Making better recycled water investment decisions: Shifts happen

This study is funded by the Australian Water Recycling Centre of Excellence under the Commonwealth's Water for the Future Initiative

ABOUT THE PROJECT

This national collaborative research project entitled "Building industry capability to make recycled water investment decisions" sought to fill significant gaps in the Australian water sector's knowledge by investigating and reporting on actual costs, benefits and risks of water recycling **as they are experienced in practice.**

This project was undertaken with the support of the Australian Water Recycling Centre of Excellence by the Institute for Sustainable Futures (ISF) at the University of Technology Sydney (UTS), in collaboration with 12 partner organisations representing diverse interests, roles and responsibilities in water recycling. ISF is grateful for the generous cash and in-kind support from these partners: UTS, Sydney Water Corporation, Yarra Valley Water, Ku-ring-gai Council, NSW Office of Water, Lend Lease, Independent Pricing and Regulatory Tribunal (IPART), QLD Department Environment & Resource Management, Siemens, WJP Solutions, Sydney Coastal Councils Group, and Water Services Association of Australia (WSAA).

ISF also wishes to acknowledge the generous contributions of the project's research participants – approximately 80 key informants from our 12 project partners and 30 other participating organisations.

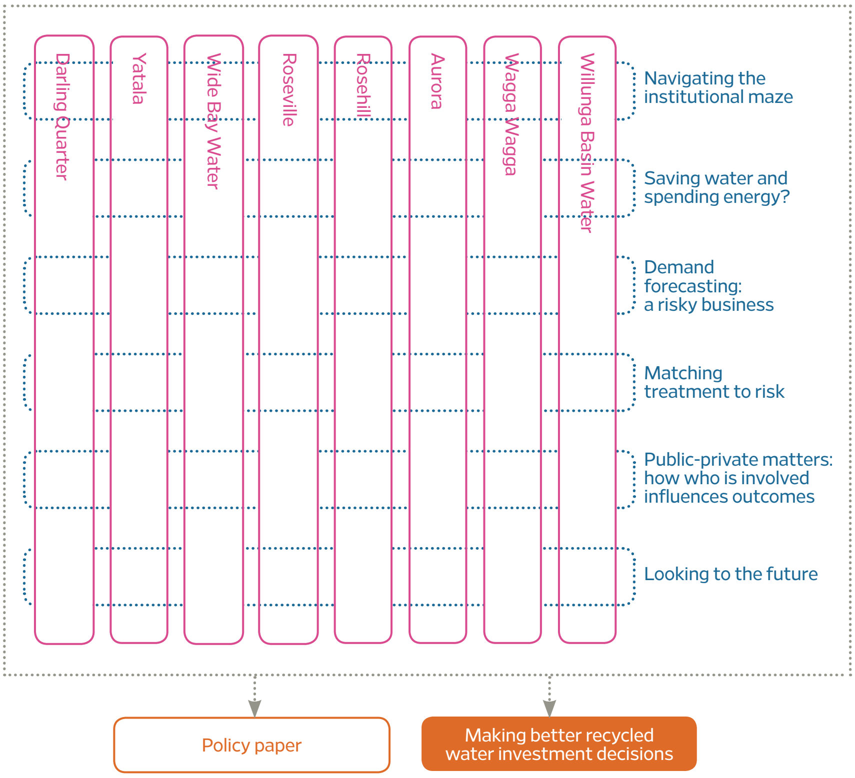
Eight diverse water recycling schemes from across Australia were selected for detailed investigation via a participatory process with project partners. The depth of the case studies is complemented by six papers exploring cross-cutting themes that emerged from the detailed case studies, complemented by insights from outside the water sector.

For each case study and theme, data collection included semi-structured interviews with representatives of all key parties (e.g., regulators, owners/investors, operators, customers, etc) and document review. These inputs were analysed and documented in a case study narrative. In accordance with UTS ethics processes, research participants agreed to participate, and provided feedback on drafts and permission to release outputs. The specific details of the case studies and themes were then integrated into two synthesis documents targeting two distinct groups: policy makers and investors/planners.

The outcomes of the project include this paper and are documented in a suite of practical, accessible resources:

- **8 Case Studies**
- **6 Cross-cutting Themes**
- **Policy Paper, and**
- **Investment Guide.**

For more information about the project, and to access the other resources visit www.waterrecyclinginvestment.com



ABOUT THE AUTHORS

The Institute for Sustainable Futures (ISF) is a flagship research institute at the University of Technology, Sydney. ISF's mission is to create change toward sustainable futures through independent, project-based research with government, industry and community. For further information visit *www.isf.uts.edu.au*

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Overview

This document aims to illustrate, through the case studies examined in this project, that by considering contextual and project-related risks separately, a wider range of **business-related risks** become apparent. It is evident that **shifts** in the **contextual landscape** and the **objectives of players** involved can often occur over the life of a project. The threat of such shifts brings significant risks and uncertainties. Through a thorough consideration of the potential **risks** presented in this document, as well as others relevant to specific recycling schemes, proponents as well as owners and managers might **make better recycled water investment decisions** and could enhance the **benefits** and minimise the **costs** associated with new water recycling schemes. The equitable allocation of the risks, costs and benefits depends on this improved identification and management of the risks and uncertainties.

Introduction

Much can be learned from the numerous recycling schemes currently in operation around Australia, which can help us make better water recycled investment decisions. Many of these schemes have benefitted from financial grants and subsidies. However, significant government sources of funds are no longer available for the water sector and are unlikely to return in the near future (see, for example, the Chair of the National Water Commission's key note speech delivered in Ozwater 2013). If recycling schemes are to play a successful part in the portfolio of water service provision options going forward, we will need to improve our capacity to identify and assess a wider range of potential risks. We need to be able to predict their impact on costs and benefits, and how these will be borne by different stakeholders.

There are many, many guidelines and resources on water recycling. Most of them focus on technical risk and therefore take the Australian Guidelines for Water Recycling (AGWR) (2006) as their starting point. The aim of this document is to look beyond technical risk guidelines, and help those involved in recycling schemes to **learn** from the case studies examined in this project. It aims to help proponents of recycling schemes take a **broader perspective** when **identifying** and **assessing** the **risks and uncertainties involved.** This will ultimately help them make more **informed and therefore better investment decisions,** taking into account a **broader spectrum of costs and benefits.**

This document highlights key **issues** and **questions** to consider when planning a recycling scheme, illustrated by examples from the case studies. Because every recycled scheme has its own context, this document avoids prescribing solutions, but rather assists practitioners to interrogate their own situation and identify and assess what could change or shift in the context of their scheme, allowing mitigation measures to be built in upfront.

Although only a small sample, the eight case studies investigated as part of this project illustrate a wide array of recycling schemes with very different scales, characteristics and applications. Refer to Table 1 (next page) for a summary of the case studies examined. Although the eight schemes are very different, they provide common lessons and powerful insights about uncertainty and risk and the associated costs and benefits for those water "players" embarking on recycling schemes. Each case study is a fascinating story in its own right, documented in separate short, to-the-point case study papers.

A key finding of this project is that issues around uncertainty and risk go well beyond the technical realm, and need to be considered up-front in the planning stage to avoid unnecessary and inequitable costs and impacts. Of course not everything can be foreseen, but considering uncertainties and risks more holistically can only improve the outcomes of recycling schemes. In its position paper on the topic, the National Water Commission (2010) states its support for expanding urban water recycling subject to four conditions. The first of these has relevance for this document. It is that 'prior cost/benefit and risk analyses are conducted which take full account of social and environmental externalities and avoided costs.'

Broadening the upfront consideration of uncertainties and risks in recycling schemes will enable those involved to be in a better position to:

- identify the risks and uncertainties that matter in their situation
- assess the likely impact of relevant risks and uncertainties
- develop mitigation strategies to moderate impacts, reduce costs, and capture benefits
- articulate the suite of players involved over the life of the scheme and how changes in their decisions and actions will impact on the scheme
- identify which players bear what risks
- distribute quantifiable and non-quantifiable costs and benefits more equitably.

Table 1: Case studies – summary details

SCHEME/ LOCATION	SOURCE	USAGE (HISTORICALLY/NOW)	INITIAL PROPONENT
Aurora VIC	Sewage	Residential (toilet flushing, garden watering, car washing and irrigation of open space)	State land development authority
Darling Quarter NSW	Sewage	Commercial precinct (toilet flushing, irrigation and cooling towers)	Private developer (Lend Lease)
Wide Bay Water (Hervey Bay) QLD	Sewage	Irrigation (golf course, cane farms, tree plantation, sporting fields, airport), commercial reuse	Public utility
Rosehill NSW	Sewage	Private developer, owner and operator (AquaNet consortium) Public utility retailer (Sydney Water)	Private utility
Roseville NSW	Stormwater	Industrial reuse and irrigation	Private (Roseville Golf Club)
Wagga Wagga NSW	Sewage	Irrigation (council ovals and open space, lucerne farm) and formerly, residential garden watering, tree plantation irrigation and research	Local council (Wagga Wagga City Council)
Willunga SA	Sewage	Irrigation for crops (grape vines)	Private utility (Willunga Basin Water Corp)
Yatala QLD	Onsite trade waste	Industrial brewery reuse (toilet flushing, irrigation, cooling towers, boiler fed, CIP systems, pasteurisation, pre-cleaning, floor washing)	Private company (Carlton United Brewery)

Types of risks

Considering risks and uncertainties

When considering the risks and uncertainties associated with recycling schemes, it is useful to distinguish between technical, operational risks and broader business risks. As already mentioned almost all existing guidance resources on recycled water focus on what might be called the technical operational risks, which are all about regulatory compliance - identifying and managing hazards and ensuring the quality of the product from a public health perspective.

However, very few of these resources deal with what might be termed the broader 'business risks', discussed in this document. Getting the technical operational risks under control is absolutely fundamental to managing business risks, but what this project has shown is that there are many additional risks, that historically have received inadequate attention. Such risks and uncertainties depend on a variety of factors such as:

- the stakeholders directly involved in the scheme or those indirectly involved who may have significant influence or control
- the drivers and motivation of the scheme
- the context of the scheme and how this might change over time
- the type of recycling scheme
- how the scheme is implemented
- the public or private business model adopted.

The case studies in this project reveal a number of key issues that need to be considered upfront to assist those embarking on a recycling scheme to reduce risks and uncertainty and capture costs and benefits more holistically. These key issues include:

1. **Stakeholders - Who are the players?**
2. **Scheme objectives - What does success look like?**
3. **Supply and demand - What volumes are required?**
4. **Treatment - What level of treatment makes sense?**
5. **Institutional arrangements - What are the approvals and contracts that affect the scheme?**
6. **Financing - What are the financial arrangements?**

In the following sections we expand on these **six key issues** and provide short **examples** from the case studies. These examples may be positive or negative illustrations. We aim to encourage the reader to read the whole story in the relevant case study. In this document we also identify **trigger questions** to help the reader interrogate their own scheme.

Table 2 identifies where key changes or shifts took place in the case studies examined that proved to be an obstacle in some cases or had no adverse consequences in others.

Table 2: Case studies - responding to shifts over time

KEY

■ (orange) SHIFT AVOIDED OR MITIGATED ■ (grey) SHIFT NEITHER ANTICIPATED NOR MITIGATED

SCHEME/ LOCATION	STAKE-HOLDERS	SCHEME OBJECTIVES	SUPPLY & DEMAND	TREATMENT	INSTITUTIONAL ARRANGEMENTS	FINANCING
Aurora VIC		■ (grey)	■ (grey)	■ (grey)		
Darling Quarter NSW	■ (orange)	■ (orange)	■ (orange)	■ (orange) ■ (grey)	■ (grey)	
Wide Bay Water (Hervey Bay) QLD			■ (grey)	■ (grey)	■ (grey)	
Rosehill NSW				■ (orange)		
Roseville NSW				■ (grey)	■ (grey)	
Wagga Wagga NSW		■ (grey)	■ (grey)	■ (grey)		■ (orange)
Willunga SA		■ (orange)			■ (orange)	
Yatala QLD				■ (orange)	■ (orange)	■ (orange)

1 Stakeholders

Who are the players?

It seems obvious that knowing the suite of stakeholders and their roles in the scheme from inception to operation is fundamental for considering the potential risks and uncertainties, and for assessing the associated costs and benefits of the scheme. Yet our case studies show how fundamental it is to pay more attention to them and their potential to influence the success or failure of the scheme.

The first task is to consider whether each stakeholder is a "direct player" (i.e. they are internal to the scheme and will bear direct costs or benefits) or an "indirect player" that may be external to the scheme (i.e. regulators) but who don't have a direct interest in the outcome.

The players will vary depending on the type of scheme. There may be only a few players as in the case of Yatala, or multiple players, as in the Darling Quarter case study (see left).

The second task is to map the direct and indirect players and their levels of control and influence. This is likely to prove a highly useful process when considering the risks, uncertainties, costs and benefits of your scheme. The process is described further in the ***Tools section:*** T1 ***Stakeholder Mapping*** at the end of this document.

It should also be noted that the level of control and influence of these direct and indirect players may change over time. For example, in the Aurora case study, the developer installed a dual pipe system, and then passed it on to the local water utility to operate. Understanding how each player's role might change over time enables risks and uncertainties, together with potential issues that could enhance or undermine the success of the recycling scheme, to be revealed.

The third task is to think through which of the players it might be prudent to bring on board early. For example, it may be appropriate to involve those who will operate and manage the scheme in the design phases so that the designs match the operational requirements. This approach may prevent having to make costly changes to the scheme at the commissioning stage to accommodate unforeseen operational requirements.

Darling Quarter players

INDIRECT PLAYERS
- Regulator (IPART)
- Utility (Sydney Water)
- Users (Building Tenants)

DIRECT PLAYERS
- Owner
- Building manager (Jones Lang La Salle)
- Developer (Lend Lease)
- Treatment contractor (Veolia)

EXAMPLES FROM CASE STUDIES
See each case study paper for more detail

Darling Quarter – bringing players on early
At Darling Quarter the developer (Lend Lease) decided to go to tender for the recycling plant after the architectural design phase, so the basement room for the plant had already been designed for a particular technology. The successful recycled water treatment contractor (Veolia) had to choose equipment that fitted the shape and size of the available space, which meant **increased costs** because of the need for smaller footprints (e.g. a moving bed biological reactor (MBBR) plant rather than a membrane bioreactor (MBR) plant, and stainless steel rather than concrete storage tanks).

However there were two instances in the same project where **stakeholders were brought in early** and this resulted in a **positive outcome**:
- the building manager (Jones Lang La Salle) was brought on board 12 months before practical completion in order to learn about the building's systems before handover to enable a smooth transition
- Veolia consulted their operating staff during the development of their designs to ensure viability and practicality as part of their design, build and operate contract.

Questions to prompt your thinking about the players (see *Tools section:* T1 *Stakeholder Mapping* for more details):
- Who are the direct and indirect players?
- What did the stakeholder mapping reveal for the various stages of the project, especially relating to roles and responsibilities? Who do you need to engage and how?
- What internal players can be engaged at the onset - especially technical and operational partners? When should other internal and external players be engaged?
- What champions in the other key organisations have been identified or cultivated?

2

Scheme objectives

What does success look like?

It seems obvious that having clear and common objectives amongst the direct players involved in implementing the scheme, and sharing these with indirect players, is a key ingredient of whether a project is likely to be successful or whether it is at risk of partial failure for one or more parties. Again, our case studies show that attention needs to be paid to this from the earliest stages of scheme planning. The objectives need not be exactly the same for every player but they must be aligned rather than conflicting. Being explicit about the motivations of the key direct and indirect players, and about the potential risks, can be extremely valuable in anticipating potential issues and mitigation measures.

The case studies provide examples in which having common objectives has created very successful projects (Darling Quarter; Willunga). Having common objectives has allowed players directly affected by the scheme, and indirect players that may have an influence on the scheme, to see the multiple benefits the project can bring, and for them to reduce potential barriers, collaborate to solve problems and avoid potential additional costs.

There are also examples in which key direct or indirect players have shifted their position over time for varying reasons (Aurora; Wide Bay Water), and this has had both positive and negative impacts.

EXAMPLES FROM CASE STUDIES

See each case study paper for more detail

Darling Quarter – bringing players on early

The building owner, building developer and tenants all wanted a 6-star building, and meeting that objective required a water recycling plant. In addition, the recycled water contractor (Veolia) wanted their first small-scale commercial recycled water plant to be a success. These common and/or parallel objectives meant the **direct players worked together** to overcome hurdles such as the additional costs for equipment needed to reduce the risks of malodour, health risks associated with the adenovirus and corrosion of the building's pipework due to the purity of the recycled water. The owner, developer and recycled water contractor agreed to split these "unforeseen" costs between them because they all saw the need to address them and were prepared to **share the additional costs** for the good of the project.

Willunga – shared interest amongst direct and indirect players

The private utility (set up to take wastewater from the public utility sewage treatment plant (STP) to supply recycled water to McLaren Vale wine irrigators), the public utility, state government and local vineyards (the users) all had a **common interest** in ensuring the success of the Willunga recycled water scheme when it was first set up in the late 1990s. Thirteen of the original 15 investors in the private utility were also irrigators aiming to purchase the recycled water. The **public utility signed a 40-year agreement** allowing the private utility to take the STP effluent at no charge. The **state government endorsed the scheme** due to the benefits of avoiding STP discharge and of fulfilling policy objectives of working with the private sector on projects to use non-potable water for agriculture. The initial customer base of 17 has now grown to nearly 200 and is expected to expand further, representing a **highly successful recycled water scheme.**

Aurora – a shift in business case creates difficulties

In the residential housing development of Aurora, initially it was the developer who placed a high priority on sustainability and the need to move the development forward at an unheard-of pace. They brought the council and water utility on board with the idea of recycled water provision, which had sustainability benefits as well as major benefits of being able to develop the site – there was no sewer trunk main in the vicinity at the time. As the development progressed, the developer merged with the Docklands Authority to become VicUrban. This merger was accompanied by **a shift in the developer's philosophy** to a stronger focus on commercial viability. This shift had multiple impacts (see the case study for details) which, along with other factors, had financial consequences for the recycled water scheme. Most of the resulting additional costs of running the scheme have been borne by the water retailer (Yarra Valley Water), and ultimately have been met by their entire customer base through legitimate water pricing.

Wide Bay Water – new player reassessed the value of recycling
In Hervey Bay, despite the utility, Wide Bay Water having looked for opportunities and gaining significant financial assistance over the years from federal and state funding (approximately $14M), aspects of the recycling scheme have not provided the anticipated financial returns and the costs and benefits of the scheme have not been fully explored. Now, with Wide Bay Water being reintegrated as a service arm of the local council, decision-makers (along with other aspects of the utility business) are reassessing the value of recycling to the community and **the extent to which recycling should play a role in the region in the future,** thus putting into question future expansion of the recycling scheme.

Questions to prompt your thinking about shared objectives (see *Tools section:* T1 *Stakeholder Mapping* for more details):

- What is the common objective and vision shared by all the players for the scheme?
- How might a change in leadership or values in your own organisation influence what is possible?
- How might a shift in one of the influential player's objective or vision affect the scheme?

3

Supply and demand

What volumes are required?

It is obvious that having a clear picture of the volumes and associated timing of both the source water and the demand for water is fundamental when designing a water recycling scheme, as discussed in the *'Demand forecasting: a risky business'* paper. And yet in half of the case studies this information was lacking, and this had consequences for various players. The schemes that lacked this information were not flexible enough to accommodate changing circumstances.

Potential changes in circumstances can be identified by having a really close look at the supply and demand forecasts and considering what might cause a gradual or sharp change in your volume projections. A useful tool for assessing the risks associated with both supply and demand is a PESTLE matrix (see Table 3), which serves as a prompt to consider possible influences across wide-ranging political, environmental, social, technical, legal, and economic components of the local context for both source supply and demand volumes (see also ***Tools section:*** T2 ***Identifying risks and uncertainties***).

Source volumes and quality

Having a reliable and sufficient quantity and quality of source water is important for ensuring that the recycling plant can function optimally and meet demand.

A fluctuating supply of source water due to rainfall variability for stormwater harvesting or variable sewage flows, will mean there needs to be onsite storage to act as a supply buffer. This can take up valuable space, which in some developments may not be available, or have cost implications. Equally, the possibility of a decrease in supply (e.g. less stormwater available during a drought, or less sewage due to increased water efficiency or upstream extraction) needs to be considered.

Fluctuations in source water quality are also of concern. Such fluctuations may occur as a result of water efficiency measures that reduce sewage flows and increase the concentration of organic material. Alternatively, increases in source water due to leaking fixtures and fittings in a building can increase flows and reduce concentrations causing plant operational difficulties.

Table 3: PESTLE matrix

PESTLE	Source volume or quality		Demand volume or quality	
	Gradual shift	Sudden shift	Gradual shift	Sudden shift
Political			Government policies and attitude towards recycled water	Government invests in large new supply e.g., desalination
Environmental	Reduced stormwater flows; seasonality in stormwater flows		Higher rainfall reduces the need for irrigation	Drought breaks resulting in lower demand for alternative water supplies; seasonality in rainfall
Social	Slower rate of new building uptake produces lower volume of sewage		Slower rate of new housing reduces demand for recycled water	
Technical		Changes in the quality of the source water		Changes in the quality requirements by customers
Legal	Regulatory processes delay supply of source water			
Economic		A significant industrial source of wastewater shuts down	Fluxes in the economy positively and negatively affect the demand for recycled water	

EXAMPLES FROM CASE STUDIES
See each case study paper for more detail

Darling Quarter – ensuring consistent source water quantity and quality
The developers of Darling Quarter chose to mine sewage directly from the Sydney Water sewer main instead of using the onsite wastewater. They did this to ensure reliable supply volumes and reliable quality of source water. This also avoided the need to build holding tanks on site.

Aurora – unexpectedly low supply of wastewater
At Aurora the developer originally anticipated there would need to be a rapid land release, and so the recycled water treatment plant was developed in one stage, with the capacity to service 8,500 homes as well as provide open space irrigation. However, due to a lower and slower uptake of the housing lots, wastewater flows were inadequate for the efficient operation of the plant, so it was mothballed for some years, during which the developer had to truck effluent offsite, resulting in increased operating costs. The slow uptake of houses led to a **low supply of wastewater for recycling** and **unplanned additional costs** for the utility, the developer, and the broader customer base.

Questions to prompt your thinking about supply:

- What does the availability of the source water depend on? What could influence its availability?
- What could affect the source water quantity or quality upstream? Use PESTLE to prompt your thinking **(see *Tools section:* T2 *Identifying risks and uncertainties* for PESTLE matrix).**
- What will be the response to changes in source water quantity and/or quality?
- How can the scheme be phased or staged to give it the flexibility to accommodate these potential changes?
- What contingency plans have you put in place?

Demand volumes

Demand for recycled water can be underestimated or overestimated during the planning stage, and could change over the life of the project. It is therefore important to build in sufficient flexibility to accommodate these potential changes and so that the scheme can remain cost effective.

In several of the case studies, which are effectively underwritten by public utilities, anticipated demand has not met projections. The case studies include examples where:

- demand took longer to come to fruition than anticipated (Aurora)
- demand is significantly less than originally anticipated (Aurora, Rosehill, Wide Bay Water)
- demand has reduced during the operation period because key end users are no longer using recycled water (Rosehill)
- demand is affected by seasonality (Wide Bay Water).

Such situations can have a significant effect on the cost of a recycling scheme because:

- investment in a plant may be larger than is actually required
- it may not be possible to run the plant effectively or efficiently
- additional costs may arise because the plant is running sub-optimally or cannot operate at all
- one party may be paying for recycled water when they don't actually use it (i.e. use-or-pay contracts).

EXAMPLES FROM CASE STUDIES
See each case study paper for more detail

Aurora – slow uptake in demand
At Aurora the developer anticipated the need for a rapid land release, and therefore the need to supply 8,500 homes with recycled water. Hence the recycling plant was constructed in one stage. However, the uptake of the development was not as rapid as anticipated and the plant is currently only servicing 2,500 homes. The slow uptake and **lower than expected revenue streams** have resulted in significant and unplanned costs for the utility, the developer and the broader utility customer base.

Rosehill – reduced demand
At Rosehill the scheme was developed for six foundation customers with the potential to expand. However in less than five years **demand has dropped** due to two of the foundation customers ceasing operation and no additional customers coming on board. This has left **the plant under-producing** (capacity is 20 ML/d and current production is 7 ML/d on average). This has resulted in lower revenue and higher costs for multiple players involved. **The private consortium is receiving lower** than expected returns on investment. **The utility has incurred higher costs** due to the 20-year use-or-pay contract with the private consortium. The associated **revenue losses are transferred to Sydney Water's broader customer base** through a government directive, effectively underwriting the mismatch between supply capacity and actual demand.

Wide Bay Water – limited uptake of recycled water
In Hervey Bay the utility sought to develop a **new external revenue stream** through selling recycled water to local cane farmers and a **new internal revenue stream** through developing irrigated hardwood plantations, with the trees being sold to energy providers as power poles. However, a number of local **contextual challenges** have resulted in **lower uptake in recycled water** than anticipated. Firstly, although irrigation can increase yield in cane farming it requires investment and a more intensive farming style. Older and/or small lot farmers were not always willing to invest in moving away from dry cane farming. Secondly, some local farmers were concerned about increasing the salinity of the soil. Thirdly, in wet years and during the rainy season sugar cane and hardwood plantations require less water. To partly mitigate the revenue issue caused by the lower than anticipated uptake, the utility has a use-or-pay contract with irrigation farmers, which means the utility receives payment for a proportion of the recycled water even if it is not used. However, the reduced demand still provides a risk associated with infringement of its discharge licence due to the need to dispose of excess wastewater.

Questions to prompt your thinking about demand:
- What will the customer base look like in the medium to long term, and how will this affect demand?
- What could affect the demand quantity or quality? Use PESTLE to prompt your thinking **(see *Tools section:* T2 *Identifying risks and uncertainties* for PESTLE matrix).**
- What are the consequences of overestimating or underestimating demand?
- What will the response be to changes in the demand quantity or quality.
- How would a phased or staged approach for the scheme suit the objectives and the demand projections?
- What contingency plans have you put in place?

4

Treatment

What level of treatment makes sense?

Choosing the appropriate level of treatment will depend firstly on what the end-users want and when the water will be needed, and secondly on the quality of the source water. Perceptions of risk are key in setting treatment levels, as discussed in the *'Matching Treatment to Risk'* paper, since inaccurate perceptions can lead proponents and regulators alike to err on the side of caution. The introduction of the AGWR, with its shift to a risk-based approach, has unintentionally encouraged this cautious approach to setting treatment levels, despite the protections offered by end-use control points. Higher levels of treatment are not always better. Cost and energy implications aside, higher treatment levels can introduce other unforeseen risks - as in the case of Darling Quarter where the resalting of the over-treated recycled water with calcium resulted in struvite precipitation in urinals.

Treatment to match demand

Many of the case studies reviewed in this project provide treatment levels in excess of those required for various reasons. This is in part driven by the difficulty in providing a range of water qualities to meet different quality demands (as in the case of Rosehill) for various end-users and in predicting the quality of water needed by potential future customers. In the Wide Bay Water example, a treatment facility was built to supply a future potential demand. The outcome is the installation of more expensive equipment and higher energy usage and costs.

By negotiating on-site treatment for customers who require higher levels of treatment, a lower quality product could be supplied to the majority of other customers, thereby saving on treatment costs. Further by opting for a modular design, upgrades can be made at a later stage when demands for, say, indirect potable reuse come into play.

EXAMPLES FROM CASE STUDIES
See each case study paper for more detail

Rosehill – not all customers required water treated to a high standard
The Rosehill industrial scheme was introduced during a drought. At least one prospective customer agreed to be involved only if water with low total dissolved solids was supplied. Hence, reverse osmosis treatment was considered essential by the developers to secure sufficient demand volumes from foundation customers. However, not all customers required water treated to this high standard, and in hindsight it may have been more cost-effective for specific customers to **undertake additional treatment as and if required on their own sites.**

Wide Bay Water – mismatch between demand and supply quality
One of the treatment plants (Nikenbah) in the Hervey Bay scheme produces recycled water to a class A standard. It is then blended with lower grade class B water before distribution. The plant was constructed using federal and state government subsidies and rebates to support the financial viability of the scheme. Nikenbah was deliberately designed with the potential to be upgraded to supply class A+ potable water during drought. This enabled it to attract a substantial reuse subsidy. However, with the drought breaking the need for class A+ water has disappeared. There are currently no customers for the class A+ water currently being produced, resulting in **higher treatment and associated capital and operating costs than required**, because the flexibility to treat just to class B was not designed into the plant.

Questions to prompt your thinking about treatment choices (see *Tools section:* T2 *Identifying risks and uncertainties*):
- How might the water quality requirements of the end-users change?
- What are the consequences of over/under treatment for the end-users?
- How would a supply of differentiated quality suit the objectives and the demand profile?

Treatment to match public health risk

Together with the mismatch between quality provided and quality required, developers' and regulators' perceptions of public health risk can drive up the levels of treatment beyond those recommended by the AGWR. A perception remains that "best quality" and not "fit for purpose" water is required to mitigate potential health risks, and this often adds unnecessary additional energy requirements and costs. The *'Matching Treatment to Risk'* paper explores this issue in detail across all the case studies in this project.

Reputational risk, where developers are concerned with lower quality water and/or associated amenity disruptions, have also led to higher levels of treatment, for example at Darling Quarter. The Roseville example illustrates a pragmatic approach where the council viewed the public health risks to be low and therefore currently do not disinfect the water before irrigation and toilet use.

EXAMPLES FROM CASE STUDIES
See each case study paper for more detail

Darling Quarter – high level of treatment
Concerns were raised during the design phase of the Darling Quarter project about **odour from the plant potentially affecting tenants, residual health risks and long term operation and maintenance.** This led to additional plant equipment being installed, which included a 100% sealed room under negative pressure and an activated carbon ventilation system in the plant room to minimise the risk of malodour escaping from the building (i.e. to avoid public embarrassment of a "smelly building" due to sewer mining similar to the then new Australian Google headquarters in Sydney in 2009). These additional measures **increased the planned capital and operating costs.**

Roseville – a pragmatic approach saved on treatment costs
Roseville Golf Club and Ku-ring-gai Council collaborated on the stormwater reuse scheme supplying the Roseville golf course and the adjacent council oval and amenity toilets. The council assessed the risk of irrigating the oval according to the AGWR and assumed a low risk due to the end-use controls in place. This is because there is a low probability of anyone being on the field during irrigation because it is generally irrigated at night and there are signs advising the public not to enter during times of irrigation. The risk of ingesting the amenity toilet water, the risk of cross contamination and the consequences of drinking the water were all also considered low. Against advice from the NSW Office of Water, the council has not to date installed a UV treatment system.

Questions to prompt your thinking about public health risks (see *Tools section:* T2 *Identifying risks and uncertainties*):

- What is the magnitude of the identified public health risks?
- What are the possible consequences of the identified public health risks?
- How does the planned treatment level match the end-users' views of public health risks?
- How can the level of public health risk be reduced through means other than treatment?

Changes to the national recycling guidelines

The introduction of the AGWR in 2006 shifted the focus for recycled water from a prescriptive end-product management approach to one that focuses on risk management. This has led, in some cases, to different interpretations of risk (see the *'Matching Treatment to Risk'* paper for more intriguing stories about this), and consequently to different associated levels of treatment. It has meant that some recycling schemes do not meet the recommendations of the AGWR and hence are required to upgrade their treatment regimes to achieve approval (for an example, see the Wagga Wagga case study).

The AGWR recommends supplying dual reticulation water with a quality whereby the pathogen concentration is tolerable with an annual cross-connection frequency of around 1 event in 1,000 dwellings per year. Curiously at odds with this, in a table of suggested critical control points, the AGWR (Table 2.8, p.48) also suggests all houses receiving recycled water should be inspected every five years. This seems contentious and particularly onerous, given that the recorded incidence is on average 1 event in 10,000 dwellings per year (Storey, Deere, Davison, Tam, & Lovell, 2007).

EXAMPLES FROM CASE STUDIES
See each case study paper for more detail

Wagga Wagga – further treatment required under the AGWR
The introduction of the AGWR in 2006 has meant that, despite significant upgrades to the STPs to comply with the new EPA discharge license, the existing >30-year-old recycling scheme does not conform with the new AGWR. The implication is that in order to get recycled water approval they are now likely to **have to install additional treatment** (such as UV) in order to achieve the required log removal for water used in their recycling schemes. This will have significant cost implications.

Aurora – onerous auditing?
The Aurora scheme provides recycled water to households for toilet flushing and garden irrigation. The Victorian EPA's concern about the **ongoing risk of cross-connections** has resulted in all households connected to recycled water having to undergo an **inspection audit every five years.** Under current arrangements, the **additional cost** ($50/household/year) is borne by Yarra Valley Water and therefore **spread across their whole customer base.**

Questions to prompt your thinking about changes to the national guidelines (see *Tools section:* T1 *Stakeholder Mapping* for more details):
- Is the planned treatment regime consistent with the regulating authority's current interpretation of the AGWR?
- What are the real auditing requirements for the scheme?
- How can savings be made on the validation of the treatment technology option?
- How might the AGWR change in ways that would impact your scheme?
- How might changes in water industry practices affect your scheme?

Treatment technology

A number of technological performance issues can be of concern especially if this is the proponent's first foray into recycled water. A robust assessment of the source water quantity and quality, and the associated consistency, will avoid additional treatment processes being added at a later stage.

Using tried and tested treatment processes will ensure that the plant can function effectively for a specific application (i.e. it will treat the source water and produce the quality of water required). The AGWR suggests that treatment processes be validated prior to the operation of the water recycling scheme. This is a positive approach, which shifts the focus from end point monitoring to process barriers, and the operational monitoring of those barriers. This approach has the potential to save costs in future when a greater number of treatment systems are pre-validated.

EXAMPLES FROM CASE STUDIES
See each case study paper for more detail

Darling Quarter – learning from own experience
In Darling Quarter the developer wanted to learn from their experiences with using recycled treatment plants at other sites. Some of the specific steps they took to minimise risks were to:
- ensure the plant had a constant source of supply by entering into a sewer mining agreement rather than relying on the variable supply of sewage generated on-site
- manage the input quality by clever design of the off-take to largely exclude both grit and FOGs (fats, oils and greases)
- test the actual quality of the influent to inform design of the treatment plant – this proved to be highly beneficial as the tests showed the presence of unusual fluoro-hydrocarbons that could inhibit bacterial growth
- have a "non-critical" plant which enabled them to choose to shut the plant down and resort to potable backup without having to store effluent on-site if there were problems with the plant.

Yatala – learning from others' experience

As is becoming common in large engineering projects, before committing to a specific technology, representatives of the proponent, Carlton United Brewery (CUB) reviewed other sites with similar on-site recycled water treatment facilities in the Netherlands and Bangkok. Observing the treatment plants first hand, especially in similar climatic conditions, and investigating the plant records gave CUB the **confidence to invest in the chosen technology.** Similarly, having had poor firsthand experience of outsourcing O&M to a third party in one of their own plants in another state, which had led to poor plant performance and strained relations, CUB decided to take responsibility for O&M themselves at the Yatala site. This has proved to be highly successful in terms of problem solving and providing internal incentives for both improved plant performance and **further cost saving** in the manufacturing processes that the plant supports.

Questions to prompt your thinking about technological risks (see *Tools section:* T2 *Identifying risks and uncertainties*):

- How well do you really know your source water?
- What if the treatment technology does not perform as expected?
- What technological components of the scheme are tried and tested/validated?
- What technical support is readily available?
- How will non-health risks (e.g. odour, machinery noise, truck movements) be addressed?
- What contingency plan is there in the event of a technical failure of the treatment process?
- How resilient is the treatment process to changes in influent quality, influent quantity and demand?
- How has future equipment obsolescence been addressed?

5

Institutional arrangements

What are the approvals and contracts that affect the scheme?

Regulatory processes

The case studies investigated illustrate an array of different approvals processes relevant to different jurisdictions, arrangements and applications. Ambiguity exists around the need for formal and informal approval from multiple agencies potentially involved, as described in the *'Navigating the Institutional Maze'* paper. And in some cases there are gaps in regulations (for the NSW metropolitan councils for example) and this means proponents are left without an official regulatory authority.

The recent drive to tighten approvals processes, and the shift to a risk management approach (i.e. WICA and AGWR), have resulted in some ambiguity for those existing and new proponents seeking approval for their recycled water schemes. The desire by regulators to shift to a risk management approach, but with limited staff and regulatory resources, together with proponents aiming to do so with limited guidance, available skill levels and time, has led to a capacity gap in the sector.

In the case studies investigated, these multi-layered difficulties have led to the approvals processes taking far more time and resources than originally anticipated.

EXAMPLES FROM CASE STUDIES
See each case study paper for more detail

Darling Quarter – long regulatory process times and the need for tighter contractual delineation
The Darling Quarter approvals process took **significantly longer than anticipated.** This was due partly to its pioneering nature as it was the first plant to be licensed and operating under WICA. In most cases, although taking time, the licensing and contractual arrangements were well thought through. However, in some cases (i.e. the WICA licence), the lines of responsibility and reporting versus control needed better delineation.

Wagga Wagga – confusing and unclear processes
The Council investigated Section 60 approval for their existing recycled water system but due to **time constraints, resource constraints and a lack of clarity** (despite talking to regulators) they had to put seeking approval for their recycled water scheme on hold until their STP upgrades were complete. After finalising the upgrades they engaged an expert adviser with technical and facilitation skills to help break the approvals barrier and they brought key stakeholders to the table to discuss what needed to happen to gain approval. **Seeking expert advice and engaging with the major stakeholders** was a major breakthrough in the approvals process.

Yatala – splitting waste streams significantly simplified the regulatory compliance process
At the Yatala brewery a decision was made not to include the on-site human sewage in the on-site recycled water system. The sewage is discharged directly to the council sewerage system. For this reason the plant was considered low risk and the approvals process was relatively straightforward.

Questions to prompt your thinking about getting approval (see *Tools section:* T1 *Stakeholder Mapping* for more details):
- What approvals processes apply to your jurisdiction and specific application?
- Who do you need formal approval from versus informal approval/advice?
- How will you cope with varying interpretations within and between regulators?
- How will you cope with lengthy approvals processes?
- How might the approvals processes or regulators change over time? How will you deal with this?

Contractual issues

Due to the emerging nature of the recycled water sector and with so many combinations and permutations for scheme set-ups, the contractual arrangements remain somewhat fraught. The contractual arrangements between key players involved in any particular scheme therefore require careful consideration to ensure clear roles and responsibilities and to avoid conflict when things don't go according to plan. From the case studies it is clear that discussions to resolve these often complicated contractual arrangements are indeed protracted, especially when key players come and go (e.g. in regulatory or agency roles). Negotiating these new contractual arrangements takes time and can result in added financial stress for the various parties involved. Also, getting the balance of contractual risk right is important to avoid unfair financial bias in the long term.

Developers are often dependent on entering into agreements with utilities to either source sewage or to discharge waste from the treatment plant. The arrangements need to provide security for the developer to proceed with investing in the scheme in the first place (e.g. an adequate source water quantity and/or quality is available long-term). Yet the utility needs to be sure that they can commit to providing the source water. The Gordon Golf Club case study illustrates this (refer to the *'Navigating the Institutional Maze'* paper for further details). The well-negotiated long-term arrangement set up at Willunga is an example of where contractual arrangements for multiple players have gone well.

Some contractual arrangements guarantee revenue from recycling scheme end-users or retailers who are contractually bound to pay a set amount regardless of whether they use the recycled water ("use-or-pay" agreements). Such arrangements can impose an unfair financial burden, as in the case of Rosehill.

EXAMPLES FROM CASE STUDIES
See each case study paper for more detail

Willunga – long term contract provides security of supply

The Willunga scheme was able to secure a 30-year supply agreement with SA Water (with an optional 10-year extension), giving them security and enabling them to build a strong customer base. Securing a reliable supply of water for 30 to 40 years helped the Willunga investors feel confident they could make the business work, building and growing the irrigation customer base. For SA Water, the opportunity to significantly reduce their discharge of wastewater to the Gulf was appealing, and without plans (at that time) to enter the recycled distribution business themselves, they were happy to agree to a long-term arrangement.

Rosehill – bound by a use-or-pay contract

It was clear that Sydney Water Corporation acting as the **retailer** and bearing the demand risk at Rosehill was essential for the scheme to get off the ground in a timely way to assist address the Sydney-wide water security pressures at the time. Under the agreed model, Sydney Water purchases treated recycled water from a consortium at a specified **use-or-pay volume** (irrespective of actual amount used), guaranteeing income for the consortium for 20 years. However, because some of the original foundation customers have ceased operation and new customers have not come on-line the anticipated demand has not eventuated, resulting in lost revenue for Sydney Water. These **revenue losses are transferred to Sydney Water's broader customer base** through a government directive, effectively underwriting the mismatch between supply capacity and actual demand.

Questions to prompt your thinking about contractual arrangements (see *Tools section:* T3 *Capturing costs and benefits more holistically*):

- What business security does each of your contracts provide?
- What level of flexibility do the contracts allow to accommodate future changes in circumstances?
- How will long-term binding agreements affect the future financial viability of the scheme?

6 *Financing*

What are the financial arrangements?

Whilst the financing for recycled water schemes might have a chequered history, it has an intriguing future, as outlined in the *'Looking to the Future'* paper.

Many water recycling schemes have received federal and/or state grants, either directly related to recycling and/or the end users of the recycled water supplies (i.e. Wide Bay Water sugar cane farming and tree plantation ventures). These kinds of funds have assisted in driving some recycling schemes – in some instances the case study participants have indicated that without such funding they may not have been able to proceed with their schemes. Other schemes have been able to negotiate favourable arrangements. For example at Willunga a long-term, free supply of high quality water.

It is now clear that both of these situations are unlikely to continue. Significant government sources of funds are no longer available for the water sector and are unlikely to return in the near future (see, for example, the Chair of the National Water Commission's keynote speech delivered to Ozwater 2013). Widespread state and federal government targets for recycling mean that utilities are also looking for opportunities to meet their performance targets, so they are unlikely to give away recycling opportunities. Helping proponents develop a better understanding of the costs, benefits and risks of recycled water is therefore an important task.

The most significant thing to note from our case study work, and from others work in this field, is that calculating the costs and benefits of recycled water is not straightforward. As explored in the *'Looking to the Future'* paper, the schemes investigated in this project demonstrate that whilst some costs are direct and fixed, many other costs and essentially all of the benefits associated with recycled water schemes can be:

- indirect and difficult to measure (e.g., the business value to Veolia of a successful first foray into small-scale recycling systems in Australia)
- imprecise (e.g. the cost to Yarra Valley Water of adapting all its business processes to include the provision of the new service of recycled water)
- uncertain and variable (e.g. the take-up of recycled water by cane farmers at Hervey Bay was lower than expected because many of the local farmers were reluctant to try new farming methods, many farmers had unfounded concerns about soil salinisation, and is because demand is rainfall dependent)
- contingent on certain future scenarios that are beyond the control of providers (e.g. the real value of the Rosehill scheme was in its contribution to potable water availability in a drought, but the state government decision to construct the desalination plant obviated that benefit)
- dispersed (e.g. the real value of the Willunga scheme may be that it avoided the decimation of the local winery sector, which underpins the entire regional economy).

As if that weren't enough, there are other benefits from recycling schemes that are frequently excluded from consideration because they are only noticeable at an aggregated scale when the recycling scheme sits within a large, highly centralised water and sewage system[1]. For example, the local utility or agent responsible for a recycling scheme may obtain a twofold benefit: the scheme may reduce the load on an STP while at the same time reducing the demands on the potable water supply system and associated networks. Such broader system benefits can save millions of dollars by delaying or obviating network or system upgrades, yet they are rarely monetised or captured in the analysis conducted for recycling schemes. And the cumulative effects of individual recycled schemes on a specific water and/or wastewater system are rarely considered.

The multiple players involved in recycling schemes often take very different perspectives and approaches when looking at the costs and benefits of water recycling schemes, which leads to conflicting and confusing results. The *'Costing for Sustainable Urban Water Outcomes'* (Mitchell et al, 2007) provides guidance on how to get the fundamentals right – how to set consistent boundaries around different systems that are being assessed, and how to fairly include in the analysis the distribution of costs, benefits and risks across different players – as described under ***Tools section:*** T3 ***Capturing costs and benefits more holistically***.

EXAMPLES FROM CASE STUDIES

See each case study paper for more detail

Wide Bay Water – innovative funding arrangements

The Hervey Bay utility (Wide Bay Water) has numerous examples and has been highly successful at tapping into funding and additional business opportunities to assist in financing its recycling scheme:

- Wide Bay Water secured >$14M of **federal and state funding** to assist them in expanding their recycling scheme – identifying nutrient removal, sugar industry reform as well as reuse as goals.
- Wide Bay Water signed up irrigating cane farmers in the region on retainers to take recycled water (take-or-pay contracts)
- Wide Bay Water bought land (an appreciating asset) and is irrigating hardwood trees with recycled water for poles to sell on consignment to the energy sector as an internal revenue stream.

Yatala – mutual benefits

Carlton United Breweries (CUB) discussed their expansion plans and associated trade waste requirements with the local council in the 1990s and again in the mid-2000s. On both occasions the council, whilst wanting to assist industry expansion in the region, was unable to cope with the proposed additional loads from the CUB expansions at the local STP. This, together with other factors (the timing of the local STP upgrades and associated headworks costs), drove CUB to invest in on-site treatment on both occasions. In the 1990s CUB invested in on-site effluent treatment, which they paid for. In the mid-2000s however, discussions between CUB and the Council identified a mutual benefit. Hence the council **waived significant headworks charges** because CUB were able to add a recycling plant that would **reduce both water demand and trade waste volumes**, which were stretching the local utility services at that time.

Questions to prompt your thinking about the financial arrangements (see *Tools section:* T3 *Capturing costs and benefits more holistically)*:

- What are the broader costs and benefits for the scheme? To whom do they fall? And when?
- How does your financing model take account of the full spectrum of costs and benefits?
- What grants, funds, other public or private entities are available to assist in financing the scheme? (e.g. Are there funds available that are not directly relevant to recycling but have a similar aim?)
- What happens to the scheme if these funds dry up in future?
- What happens if the application for funding is not successful?
- What happens if the motivation for the funding does not eventuate when the scheme is operational?

Tools

T1 Stakeholder mapping

As indicated in Section 1, analysing your stakeholders or direct and indirect players over the duration of the project is crucial to the success of your scheme. The process of identifying stakeholders will likely result in a long list of individuals and groups. The value of stakeholder analysis is in working out whether and why different stakeholders matter to your project. Mapping them according to different dimensions will provide you with a better picture of how to work with such players and when it may be important to do so. There are basically two types of tools to do this. The first type focuses on the player's relationship to the project - their level of interest or degree of control over your scheme. The second type is interested in the player's orientation to the project - how they understand the world and how that affects their perception of risks and therefore their beliefs about what sort of actions are reasonable. Here, we introduce a series of tools and techniques that will help you to explore both realms.

There are many interesting approaches to identifying stakeholders and mapping their associated influence. They range from relatively simple mapping to complex modelling approaches. Whichever tool you choose, a useful twist is to undertake the stakeholder mapping exercise with a diverse group of people associated with your recycling scheme. You will likely find that different individuals have different perceptions of different players' positions in the field. You will certainly get different ideas about what conversations and communications you will need to have with each of the players. The fundamental idea is that a structured approach to thinking about the range of players involved provides an incredibly useful starting point for identifying and managing risks.

Power, control and influence

A powerful and simple approach comes from Stephen Covey's work, '*7 Habits of Highly Effective People*'. The concept had more of a personal development orientation early on, but a quick internet search shows it is now used in powerful ways in many, many realms. The task is straightforward - position each of the players in your system according to the level of control, influence, or concern they have about your scheme (see Figure 1).

A related approach that comes from the policy arena is the Stakeholder Influence Map (see Figure 2). In this visual technique, the basic shape is a triangle. The apex is the policy, and influence increases as you approach the apex. Each stakeholder or stakeholder group is represented by a circle, The size of the circle is determined by the number of members in the stakeholder group (e.g. a large circle at the bottom of the triangle could represent the local population, while a small circle closer to the apex could represent an influential government department/decision maker).

Figure 1
Source: Covey 1989

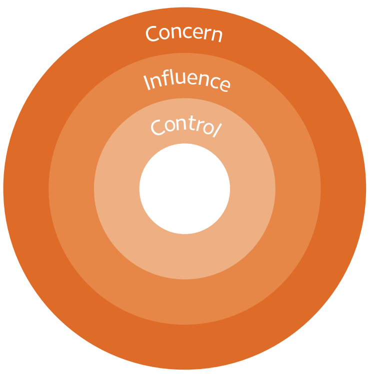
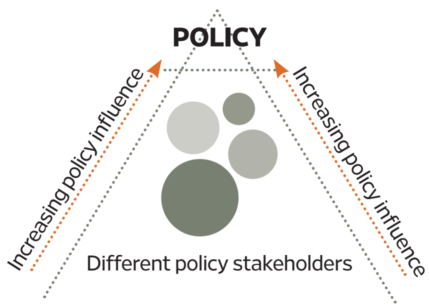
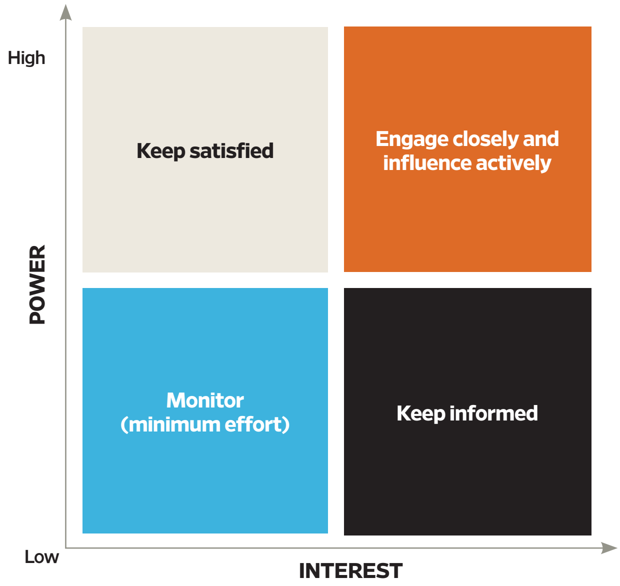
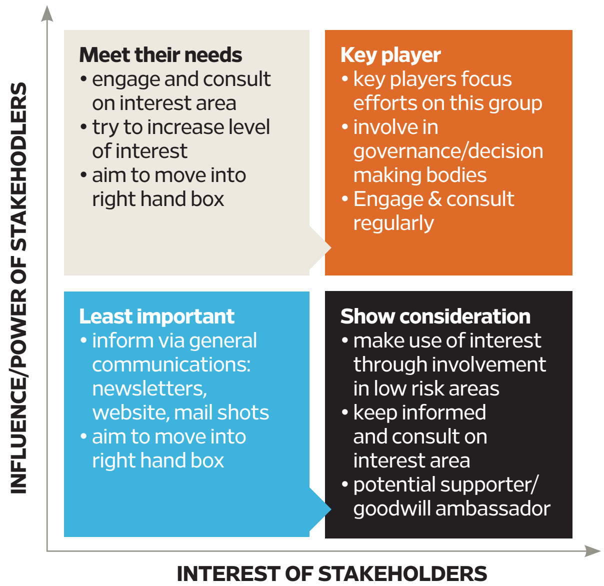


Figure 2
Source: Mayers and Verneulen 2005



Perhaps the most powerful of the simple approaches are those that combine an analysis of power with an analysis of interest. These are usually prepared as a simple matrix, as shown below. The Overseas Development Institute in the UK is a leading agency internationally, and has useful resources on its website.

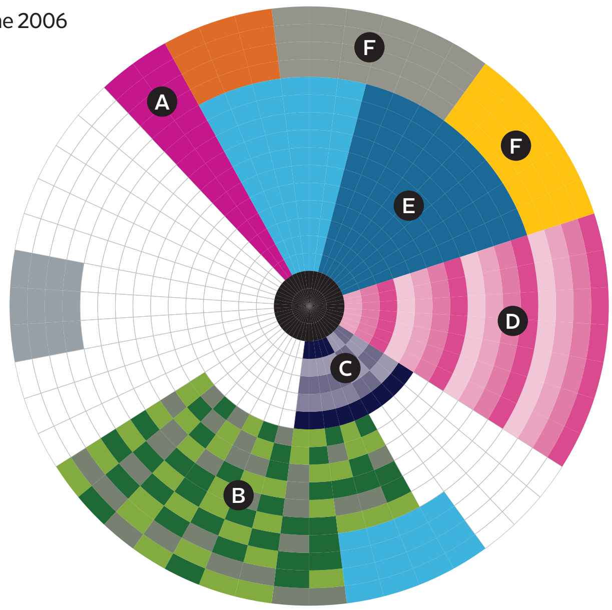




A more complex modelling approach is the Stakeholder Circle™. The output of the process is again highly visual, and seeks to represent both the scale of the stakeholders (i.e. the number of people in a group) and the degree of power, control or influence they can exert over the project. An example of a generic output (Bourne 2006) is shown on the next page.

Stakeholder Circle™

Source: Borne 2006



A This stakeholder has limited influence but the power to kill the project.

B The project clients may have limited individual influence and be remote but have a significant influence as a group.

C The project team are close to the project but have limited individual influence.

D This group of stakeholders has significant influence and the power to kill the project (e.g. a project board).

E This in an influential stakeholder close to the project (e.g. the project manager).

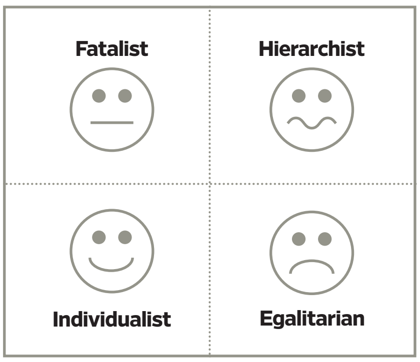
F These stakeholders are relatively remote but influential (e.g. suppliers).

Perceptions of risk

A completely different, but equally important realm, relates to our beliefs as individuals and members of a society. For example it considers our views and values about how the world works, whether nature is fragile or capricious or benevolent, and fundamentally influence how we assess different scenarios - what we see as risky, or as a reward worth having. A widely used framework in this realm is cultural theory. It is about the relationship between risk and culture, and was first put forward by Douglas and Wildavsky (1982), and has been applied in many different arenas, from climate change negotiations to issues of pensions in aging populations, as well as urban water management. It differentiates between four orientations: fatalist, hierarchist, individualist, and egalitarian, which were later caricatured by Thompson et al (1990) (see Figure 3). The *'Costing for Sustainable Urban Water Outcomes'* guidebook (Mitchell et al., 2007) explores this idea in relation to water planning. Another useful resource is Beck et al. (2011), because it explains the framework in accessible language, and applies it to a very live groundwater management issue.

Figure 3

Source: Thompson et al 1990



T2 *Identifying risks and uncertainties*

Tools produced to assist in the development of Melbourne's water supply-demand strategy, *'Planning for Resilient Water Systems'* (Mukheibir & Mitchell 2011), provide a specific risk and uncertainty identification and assessment process for developing resilient water supply systems. This tool can be used when considering recycling schemes. The process firstly identifies the uncertain drivers and pressures that may affect the context within which the recycling scheme operates. It allows them to be characterised as trends or shocks in order to distinguish and better respond to their consequences. Trends gradually change over the longer term (e.g. stormwater run-off or slow changes in demand growth) whereas shocks suddenly lead to new norms (e.g. energy price increases or sudden changes in demand). Separating and characterising how the pressures and drivers occur is important because different responses will be required to manage or avoid them.

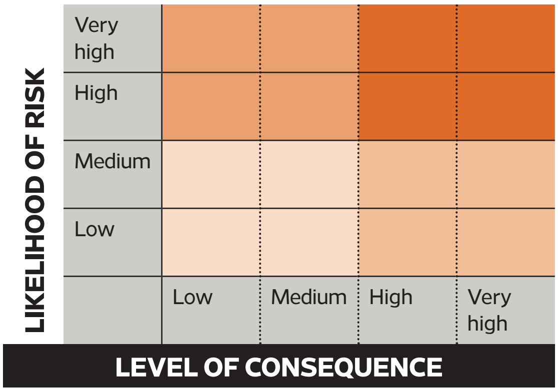
Together with the PESTLE framework, separating the problem into issues that relate to the "supply" of recycled water and those that could affect the "demand" ensures that a comprehensive analysis of the contextual uncertainties and risks is undertaken. Table 4 below provides some examples drawn from the case studies.

Table 4: PESTLE matrix

PESTLE	Source volume or quality		Demand volume or quality	
	Gradual shift	Sudden shift	Gradual shift	Sudden shift
Political			Government policies and attitude towards recycled water	Government invests in large new supply e.g., desalination
Environmental	Reduced stormwater flows; seasonality in stormwater flows		Higher rainfall reduces the need for irrigation	Drought breaks resulting in lower demand for alternative water supplies; seasonality in rainfall
Social	Slower rate of new building uptake produces lower volume of sewage		Slower rate of new housing reduces demand for recycled water	
Technical		Changes in the quality of the source water		Changes in the quality requirements by customers
Legal	Regulatory processes delay supply of source water			
Economic		A significant industrial source of wastewater shuts down	Fluxes in the economy positively and negatively affect the demand for recycled water	

Since it is not practical to assess the impact of all the possible risks and uncertainties, the most significant trends and shocks need to be identified using a traditional risk matrix (i.e. those that have a high likelihood and a high consequence should receive primary consideration) as shown in Table 5.

Table 5 : Traditional risk matrix



Further guidance materials can be found on the *Smart Water Fund website under the 'Options Assessment Framework' project* (Mukheibir & Mitchell 2011).

T3 *Capturing costs and benefits more holistically*

Capturing costs and benefits, and risks that manifest as costs or benefits, and bringing them into the decision-making process is just good business. There are many, many different ways to accomplish this. An important principle to start with is to assess the costs and benefits of an individual scheme or selection of options using a much broader boundary than narrow financial analysis, which might seek to maximise the return to an individual business or entity. One approach to this broader economic analysis is to monetise everything. **Cost benefit analysis** (CBA) involves quantifying in monetary terms the direct and indirect impacts on all potentially affected players (e.g. utility, government, developer and customers). **Cost effectiveness analysis** (CEA) seeks to achieve the same broader economic picture but recognises that not all costs and benefits can be monetised and therefore accommodates non-monetised benefits into the assessment. Multi-criteria analysis (MCA) can help here. Multi-criteria analysis is often maligned, because it is often done badly, but there are resources that can help to set the right ground rules, and lead to better outcomes. There are Australian water industry specific guidance materials on CBA, CEA, and MCA freely available on the *Smart Water Fund website under the 'Options Assessment Framework' project*. Here, the focus is on the fundamentals.

The boundaries of analysis determine whose costs, benefits, and risks are included. Making those boundaries clear, explicit and consistent is therefore an essential first step in determining the viability of a recycling scheme. This means clearly articulating the players, who bears what risks, and how costs and benefits are shared over time. Importantly, how costs might potentially change over time (e.g. change in policy, loss of subsidies, energy price rises, reduced demand) needs to be thought through.

As identified in Section 6 the multiple players involved in recycling schemes can often have very different perspectives and approaches when they look at the costs and benefits of water recycling schemes. These need to be taken into account, and the guidebook *'Costing for Sustainable Urban Water Outcomes'* (Mitchell et al., 2007), available for free[2], provides guidance on core costing principles that can assist in capturing the diverse financial and economic costs and benefits of a scheme more holistically.

These principles for effective costing for sustainable outcomes include:
- **the use of appropriate cost perspectives** – the use of a whole-of-society perspective which includes utility, developer and customer etc.
- **provision of water service outcomes** – focuses on the service outcome required, not just the assumed volume required
- **thinking in terms of systems** – use of clear consistent system boundaries
- **inclusion of life cycle costs** – use of a clear analysis period and inclusion of replacement capital and operating assets as required
- **assessment using incremental cost** – consideration of the recycling system against business as usual to enable capture of the relative benefits of avoided system capital and operating expenditure
- **accounting for externalities** – incorporation of broader benefits in terms of dollar values or through qualitative means as appropriate
- **accounting for the time value of money** – where costs are reported in a particular year using net present value
- **acknowledging and managing precision and uncertainty** – being explicit about uncertainty and lack of accuracy
- **reporting transparently** – ensuring the analysis and results are summarised clearly to facilitate a shared understanding.

Many of the diverse costs and benefits of the individual schemes in the case studies were not explored when they were being implemented. However, they highlight a range of realised benefits, which are both monetised and non-monetised. Examples of less tangible but highly important non-monetised benefits include:
- being able to maintain a high quality golf course during water restrictions
- having a 6-star green star building in the owner's portfolio
- development of skills and knowledge on water recycling by the organisations involved
- insurance against future drought
- opportunity benefits of improving the quality and management of open spaces.

Further guidance on how to capture costs and benefits more holistically and additional useful references on this subject can be found in *'Costing for Sustainable Urban Water Outcomes'* (Mitchell et al., 2007)

Notes

1. The Yatala case study stands out as an exception because the scale of the existing local infrastructure was very small – the new brewery would have doubled existing demands and loads. That provided the opportunity to negotiate directly with the local utility about financial incentives associated with headworks charges and the like.
2. cfsites1.uts.edu.au/find/isf/publications/CostingGuidebookCRCWQT.pdf

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