2008a) Website for the Wungong Urban Water Project, last accessed 30 August 2008, at www.wungongurbanwater.com.au

ARA (2008b) *Wungong Urban Water Master Plan – Urban Water Management Policy*, August 2008.

ARA (2008c) *Wungong Place Code*, May 2008.

ARA (2008d) *Wungong Urban Water Master Plan – Heritage Policy*, August 2008.

ARA (2008e) *Armadale Redevelopment Authority Sustainability Audit*, last accessed 26 August 2008, at http://scorecard.ara.wa.gov.au

ARA (2007a) *Wungong Urban Water Redevelopment Scheme 2007.*

ARA (2007b) *Wungong Urban Water Project Developer Contribution Scheme (DCS) – Preliminary Draft*, ARA: December 2007.

ARA (2006) *The Brookdale Water Cycle Project: Sustainable Water Management in the Urban Environment – Application for the Water Smart Programme Grant – National Water Commission*.

ARA (2008f) *Website of the Armadale Redevelopment Authority*, last accessed 30 August 2008, at www.ara.wa.gov.au

ATA Environmental Services (2006a), *Wungong Urban Water Redevelopment Scheme 2006 – Environmental Review – EPA Assessment No. 1647 – Version 3*, ARA: November 2006.

ATA Environmental Services (2006b) *Vertebrate Fauna Assessment, Brookdale Redevelopment Area*, Version 4, ARA: September 2006.

ATA Environmental Services (2006c) *Flora and Vegetation Assessment Brookdale Redevelopment Area*, Version 3, ARA: October 2006.

Barron, O., Pollock, D., Donn, M., Barr, A., and Dawes, W. (2009) Building catchment scale decision support tools to assess the effect of urbanisation on catchment water resources and water quality. *Proceedings of the 6th International Water Sensitive urban Design Conference and Hydrolpolis 3#, Perth, Western Australia,* 5-8th May 2009: 316-322.

Brown, R.R. and Clarke, J. (2007) *Transition to water sensitive design: the story of Melbourne, Australia.* Facility for Advancing Water Biofiltration, Monash University, Melbourne.

Department of Environment, Water, Heritage and the Arts (2008), *Wungong Urban Water Project Summary*, last accessed 26 August 2008, at http://www.environment.gov.au/water/programs/wsa/projects/wa04.html

Devenish, S and Ellis, J. (2009) Water Sensitive Urban Design: A Tool for Viable Urban Development. *Proceedings of the 6th International Water Sensitive urban Design Conference and Hydrolpolis 3#, Perth, Western Australia, 5-8th May 2009.*

Environmental Protection Authority (EPA) (2007) *Wungong Urban Water Redevelopment Scheme 2006 - Report and Recommendations*, Bulletin 1253, Perth, Western Australia: April 2007.

Government of Western Australia (2008), *Armadale – Wungong Urban Water Newsletter*, March 2008.

Government of Western Australia (2007), *State Water Plan*. Department of Water, Government of Western Australia, Perth.

Grace, W., Martens, S., Taylor, M., and Sack, C. (2006) "The Wungong Urban Water Project: Toward Sustainable Water Management in the Urban Environment", 1st National Hydropolis Conference, Burswood Convention Centre, Perth, Western Australia (MONTH) 2006.

Green, M.; Johnston, C.; and Nancarrow, B. (2004) *The Development of an 'Identity' for the Brookdale Redevelopment – Scoping Study*, Australian Research Centre for Water in Society, CSIRO: August 2004.

JDA Consultant Hydrologists; CSIRO; and GHD (2006) *Wungong Urban Water Master Plan – District Water Management Strategy*, ARA: October 2006.

JDA Consultant Hydrologists (2004) *Brookdale Redevelopment Project Phase 2: Hydrology Constraints and Opportunities*, ARA: August 2004.

JDA Consultant Hydrologists (2002) *Southern River/Forrestdale/Brookdale/Wungong Structure Plan: Urban Water Management Strategy*, Water and Rivers Commission: April 2002.

Johnston, C.; Green, M.; and Nancarrow, B. (2004) *The Development of an 'Identity' for the Brookdale Redevelopment*, Australian Research Centre for Water in Society, CSIRO: December 2004.

Memorandum of Understanding (MOU) (2003) *Southern River/Forrestdale/Brookdale/Wungong Memorandum of Understanding: EPA, Water and Rivers Commisssion, WAPC, City of Armadale, City of Gosnells, Water Corporation, ARA*, October 2003.

Office of the Appeals Convenor (2007) *Report to the Minister for the Environment – Appeals against EPA Report and Recommendations, Wungong Urban Water Redevelopment Scheme 2006 – Bulletin 1253*, December 2007.

Templeman, D. (Minister for the Environment) (2008) *Minister Appeal Determination – Appeals against EPA Report and Recommendations, Wungong Urban Water Redevelopment Scheme 2006 - Bulletin 1253*, February 2008.

Tempus Archaeology (2007) *Aboriginal Heritage Investigations, Volume III: Aboriginal Heritage Management Plan*, ARA: May 2007.

Water Corporation (2008) *Waterwise Land Development Criteria*, March 2008.

Water Corporation (2007) *Southern River Interim Integrated Land and Water Management Plan*, July 2007.

Western Australian Planning Commission (WAPC) (2001) *Southern River/Forrestdale/Brookdale/Wungong District Structure Plan*,

Wood-Gush, B. (2008) "Wungong Urban Water Project – Going beyond liveable neighbourhoods in the pursuit of environmental planning best practice", *Australian Planner* 45:2, June 2008: 8-11.

Summary

The purpose of reviewing four demonstration projects in detail was to reveal any similarities and/or key differences amongst the case studies in relation to the drivers for each project, the processes involved in designing and implementing the on-ground innovation and to reveal the key implications arising from each case study.

The drivers for the four projects in the Perth metropolitan region varied considerably. An important driver for the implementation of projects addressing water supply, such as the Kwinana Water Reclamation Plant and The Green at Brighton Estate, was recent and continuing water scarcity and drought, further supported by State Government targets for water saving and reuse (Government of Western Australia, 2007; 2008). Individuals or "project champions" have also played a significant role in maintaining momentum during implementation, and managing organisational reluctance to participate for projects such as The Green or the Liege St Wetland. Overall, there was not a common, major driver for all four projects. The broad drivers for each project included:

- Kwinana Water Reclamation Plant: State water recycling targets; water scarcity;
- Liege Street Wetland: Environmental health concerns, State funding;
- The Green: Individuals, sustainability, innovation, marketing edge;
- Wungong Urban Water Project: Sustainability vision; integrated planning necessitated by environmental conditions (but the initiation of the collaborative, interdisciplinary process was the driver for success).

Nevertheless, there were similarities in the challenges experienced by participants in at least three or four projects. Common challenges included:

- Regulatory/approvals issues, unclear processes for implementation;
    - i.e. gaining Department of Health support and/or approval;
- Securing organisational/stakeholder commitment; and,
- Extended timelines and delays.

There were also issues regarding the pricing of alternative water sources for at least two of the projects to date (note that pricing at Wungong is yet to be determined).

Key process lessons were identified across the four case studies including the importance of stakeholder engagement and intra- and inter-organisational collaboration (i.e. Liege Street and the Wungong Urban Water Project) and the significant role individuals and/or organisational champions have in the Perth context (i.e. The Green; and Armadale Redevelopment Authority).

Broader insights gained from reviewing the case studies reveals the critical influence the institutional context has on projects in the urban water sector of Western Australia. Intra- and inter-organisational collaboration were identified as key factors. For example, the participation and interaction of the Water Corporation with other stakeholders such as State and Local governments was a key feature of all four case studies, due to their size and power in relation to water management in Western Australia. As such, their role in urban water management places the Water Corporation in the unique position of acting either as a driver or a barrier to innovation. The Water Corporation also has a good reputation, high capacity and is efficient in achieving their mandate (centralised water supply and sewerage). Such success may limit the business incentive to explore new roles and participate in decentralised approaches. Furthermore, the Water Corporation has been successful in building high levels of public trust, which may also act as a disincentive to participate in alternative projects where outcomes are perceived as 'uncertain' or 'risky' to the general public (i.e. recycled water plumbed into homes).

However, in the absence of direct competition, the Water Corporation's good standing, efficient business and high capacity makes the organisation an obvious choice for service provision in the case of alternative water servicing and experimentation. In cases where alternative providers do not exist, the Water Corporation's commitment and attitude towards a proposal will certainly impact on the project outcomes and success. The tension this has generated within the Water Corporation can be seen in all four case studies, where individuals working on demonstration projects struggle to gain organisational support for alternatives to "core business". This is not to suggest, however, that the Water Corporation does not see a role for alternative systems in Perth, rather their position appears to be that responsibility should not immediately fall to the organisation to operate and maintain such systems. However, irrespective of who has responsibility, the Water Corporation's perspective on alternative water servicing is critical to the future of innovation and learning in Perth and Western Australia more broadly, due to their principle role in water management.

Importantly, there have been some significant changes across the broader urban water sector in Perth over the last few years, (partially) as a result of experiences with projects such as the case studies presented. Inter-agency initiatives supporting integrated water management and land use planning are being developed and implemented, and projects such as the Wungong Urban Water Project (if successfully implemented) will have a significant impact on the processes undertaken for future urban development in Perth.

The Department of Health in particular has come some way towards altering its position on recycled water and alternative household water supply with the release of their first *Draft Guidelines for the Use of Recycled Water* (Department of Health, 2009a). Interestingly, a recent Department of Health survey of public perceptions of health hazards in Western Australia indicated that the community perceives the health risks from the use of recycled wastewater for drinking and/or market garden irrigation as low compared to risks such as passive smoking, high voltage powerlines or air pollution (Department of Health, 2009b).

Finally, a common thread throughout many of the interviews focused on the potential learning opportunities from the many projects underway (and in planning) in rural areas; particularly those related to alternative water source uses. For example, water recycling for irrigation has long been used in rural areas (but is viewed as necessary, rather than innovative). Similarly, the innovation around stormwater treatment and reuse occurring outside the metropolitan boundary, in places like Bunbury and Mandurah, along with the forthcoming dual reticulation schemes at Gracetown and Denmark, can provide considerable learning opportunities. With the significant changes beginning to occur in Perth, there is a need to ensure the lessons from past (and current) experiences are effectively collated, assessed, shared and built upon to inform the development of new approaches to urban water management.

References

Birrell, B., Rapson, V. & Smith, T.F. (2005) Impact of Demographic Change and Urban Consolidation on Domestic Water Use. Water Services Association of Australia, Melbourne, Australia, 24.

Brandes, O.M. & Kriwoken, L. (2006) Changing Perspectives - Changing Paradigms: Taking the "Soft Path" to Water Sustainability in the Okanagan Basin. *Canadian Water Resources Journal*, 31(2): 75-90.

Department of Health (2009a) *Draft Guidelines for the Use of Recycled Water in Western Australia*, Government of Western Australia, April.

Department of Health (2009b) *Community Survey of Perceived Environmental Health Risks in Western Australia*, Government of Western Australia.

Engineers Australia (2005) *Australian Infrastructure Report Card,* August 2005, Engineers Australia, Canberra.

Government of Western Australia (2007) *State Water Plan 2007.*

Government of Western Australia (2008) *State Water Recycling Strategy: An Overview,* June.

Maksimovic, C. & Tejada-Guibert, J.A. (2001) Frontiers in Urban Water Management: Deadlock of Hope? IWA Publishing, Cornwall, United Kingdom: 416.

Marsalek, J., Rochfort. Q. & Savić, D. (2001) Urban water as a part of integrated catchment management. In *Frontiers in Urban Water Management: Deadlock or Hope,* Č. Maksimović and J.A. Tejada-Guibert (Eds), 37-83. London: IWA Publishing.

Mitchell, V.G. (2006) Applying integrated urban water management concepts: A review of Australian experience. Environmental Management 37(5): 589-605.

Pahl-Wostl, C. (2007) Transitions towards adaptive management of water facing climate and global change, *Water Resources Management*, 21: 49-62.

Van der Brugge, R. & Rotmans, J. (2007): Towards transition management of European water resources. *Water Resources Management*, 21(1): 249-267.

Wong, T.H.F. (2006) Water Sensitive Urban Design: the journey thus far. *Australian Journal of Water Resources,* 10(3): 213-22.

Wong, T.H.F & Brown, R.R. (2009) The Water Sensitive City: Principles for Practice. *Water Science and Technology* – submitted.

MONASH University

National Urban Water Governance Program

National Urban Water Governance Program
Monash University, School of Geography and Environmental Science

Building 11, Clayton Campus, Wellington Road, Clayton / Postal - Monash University, VIC 3800, Australia
Phone + 61 3 9905 9992 / Fax + 61 3 9905 2948 / nuwgp@arts.monash.edu.au / www.urbanwatergovernance.com

Australian Government
Australian Research Council

WATER CORPORATION

Smart Water Fund

CITY OF Armadale

Western Australian Planning Commission
50 years

Maroochy Shire Council

BRISBANE CITY

Victoria The Place To Be
Melbourne Water

Department of Water
Government of Western Australia

Victorian Water Trust

HEALTHY WATERWAYS