Australian Water Recycling Centre of Excellence

Project Report

Economic viability of recycled water schemes

A report of a study funded by the Australian Water Recycling Centre of Excellence

Marsden Jacob Associates, November 2013

Economic viability of recycled water schemes

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About the Australian Water Recycling Centre of Excellence

The mission of the Australian Water Recycling Centre of Excellence is to enhance management and use of water recycling through industry partnerships, build capacity and capability within the recycled water industry, and promote water recycling as a socially, environmentally and economically sustainable option for future water security.

The Australian Government has provided $20 million to the Centre through its National Urban Water and Desalination Plan to support applied research and development projects which meet water recycling challenges for Australia's irrigation, urban development, food processing, heavy industry and water utility sectors. This funding has levered an additional $40 million investment from more than 80 private and public organisations, in Australia and overseas.

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The Economic Viability of Recycled Water Schemes for Non-potable Use

Prepared for the Australian Water Recycling Centre of Excellence

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Executive Summary

This study, supported by funding from the Australian Water Recycling Centre of Excellence, aims to develop a holistic framework that will allow for a rigorous assessment of the economics of non-potable recycled water schemes, including residential, industrial, municipal and agricultural schemes.

Industry engagement

Over the course of this study, Marsden Jacob Associates (MJA) engaged widely across industry and government. The consultation identified that the two most prominent barriers to the successful implementation of non-potable recycled water projects have been the relative cost of recycled water compared to other water sources and commercial risk, in particular demand risk.

Industry proponents largely agreed that legislative and regulatory barriers preventing the implementation of recycled water projects had been significantly reduced, if not removed. Some of the relatively new entrants noted that the complexity and time required to navigate through the process could delay or even prevent the implementation of some projects. Some water service providers also noted that capital constraints may reduce their ability to fund recycled water projects in the future.

To improve the chance of success for new projects, this study recommends that further work be undertaken in the following areas:

1. *commercial risk:* provide further advice to project proponents regarding the contractual and other arrangements that can be utilised to reduce commercial risks, and in particular demand risk (some of the key strategies are reviewed at a high level in the body of this report);
2. *cost effectiveness:* to the extent possible, make available the information proponents require to assess the economic viability of new recycled water schemes. Specific information can be provided on a case-by-case basis or, preferably, a broader understanding could be facilitated through a ‘hotspots’ assessment. This assessment would make location specific information available (possibly using a GIS mapping system) to highlight the attributes of each location that affect economic viability and therefore the chances of success;
3. *process barriers:* continue to streamline regulatory and administrative procedures to assist proponents, including initiatives such as providing ‘one stop’ information, expanding the number of pre-validated water treatment processes, and providing more detailed information on minimum regulatory requirements;
4. *capital constraints:* investigate alternative methods of utilising private sector financing to allow water recycling projects to move ‘off balance sheet’.

Economic framework

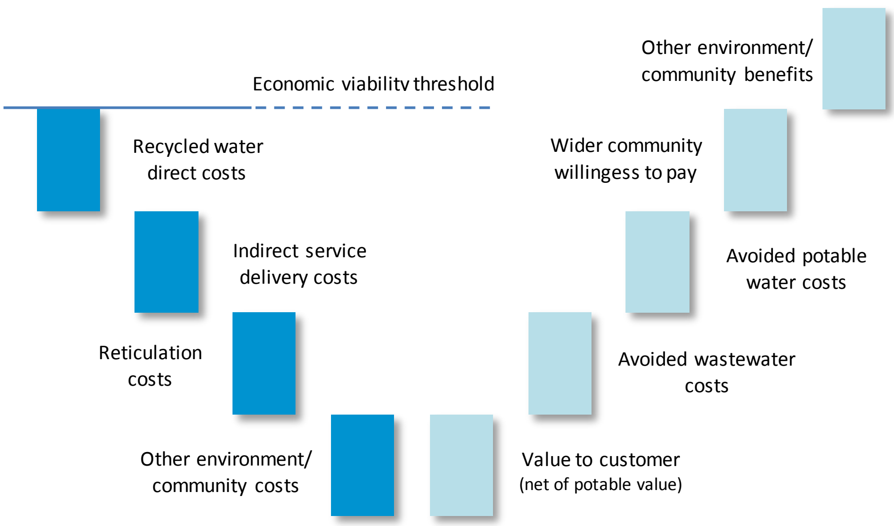
The framework in this report uses cost-benefit analysis (CBA) as the basis for evaluating non-potable recycled water projects. CBA is considered the most robust method for examining the economic viability of investments and is the preferred method of analysis for most State and Commonwealth agencies.

CBA does not specifically address matters of equity or perception, including political sensitivity, moral obligations or cultural issues. Where these or other factors cannot be quantified, they must be subjectively weighed against the economic impacts, which may be assisted through the use of tools such as threshold analysis or multi-criteria assessment.

The framework uses the well-established concept of total economic value (TEV) to assess the value of costs and benefits. TEV includes both *use values*, which measure the value of *using* recycled water, and *non-use values*, which refer to an individual's willingness to contribute to the cost of water recycling, even if the individual will not use the water from the scheme. The non-use values of water recycling may, for example, include environmental benefits or a community preference for 'sustainable' water management.

The primary costs and benefits to be considered in an economic evaluation of non-potable recycled water schemes are shown in Figure 4. If the benefits (light blue) outweigh the costs (darker blue), the scheme would be considered economically cost benefit justified.

Figure 1: Economic framework showing primary costs and benefits



NOTE: Size of bars does not reflect relative size of costs/benefits

The primary costs identified in the framework include:

- ***recycled water direct costs:*** the present value of all upfront and ongoing expenditure required to construct and operate the scheme. Scheme costs vary greatly depending on a range of factors including the level of treatment, distribution costs, land use zoning, and economies of scale;
- ***indirect service delivery costs:*** other service delivery costs include any modifications or additions required to the wastewater treatment and distribution system and the *marginal* administrative costs required to support the recycled water scheme;
- ***reticulation***: the street level infrastructure required to transport recycled water to individual residential or commercial properties. It is common for reticulation to be installed by land developers and handed over to the water service provider, and therefore the cost is often estimated separately from other recycled water costs;

- ***other environment/community costs:*** a range of other costs have been identified in previous project evaluations but as they are project specific, they have not been separately identified in the general framework. In particular, some projects have identified that diverting removing treated wastewater flows from inland waterways could reduce the volume of water available for downstream agricultural users or the environment.

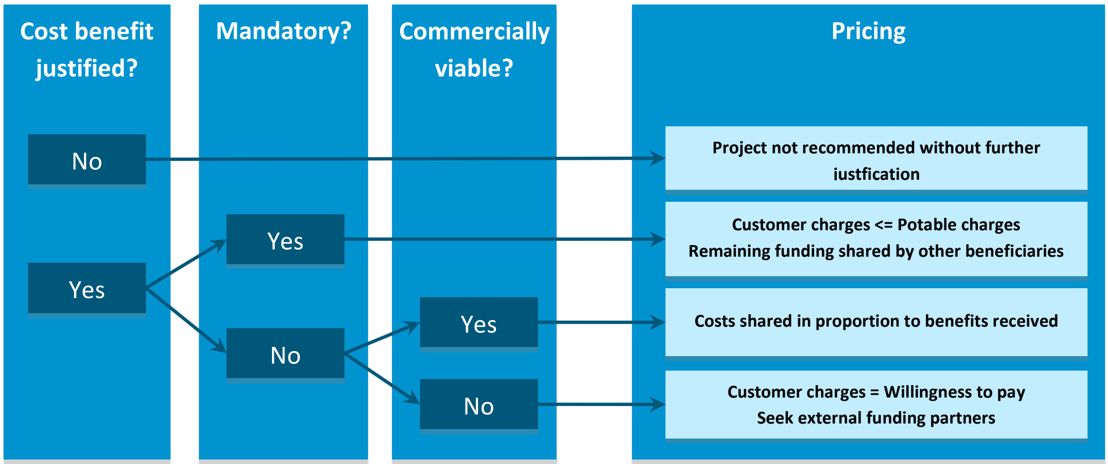
The primary benefits identified in the framework include:

- ***use value (net of potable use value):*** the benefit that will be gained by an individual or business that is supplied with recycled water. Where recycled water substitutes for potable water, the value of potable water must be netted (subtracted) from the use value as the customer will no longer receive potable water. If the recycled water is a perfect substitute for potable water, then the use of recycled water will represent neither a net cost nor a benefit. If recycled water *does not substitute* for potable water, then the value will reflect the user's willingness to pay for the recycled water, which will vary depending on the use of the water and the alternative options available to the user;
- ***avoided wastewater costs:*** the present value of avoided capital and operating costs associated with reduced wastewater volumes, in particular reduced wastewater disposal costs. Many inland water recycling schemes have been implemented to avoid the high cost of meeting environmental discharge obligations, which may require high levels of treatment or long distance outfall pipelines. Metropolitan schemes often have lower avoided costs due to the lower unit operating costs and the large historic (sunk) investment in ocean outfall infrastructure;
- ***avoided potable water costs:*** the present value of avoided capital or operating costs associated with reduced potable water use. The avoided potable water costs are often dominated by water source deferral benefits, however some savings in distribution, storage and reticulation may also be possible, particularly in greenfield schemes where infrastructure has yet to be laid;
- ***community willingness to pay (non-use):*** research (including the choice modelling survey undertaken as part of this study) has indicated that the broader community is prepared to provide a significant contribution toward the costs of water recycling, even if they do not directly use the recycled water. To avoid double counting, the community's willingness to pay for recycled water must exclude the direct benefits included in other elements of the analysis, such as avoided wastewater and potable water costs;
- ***other environmental/community benefits:*** this final element only applies if the benefits have not been completely captured in the other elements of the framework. Many ad hoc benefits have been identified for specific projects, including environmental and health benefits. Many of these benefits can be quantified by understanding the impact on the community or their willingness to pay for the identified benefit. For example, a benefit that was commonly identified during the drought was that removing demand from the potable water scheme would reduce the likelihood of water restrictions. While the importance of this benefit has reduced substantially since the breaking of the drought, the change in supply reliability may still have be relevant in some schemes, particularly those experiencing rapid demand growth.

Pricing

In accordance with the principles developed by the National Water Initiative and economic regulation agencies, the pricing framework recommended in this study utilises a beneficiary pays approach, with refinements to address other important issues. The pricing decision framework is summarised in Figure 5.

Figure 2: Pricing decision framework



The pricing decision framework indicates that:

- if the scheme is <u>not cost benefit justified</u>, then it is recommended that the project does not proceed unless justified by other (unquantified) considerations;
- if connection to the recycled water scheme is <u>mandatory</u>, then customers should be charged no more than the cost of a potable water supply to protect customers from any potential abuse of monopoly power. The remaining cost of the recycled water scheme would be shared between the other beneficiaries of the scheme, which may include the water service provider, the community and the land developer (provided that connection by the land developer was not mandatory also). Costs would be shared amongst the remaining beneficiaries in accordance with the principles described under '*Voluntary and commercially viable*' and '*Not commercially viable*' below;
- if connection to the recycled water scheme is <u>voluntary</u> and <u>commercially viable</u> without subsidisation, then the costs should be shared amongst direct beneficiaries in proportion to the benefits they receive (the beneficiaries pays approach);
- if the recycled water scheme is <u>cost benefit justified</u> from a whole of community perspective, but is <u>not commercially viable</u> without subsidisation, then beneficiaries should contribute up to their maximum willingness to pay, with the shortfall sought from external funding partners, government or from potable water/wastewater customers if there is a demonstrable willingness to pay.

The typical benefits for each major beneficiary are illustrated in Figure 6 and explained in more detail in the body of this report (note that the identified costs and benefits for each beneficiary are not exhaustive).

Uncertainty and risk

Commercial risk has been highlighted as one of the major concerns facing recycled water investors. Many water service providers have developed recycled water schemes on the basis of certain demand projections only to find that demand did not eventuate.

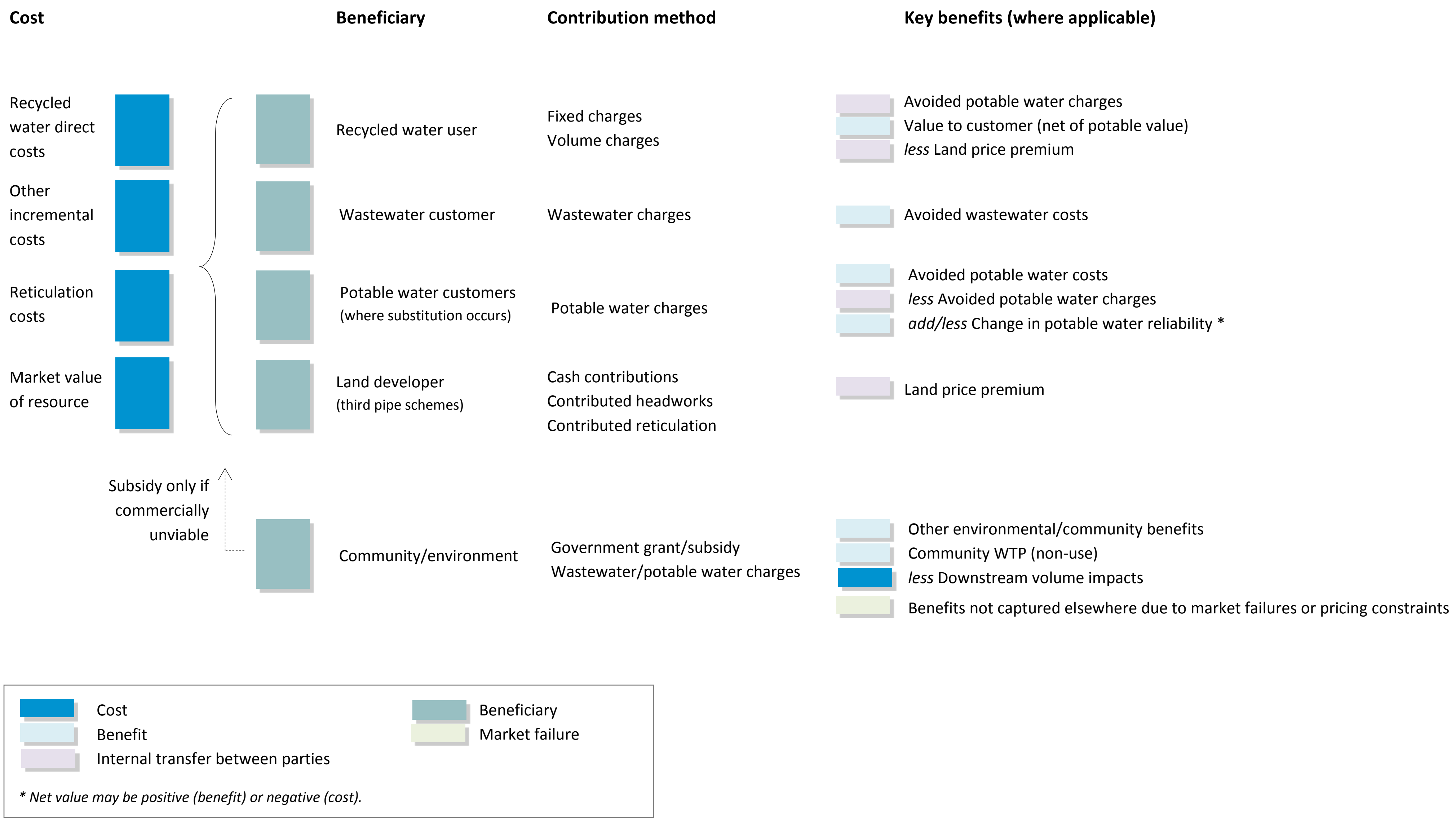
A key method of addressing demand risk for large industrial customers is to require upfront capital contributions plus fixed or take-or-pay charges to recover fixed operating costs, with usage charges reserved only for those costs that vary with consumption. Capital costs (plus a return) can potentially be recovered over more than one year if the customer can provide adequate financial assurances (such as bank guarantees), which will also ensure that the water service provider is protected from payment default.

For diverse schemes with a large number of customers, estimates of the number of *future* customers and their demand may be required. This risk cannot be addressed through pricing arrangements alone as the future customers are not yet available to enter contracts. Key methods of addressing the risk include the use of conservative assumptions throughout the analysis, incorporating the scheme into a regulatory pricing regime (ensuring that all efficient costs will be recovered through regulated prices), or obtaining government support.

For those risks that cannot be mitigated, the magnitude and probability of the risk would be included in a CBA. Where probabilities are difficult to gauge, numerous techniques have been developed to assist with the analysis, such as scenario analysis, threshold analysis, and real options analysis.

Once the risk is better understood, the proponents may examine methods of reducing or managing the risks including the use of staging and adaptive planning, allocating the risks to the parties that are best able to manage those risks, and hedging or ‘outsourcing’ the risk. Once risk management strategies have been developed, investors must decide whether the potential benefits of the project outweigh not only the costs, but also the unmitigated risks.

Figure 3: Pricing framework showing primary costs and benefits



1 Introduction

Water recycling schemes provide benefits to a range of parties including water authorities, recycled water users, the community and the environment. However, recycled water schemes have historically been difficult for any one isolated user to justify and therefore often rely on government funding. In many cases, economic and commercial benefits are inappropriately estimated and poorly delineated between parties, rendering the economic case for investment in recycled water projects difficult to establish in advance and to determine in hindsight.

As the capacity to assess economic viability differs between proponents and funding bodies, decisions are often made in the absence of a clear understanding of net benefits and without a consistent framework for their assessment.

A number of industry participants have developed their own frameworks for the assessment of recycled water projects. Some independent work has also been undertaken to explore and quantify the externalities associated with recycled water, such as the value of reduced carbon emissions and of avoiding water restrictions. Disparate analysis has also been undertaken to investigate the non-market benefits of recycled water and to explore the institutional and regulatory barriers to implementation of recycled water projects.

However, not only do significant gaps remain in quantifying the benefits of non-potable recycled water schemes, but there is currently no defensible and industry accepted framework for the economic assessment of new schemes. This project aims to fill this gap by developing and populating an economic framework for the assessment of non-potable recycled water schemes.

1.1 Scope and context

This study is supported by research funding from the Australian Water Recycling Centre of Excellence (AWRCOE), which in turn has been received from the Department of Sustainability, Environment, Water, Population and Communities under the National Urban Water and Desalination Plan. The project supports the AWRCOE's Goal 1, i.e. that *the social/ economic/ environmental value of water recycling is demonstrated and enhanced*.

The aim of the study is to develop a holistic framework that will allow for a rigorous assessment of the economics of non-potable recycled water schemes. The study considers a broad range of non-potable recycled water schemes including residential, industrial, municipal and agricultural schemes.

The framework aims to provide not only a general framework but also practical guidance on the assessment of business cases for individual projects.

The framework specifically addresses non-potable recycled water schemes. Potable recycled water schemes represent an alternative potable water source rather than a substitute product and would therefore be evaluated differently. Potable recycled water schemes are the subject of other studies being funded by the AWRCOE and being undertaken in parallel with the current study (in particular the *National demonstration education and engagement program* project - forthcoming).

This study also has close linkages with other studies funded by the AWRCOE, in particular *Identifying benefits of recycled water* (forthcoming), which is being led by the University of Technology Sydney and aims to identify the benefits and the factors affecting the success of a number of recycled water scheme case studies. These case studies provide valuable insights into the complexities of individual projects and highlight examples of benefits that would need to be considered in an overarching economic evaluation.

1.2 Approach and supporting studies

The findings of this report were developed through:

- interviews with industry service providers, government agencies, regulators and industry bodies, the results of which are outlined in Section 2.1;
- a wide ranging literature review - a list of selected documents for general reference is provided in Appendix 1 with a more detailed literature review relating to commercial and institutional issues provided in Appendix 2;
- where key information was found to be missing, the study has undertaken new primary research to assist in understanding the process for determining the information and developing estimates as a reference point for future studies. The supporting studies are referenced throughout this report and include:
    1. Marsden Jacob (2013) *Technical Report 1: The value of recycled water infrastructure to the residents of Rouse Hill:* This study examined the value of non-potable recycled water use for residential customers at Rouse Hill by utilising the hedonic pricing method (HPM) to quantify the value that customers hold for access to recycled water through third pipe infrastructure.
    2. Marsden Jacob (2013) *Technical Report 2: Community values for recycled water in Sydney:* A number of studies have revealed customer willingness to pay for recycled water projects, even if the customer does not directly benefit through use of the recycled water, for example to avoid "waste‟ of a water resource or reduce wastewater discharge. Through the use of Choice Modelling techniques we have explored actual community preferences using Sydney as a case study. The study establishes a broader societal "willingness to pay‟ for recycled water projects for use in the economic framework.
    3. Marsden Jacob (2013) *Technical Report 3: Environmental and social values associated with non-potable recycled water:* There are a number of costs and benefits that may not be included in a conventional financial analysis, such as environmental impacts and changes to community health and wellbeing. In this report, we have reviewed the theory and practice in Australia and identified relevant local and international studies to provide quantified values to assist with a more comprehensive economic analysis.

2 Commercial and institutional issues

Non-potable recycled water projects are in operation in most Australian jurisdictions, in and around the larger capital cities and in other regional centres.

Large numbers of non-potable recycled water projects operate in inland areas across Australia, primarily as a least cost wastewater disposal option. In addition, significant numbers of industrial, third pipe residential, municipal public open space, and more recently environmental[1] non-potable recycled water projects are being implemented in urban settings.

The vast majority of these projects have been developed by or with significant involvement from relevant local water service providers.

2.1 Industry engagement

There are numerous parties involved in the development, implementation and regulation of non-potable recycled water schemes, including:

- proponents of the projects (water service providers, developers, councils);
- regulators (health, groundwater and environment regulators, economic regulators); and
- policy makers (water agencies and government).

Over the course of this study, MJA engaged widely through workshops (with more than 100 participants across five States), steering committee meetings, industry presentations and general discussions regarding the extent and nature of barriers to recycled water projects.

In addition, MJA undertook dedicated in-confidence semi-structured interviews with industry participants from water service providers, government and the private sector.

During the interviews, stakeholders were asked about their involvement with recycled water within their jurisdiction, their perception of the main barriers to the implementation of non-potable recycled water projects, and how whether these barriers had changed over time. Interviewees were asked to nominate specific institutional and commercial barriers to recycled water projects in the current day.

The single most prominent barrier to non-potable recycled water projects identified by interviewees was the relative cost of supplying recycled water compared to the cost of potable and other alternative sources, i.e. the cost-effectiveness of recycled water schemes.

Interviewees largely agreed that legislative and regulatory barriers preventing the implementation of recycled water projects have been significantly reduced, if not removed, across all jurisdictions.

Some specific commercial issues and institutional barriers were identified, which we summarise in turn below.

[1] Environmental recycled water projects are highly treated wastewater recycling projects used to support environmental flow regimes in stressed waterways, such as Sydney's St Mary's recycled water project.

2.1.1 Institutional settings

Regulatory arrangements in Australia do not prohibit non-potable recycled water projects provided the project meets minimum health, environmental and customer service standards. However, a small number of regulatory gaps are recognised in different jurisdictions.[2]

Institutional settings are designed to balance the facilitation of non-potable recycled water projects with the protection of human and environmental health. This balance involves a trade-off between the cost of meeting regulatory requirements and the appropriate management of risk.

While all participants interviewed for this project agreed that institutional settings across jurisdictions did not prohibit recycled water projects, a range of views were expressed about the extent to which current settings added to project delays and costs.

A number of private sector interviewees who had successfully developed one or more recycled water projects found that compliance and monitoring costs were not significant components of total project costs, and should be undertaken as due process regardless of regulatory requirements. Furthermore, having negotiated regulatory processes, they felt they understood pathways through these processes for subsequent projects.

These interviewees tended to regard most formal institutional barriers as historical factors which had been overcome in recent years, with the foremost remaining barriers being financial and economic – the ability to produce recycled water at a cost comparable to alternative water supply and wastewater disposal options.

However, the growth of smaller scale, decentralised recycled water projects has led to a range of new players in the recycled water space, with limited experience in the establishment and operations of recycled water plants, and similarly limited exposure to regulatory processes. These businesses may require time to fully understand the complexities of the regulatory process.

Several respondents from both the private and public sector identified barriers associated with process and risk aversion within government and water service providers that have real implications on the timing and cost of recycled water projects. Negotiating regulatory processes is a particular issue when regulation is relatively new and untested (by both proponents and regulators) or project drivers differ from traditional water supply planning (for example, as a point of differentiation for new developments rather than a drought response or wastewater disposal option).

Government-owned water service providers

Government-owned water service providers develop, own and operate the majority of multi-user non-potable water recycling schemes in Australia.

While the legislative environment continuously evolves, environmental, health and economic regulation in each jurisdiction is now relatively clear and understood by most water service providers. Developing and implementing recycled water projects has involved significant investment in organisational cultural change, especially for small scale projects and projects that require significant community engagement. For some water service providers, particularly

2 Specifically, wastewater recycling within a single building is an ongoing regulatory concern in Queensland (where it is prohibited) and Victoria (where it is currently not formally regulated).

smaller organisations, a lack of experience may still be preventing the identification of opportunities and the exploration of potentially viable projects.

For those water service providers with limited experience in the development and implementation of recycled water projects, cultural risk aversion may also inhibit project development. For example, self-imposed restrictions on the type of recycled water use that will be considered (e.g. in-house use) may limit demand and therefore the economic viability of new projects.

Government-owned water service providers have also been characterised as commercially risk averse. Some proponents have argued that water service providers should take a more proactive role in developing recycled water projects and should absorb some or all of the costs and project risks. However, as corporatised entities with a responsibility for providing potable water and wastewater disposal services, most water service providers are not required to pursue recycled water opportunities and most would only do so if they were commercially viable. With regard to commercial risks, the same or greater risk aversion is often displayed by the larger private sector operators.

With the increased interest in recycled water over the past decade, many water service providers have entrenched recycled water projects within their broader planning framework, but only invest when they consider the benefits outweigh the costs and project risks.

In a climate of financial austerity, with sound economic justification required by regulators and government, economic viability currently appears to be the most significant barrier to the development of recycled water projects by government-owned water service providers.

Private sector

The private sector is frequently involved in the provision of contractor services to government-owned water service providers. However, this form of private sector involvement is well established in the water sector and has little bearing on the commercial or institutional barriers to developing new water recycling projects.

More importantly, some jurisdictions are actively encouraging the establishment of private sector water service providers in competition with government-owned entities. The *Water Industry Competition Act 2006* (WICA) in NSW is perhaps the most explicit case in point. Despite these advances, there remain relatively few multi-user water recycling facilities that are owned and operated by the private sector. To date, private schemes have primarily been small operations supplying residential and commercial customers (with the notable exception of the Rosehill-Camellia Recycled Water Scheme). Multi-user agricultural and industrial water recycling schemes are predominantly owned and operated by government-owned water service providers.

In addition to private involvement in ownership and operation, land developers are also often involved as the proponent of a water recycling project. In many cases, the developer will conceptualise, plan for and construct the scheme, for subsequent handover to a water service provider to own and operate. This is particularly the case for third pipe projects, in which recycled water supply to residences and public open space forms an important part of the market positioning for the development.

With regard to residential and commercial schemes, the private sector may be involved in a number of ways, including:

- a property developer may plan for and construct the recycled water assets and then pass those assets to a private or publicly owned water service provider (such as Mawson Lakes in South Australia);
- a private water service provider may own and operate the recycled water assets (such as the Central Park development in Sydney); or
- the property developer may take both roles and establish an entity to operate the project upon completion (such as Peel Water in Western Australia).

The drivers for residential recycled water projects are different for property developers than for traditional water service providers. For developers, a significant driver is the commercial return on residential block sales that a third pipe recycled water project can add because:

- the amenity benefits of recycled water are considered desirable features when householders are choosing between locations. Freedom from residential water restrictions, green sports fields and public open space, and a contribution to 'sustainability' are all viewed by residential developers as providing a market advantage in the competitive development industry. This translates to higher lot prices, or higher sales volumes, contributing to profit;
- some developable land may sit outside of the incumbent water authority's short term planning zone. Similarly, the residential development area may be larger than the remaining capacity of the existing wastewater system, or in an area not preferred by a local council's planners. In these cases, a development could be delayed until within the planning horizon of the water service provider or council, or require significant costs to connect to the system. A recycled water project as part of the development could facilitate approvals and avoid any delays.

Timing is a critical issue for property developers. Timing of recycled water projects is influenced by the regulatory approvals process, and (where applicable) the timeliness of negotiations with the water service provider or council for recycled water specifications and hand-over of assets.

However, both the regulatory approvals bodies and the incumbent water service provider are typically more concerned about risk management than the additional amenity or lot sales price, which can lead to project delays. The time required to gain approvals or negotiate hand over of assets can deter some developers and will, in many cases, motivate the developer to implement standard potable water supplies without investigating the feasibility of alternative supplies.

2.1.2 Commercial risk

A significant commercial risk identified by a number of stakeholders related to the management of recycled water demand in the context of changeable climate and economic conditions.

For agricultural schemes, demand estimates developed during dry conditions can prove optimistic if and when higher rainfall levels return. Similarly, industrial recycled water demand estimates generally assume the continued functioning of particular key users. Should these users reduce their production, cease operations or relocate, the financial viability of the recycled water scheme can be placed in jeopardy. For residential schemes, household demand can be estimated with better accuracy, however the rate of development and the number of households joining the scheme over time is significantly more difficult to predict.

2.1.3 Cost-effectiveness

Feedback from interviewees indicates that cost-effectiveness is seen as one of the most significant barriers to the development of new water recycling schemes.

To date, the majority of cost-effective schemes have been in regional areas where the scheme has played an important role in avoiding costly upgrades of the wastewater disposal system. Environmental regulations governing wastewater discharge (particularly to rivers and creeks) can necessitate high levels of treatment or disposal to distant environments such as the ocean. In some cases, alternative forms of disposal such as irrigation of golf courses, woodlots or public open space can cost significantly less than traditional disposal methods, particularly when the irrigation site is close to the treatment plant. The benefits are compounded if the recycled water is also substituting for potable water use.

Recycled water has also proven cost competitive in supplying fit-for-purpose water (both low and high grade) to some industrial water users.

Most other recycled water projects, including the majority of agricultural and third pipe residential schemes, have been implemented at a higher cost than traditional water supply and wastewater disposal schemes. These higher costs have typically been met:

- as a specific government grant or subsidy;
- by property developers, as part of the market positioning for their development; or
- as a cross-subsidy from potable water or wastewater customers, because the scheme was required to meet government imposed water recycling targets.

Investments requiring subsidies from any party have become increasingly rare in the current climate of higher rainfall (in the eastern states) and financial austerity.

2.1.4 'Process' barriers

Economic, environmental and health regulators are charged with ensuring adequate safeguards and the management of key risks. For recycled water projects, regulators and publicly-owned water service providers tend to operate with a similar appetite for risk.

What may be called 'process' barriers to recycled water projects can arise when the incentives and risk appetite applicable to private sector proponents clash with the incentives driving government regulators and government owned water service providers. For example:

- the *project proponent* may perceive that a third pipe recycled water project using proven technology is a relatively low risk proposition. The proponent may anticipate that regulatory approvals and commercial negotiations with a water service provider will be relatively straightforward;
- the *regulators* have an obligation to ensure the protection of customers and the environment. As regulators may have assessed relatively few projects of this kind in the past, and even fewer involving private sector proponents, high levels of proof may be required before projects can be approved; and
- the *incumbent water service provider* may perceive a number of commercial and risk related issues. For example, the project may produce water at a higher cost water than alternative sources and may require funding that the proponent did not anticipate. In addition, the water service provider might require the scheme to meet specifications that are not required by

regulators but are required to reduce reputational risk, such as specifying materials, processes and technologies that reduce inconvenience for the customer or the general public.

The differing perspectives can result in a regulatory and commercial process that may cause higher than expected costs, delays and potentially even termination of the project. Many of the regulatory and commercial issues can be resolved given adequate time, however the complexity and potential delays can cause some proponents to retreat to more conventional solutions.

Greater experience with the process may produce improved outcomes over time as proponents, regulators and water service providers will have more precedents to draw on. The slow rate of uptake for recycled water projects implies that this experience may not develop for a number of years.

While technical guidelines have been well established, regulators and water service providers can further facilitate the regulatory and commercial processes by developing advice on:

- the organisations and approval processes involved, including realistic timeframes for gaining approvals;
- the factors that are likely to facilitate or inhibit the success of a recycled water proposal;
- the potential costs and benefits of implementing a recycled water scheme, including charges that will be levied by (or cost savings the will be passed on from) the incumbent water service provider;
- making all of the above easily accessible, including a single point of contact within each organisation.

Many jurisdictions have already made significant progress on some of these issues, however we note that new participants in the process continue to highlight the complexity and do not appear well informed about the costs, benefits and likely success of new proposals until the later stages of project development.

Even with the process improvements outlined above, the technical, regulatory and commercial hurdles may be too high for some project proponents, particularly small businesses with limited resources and developers seeking fast turn-around times.

2.1.5 Capital constraints

Many water service providers face capital or borrowing constraints imposed by state or local government owners. These constraints assist governments to meet their own financial and credit rating targets.

Capital constraints limit the ability of water service provider to invest in new initiatives, even when benefits to their customers or to the community can be demonstrated. Water service providers have examined a number of options to move capital projects ‘off balance sheet’. These options typically require a private sector investor or financier to take on some or all of the demand risk. The size and expected return of the investment will also be key considerations for financiers.

Due to the significant demand risks involved, very few of these financing options have been implemented to date. Addressing some of the issues associated with demand risk may assist in improving the access to capital for recycled water projects in the future.

We note that while capital constraints are in theory an impediment, we did not find evidence that capital constraints had impeded any specific recycled water project to date.

2.2 Recommendations for the future

Much of the literature on barriers relates to the complexity of institutional arrangements and confusion in navigating through the relevant processes (see Appendix 2). However, as outlined in the previous section, our industry consultation indicated two different perspectives. Those stakeholders with longer direct experience in the water industry indicated that regulatory and institutional barriers were a historical problem that had largely been resolved. By contrast, stakeholders with less experience tended to express frustration at delays and the generally ‘risk averse’ nature of the water sector.

A recurring theme from all stakeholders was that two of the most significant impediments to the development of new recycled water projects were cost effectiveness and commercial risks, in particular demand risk.

While it is valid to ‘screen out’ projects that do not meet minimum commercial or regulatory requirements, some of the delays and false starts for new projects could potentially be avoided by making regulatory processes more transparent and easier to navigate. Some jurisdictions have already made progress in streamlining regulatory processes and providing guidelines for potential proponents.

With regard to commercial issues, project developers typically receive little guidance on the viability of water recycling projects until the later stages of project development, resulting in the investment of significant time and resources before discovering the project is not viable. The lack of information on economic viability can also result in potentially viable projects remaining unexplored. Ideally, during the early stages of a project, proponents would have access to both the general information required to assess the economic viability of recycled water projects (the subject of this project) and more specific information on the charges that would be levied by (or savings that would be passed on from) the incumbent water service provider.

In summary, this study recommends that further work could be undertaken in the following areas:

1. *Commercial risk:* the development of contractual and other arrangements that will assist in reducing commercial risks, and in particular demand risk, for investors – some of these arrangements are discussed at a high level in Section 6.1 of this report.
2. *Cost effectiveness:* making available the information proponents require to assess the economic viability of new recycled water schemes, including the primary costs and benefits identified in the framework outlined in Section 3.3 of this study. A broader understanding of these costs and benefits could also be facilitated through an assessment of recycled water ‘hotspots’, based on the variables that affect economic viability such as the distance from a treatment plant, the level of treatment required and the cost of local water supplies and wastewater disposal options. Based on these factors, location specific information (possibly using a GIS mapping system) would highlight those locations where recycled water schemes are more likely (or not) to be economically viable.
3. *Process Barriers:* continue streamlining administrative efforts to assist proponents, including initiatives such as:

- providing access to 'one stop' information, where all regulatory and administrative processes are described in one location;
- expanding the number of 'pre-validated' technical solutions so proponents are not required to undertake prolonged testing and monitoring procedures, which can be costly, time consuming, and for which the chance of success may be unclear;
- providing more detailed information on regulatory requirements (for example, rather than specifying that the proponent must 'demonstrate adequate financial capacity', the documentation should provide the specific financial thresholds against which the applicant will be assessed).

4. *Capital constraints:* Investigate alternative methods of utilising private sector financing to allow water recycling projects to move 'off balance sheet' to overcome water service provider capital constraints.

3 Economic framework

During the recent extended drought, many water recycling schemes were implemented as trials for climate independent water supplies or as a response to political imperatives. Many of these schemes required external subsidisation from government. During this period, economic analysis was often retrospective and was not the primary driver of the recycled water scheme.

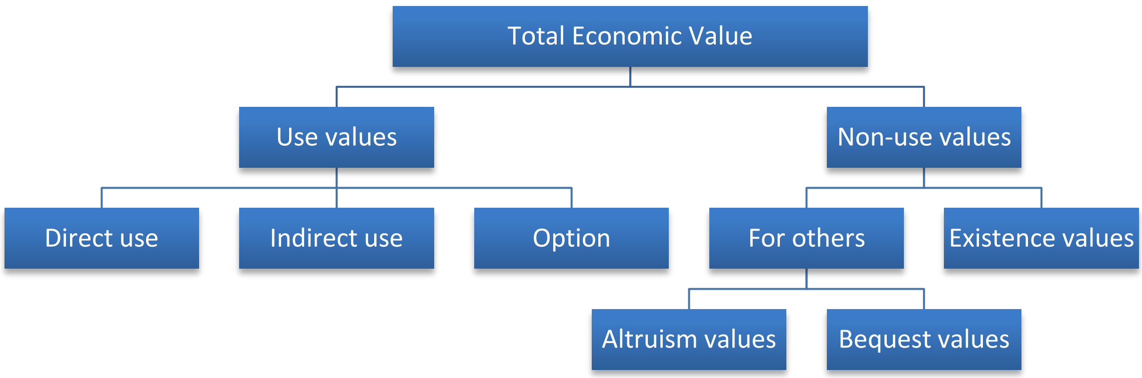
With the return of rainfall in the eastern states and the environment of financial austerity since the Global Financial Crisis, the economics of water recycling have become an issue of significantly greater focus for water service providers and governments.

In this report, we examine the economics of water recycling in the broadest sense – including not only the commercial value to businesses, but also the broader economic value to the community and environment.

3.1 Total Economic Value

The most common framework for understanding the full spectrum of economic values is the total economic value (TEV) framework. The general TEV framework distinguishes between **use** and **non-use** values as shown in Figure 1.

Figure 1: Total economic value framework



Use values measure the value arising from the actual, planned or possible use of a good or service. Use values can be direct, indirect or option values. Residential users would directly value recycled water (e.g. for garden watering and toilet flushing), while recycled water used by business or agriculture would be valued ‘indirectly’ as a part of the production processes, where it is the end good that is ultimately of value to the community. Recycled water schemes can also provide an ‘option’ value if they are not used on a day-to-day basis, but are available as an option as and when required in the future.

Users of recycled water include rural, urban (e.g. residential, commercial, public open space) and large users (e.g. mining and industry). The economic value of recycled water to these users will typically be measured by their willingness to pay for the product, whether or not payment is actually required.

The **non-use value** refers to an individual's willingness to contribute to the cost of water recycling, even if the individual will not use the water from the scheme. Non-use values are generally separated into existence value (where the mere existence of the resource is valued), altruism (where the resource provides a benefit for others) and bequest values (for future generations). Existence values can relate to environmental benefits, such as support for ecosystems through reduced wastewater discharges to oceans, rivers or creeks, while altruism and bequest values relate to benefits for others in the community.

Valuations of the willingness to pay for environmental and social resources can be sourced from either actual markets (e.g. water trading and the cost of alternative water sources) or through responses to survey questions. While the former approach is generally preferable, in some cases it is impossible to value goods and services using existing markets – often because no relevant market exists.

For some issues, particularly environmental costs and benefits, there may be some debate about the desirability of quantifying the value or about the results themselves. However, quantification may provide some idea of the community's willingness-to-pay for the benefit in question. Therefore, while the analysis will rarely be definitive and is not a replacement for human decision making, it does provide an indication of the community's preferences, measured in a common (monetary) unit.

3.2 Assessing economic viability

The most robust method for examining the economic viability of a recycled water scheme is to consider the marginal value of the scheme using a cost-benefit analysis (CBA) framework. CBA is the most comprehensive of the economic appraisal techniques and is the preferred method of analysis for most State and Commonwealth agencies responsible for economic management.

While the CBA framework is widely accepted by resource economists, some alternative methods may occasionally be presented. A summary of other approaches, including the strengths and limitations of each, is provided in Box 1.

CBA does not specifically address matters of equity or perception, including political sensitivity, moral obligations or cultural issues. Where applicable, these issues must be subjectively assessed by decision makers and weighed against the economic impacts.

If all of the costs and benefits have not been quantified, then a subjective assessment of the unquantified factors may be required to make a final assessment. In these cases, a 'threshold analysis' can be useful. A threshold analysis does not seek to quantify the remaining costs and benefits, but involves a subjective comparison of the unquantified costs and benefits against the quantified net present value result. Threshold analysis generally seeks to answer the question *'is the unquantified benefit enough to outweigh the quantified cost?'*

Box 1: Alternative economic appraisal frameworks

The *Government guidelines for economic appraisal* (NSW Treasury 2007) provides a useful summary of alternative approaches to economic appraisal. The key points are summarised below.

Cost-effectiveness analysis (CEA) is an alternative to CBA where the output of a project is not readily measurable in monetary terms (using either actual or proxy values). CEA compares the costs of different project options with the same or similar outputs. For example, if the primary purpose of a recycled water scheme was to avoid discharges to an environmentally sensitive river, but the benefits were not considered quantifiable by decision makers, then the CEA technique would compare the cost of the recycled water scheme with the cost of alternative methods of disposal (e.g. building an ocean outfall pipeline). CEA is a well-accepted alternative to CBA when the major benefits cannot (or will not) be quantified, however it is generally considered a 'second best' alternative if the benefits can be quantified and included in a CBA.

Financial analysis alone is typically insufficient for an economic appraisal as it examines a project only from the narrow perspective of the entity undertaking the project. A traditional financial analysis does not take account of effects on other enterprises or individuals nor does it consider the opportunity cost when the price of a good or service is not a good indicator of the real value.

Incidence analysis disaggregates the overall impacts of options according to the impact on individual community groups. The disaggregation is commonly undertaken in terms of the income grouping of those affected by a specific development. As such it provides valuable information to decision makers about the distribution of benefits and costs, but is not an alternative to CBA or CEA in its own right.

Economic impact assessments (e.g. input-output analysis, computable generated equilibrium models) attempt to estimate changes to economic activity associated with a development. All government expenditure, however, has economic impacts and generates employment. An economic impact assessment of the positive impacts of one particular project does not help a government decide where it should allocate public funds. More importantly, an economic impact assessment does not relate the expected benefits to the costs involved; that is, what benefits the community might expect to flow from the taxpayer-funded costs involved.

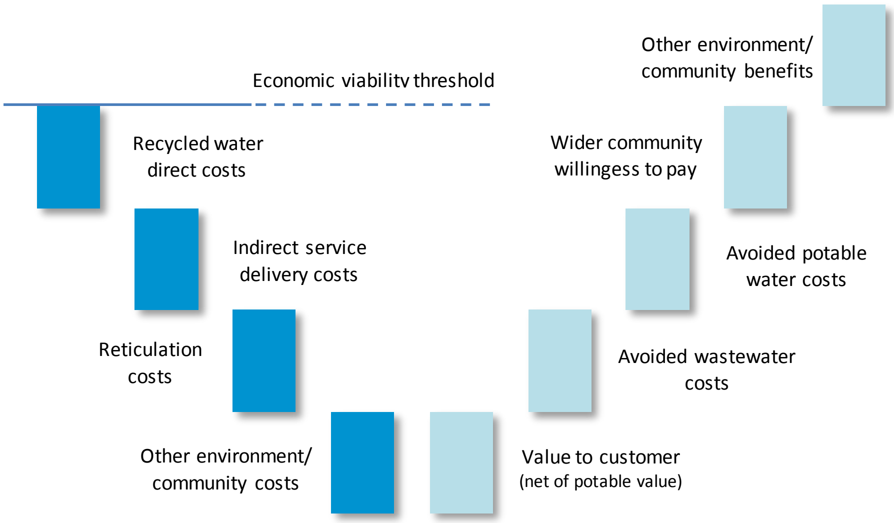
Input-output (multiplier) analysis is one of the most common tools used to assess the regional impacts of a project. In the simplest form of input-output analysis, input-output multipliers are applied to measures of direct impact to determine estimates of flow-on impacts in terms of income and employment. The most important limitation is that input-output analysis is concerned with measuring economic activity, and is not a tool for the evaluation of projects. Input-output analysis does not take account of the alternative uses (opportunity costs) of resources. Input-output analysis may indicate positive impacts – activity – without providing guidance as to whether such impacts correspond with net benefits. Poor investments, perhaps in heavily subsidised fields of endeavour, could be associated with greater levels of activity than good investments.

Multiple objective programming uses techniques (such as multi-criteria analysis) to select projects based on multiple explicit objectives, particularly for options that have several objectives which cannot be quantified in monetary terms. The estimation of weights for each objective can be tenuous, however the technique can help evaluate complex applications of CEA.

3.3 Costs and benefits of recycled water schemes

The primary costs and benefits to be considered in an economic evaluation of non-potable recycled water schemes are shown in Figure 4, with each explained in more detail below. In addition to this broad overview, further detail on calculating the costs and benefits is provided in Appendix 3.

Figure 4: Economic framework showing primary costs and benefits



NOTE: Size of bars does not reflect relative size of costs/benefits

Recycled water direct costs

Direct scheme costs represent the present value of all upfront and ongoing expenditure required to construct and operate the scheme (other than reticulation). Recycled water direct costs may include:

- design and construction of the recycled water infrastructure, including future augmentations;
- variable operating costs such as treatment and pumping;
- fixed and semi-fixed operating costs such as maintenance, renewals and repairs;
- the cost of carbon emissions (which may at least partly be included in electricity prices);
- land requirements for the infrastructure and odour buffers.

Scheme costs vary greatly depending on a range of factors including:

- the level of treatment, which depends on the quality of the water source (e.g. sewer mining, secondary or tertiary treatment plant), the extent to which the water may come into contact with humans and whether the user requires a specific quality of water (e.g. high grade industrial water);
- the cost of transporting the recycled water to the subdivision (for residential customers) or to the customer's site (for large users) – costs which are primarily driven by the peak usage requirements and the distance from the wastewater source;
- land use zoning, in particular whether the site is greenfield or brownfield, high density or low density. Installing reticulation in low density brownfield sites is generally much more expensive than either greenfield sites or high density developments;
- economies of scale – the unit costs for treatment can be significantly higher at small scales, however large scale (e.g. city-wide) schemes can suffer from diseconomies of scale as distribution and servicing become increasingly difficult.

In practice: Recycled water costs vary greatly. Efficiently designed recycled water schemes with relatively low distribution and/or treatment requirements have previously been developed for $2 per kilolitre or less (excluding reticulation costs). However, the costs can increase to well over $10 per kilolitre if significant distribution costs or treatment costs are required or if the scheme requires brownfield retrofits.

Indirect service delivery costs

In addition to direct recycled water costs, other incremental service delivery costs could include:

- any modifications or additions required to the wastewater treatment and distribution system to accommodate the recycled water scheme;
- the *marginal* administrative costs required to support the recycled water scheme including functions such as corporate management, customer service, billing, compliance and monitoring.

In practice: Incremental costs vary according to the circumstances, with two of the most significant differences being whether the recycled water is supplied to a single customer or to multiple customers (affecting customer support costs) and the level of exposure risk (affecting the level of monitoring required). Previous experience suggests that incremental costs could range from as little as 10-20% of the operating cost for large industrial customers to 50-100% (or more) for residential customers.

Reticulation

For third pipe schemes, reticulation is the street level infrastructure that is required to transport recycled water to individual residential or commercial properties. Reticulation is usually contained completely within each developer’s land holding.

Reticulation infrastructure is typically constructed by the land developer and handed over to the water service provider, and is therefore often estimated separately from other direct costs.

In practice: For some past projects, the reticulation costs for greenfield residential third pipe schemes has been estimated to cost in the order of $2,000 to $3,000 per lot. Based on use of 100 kilolitres per year and a timeframe of 50 years, the reticulation cost translates to a unit cost of $1.30-$1.90 per kilolitre.[3]

Other environment/community costs

A number of other environmental and community costs have been identified in previous project evaluations. Many of these costs are specific to a subset of recycled water projects only and therefore have not been separately identified with the framework.

For example, some projects have identified a potential cost associated with diverting the wastewater resource from other uses. These uses could be either commercial or environmental in nature. In most cases there is no alternative use as the treated wastewater is typically disposed to the ocean or rivers and is considered a pollutant rather than a resource.

[3] Based on a 6% discount rate.

However, in specific circumstances it is possible that the wastewater resource can have valuable alternative uses. In some cases, a number of parties may be interested in utilising the wastewater resource for different purposes and each of their uses may be mutually exclusive. If the costs and benefits of these alternative uses are known, then each should be determined independently and the results compared with each other to determine the preferred alternative.

However, if a recycled water project is being assessed on a standalone basis and the alternative use values are not known (for example because they are kept commercial-in-confidence), then one method of identifying the highest value use is to establish the market value of the resource, which will reflect the maximum ‘willingness to pay’ from each potential user.

Ideally, the market value should reflect the revenue that would be realised by selling the wastewater through a neutral tendering process, as recently discussed by the Economic Regulation Authority.[4]

Once established, the market value can be used as an input into the assessment of individual recycled water projects.

Where wastewater is discharged into an inland waterway or infiltrated into groundwater, the alternative value of the wastewater resource might also relate to *downstream* environmental or water supply values.

Some wastewater discharges supplement environmental river flows or have created artificial wetlands that have over time developed into important habitat areas. In these areas, the opportunity cost of diverting the wastewater stream for recycling will be the lost environmental values.

If, rather than providing environmental flows, the discharged wastewater would increase the volume that could be extracted from the river or groundwater supply (without adversely affecting the water quality), then the opportunity cost of recycling the wastewater would be equal to the value of the ‘lost’ water supplies.

In practice: In most cases, there are relatively few ‘other’ costs and the wastewater resource typically has no alternative use and therefore no opportunity cost. However, in some jurisdictions a small wastewater resource charge has been included to reflect the potential market value of the resource.

It has also been identified that some downstream users could be impacted by water recycling if wastewater is no longer discharged into waterways such as the Murray Darling. Where the water is currently discharged to the ocean, as is the case for most coastal cities, there will be no downstream users to impact.

Use value (net of potable use value)

The use value of recycled water represents the benefit that will be gained by the customer if they are supplied with recycled water.

Where recycled water substitutes for potable water, the value of potable water must be netted (subtracted) from the use value as the consumer will no longer receive potable water.

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4 Economic Regulation Authority (2013) *Inquiry into the Tariffs of the Water Corporation, Aqwest and Busselton Water: Revised Final Report*

If the recycled water is a perfect substitute for the potable water, then the user will experience no difference in value and the recycled water will represent neither a cost nor a benefit when compared with potable water.

Recycled water and potable water will not always be perfect substitutes. For example, the recycled water could be more reliable than potable water or, conversely, the user may perceive additional health risks from recycled water. Where the two values differ, the relevant value for the economic assessment will be the user's willingness to pay for recycled water, over and above their willingness to pay for potable water. If the user would be willing to pay more for potable water than for recycled water, then the use of recycled water would represent a net cost rather than a benefit.

While it has historically been assumed that customers would be willing to pay less for recycled water than for potable water, some agricultural users may prefer recycled water for its nutrient content while some industrial customers may prefer recycled water that has been highly treated to remove chemical and other contaminants. There is also evidence from surveys and feedback from land developers that some residential customers may prefer recycled water for garden watering and other non-potable uses (see *In practice* below).

If recycled water *does not substitute* for potable water, then the value of the recycled water will reflect the user's full willingness to pay for the product. While each customer's circumstances will differ, their willingness to pay for recycled water can be estimated based on the least cost alternative available to them, which may include:

- forgoing a water supply altogether (e.g. by conducting dry land farming rather than irrigating);
- installing alternative water sources (e.g. rainwater tanks) to achieve an equivalent water supply outcome;
- installing water efficiency measures (e.g. drip irrigation, moisture sensors) to reduce their use water requirements.

The options available to a user may be limited by regulatory requirements, such as environmental or planning requirements. These requirements may or may not be economically justified in their own right, but must be accommodated in a cost benefit analysis if the user does not have the power to change the requirement.

A customer's willingness to pay for recycled water will also be impacted by any additional costs that will be incurred in utilising the recycled water, such as additional treatment costs, irrigation system modifications, additional internal plumbing or changed health and safety costs.

In practice: Agricultural customers rarely use potable water due to the comparatively low margins per megalitre of water used. Therefore recycled water is rarely a substitute for potable water for agricultural users, implying that the value of recycled water will be the full value of water to the user (i.e. there will be no potable water value to net out). Water trading prices give some indication of the full value of water to agricultural users. Water traded in the Murray Darling Basin over the last year is fairly typical of agricultural prices and has ranged from around $0.01-$0.30 per kilolitre,[5] although values can temporarily spike during times of

[5] Entitlement values based on $100-$2,600/ML (Psi Delta *Water Entitlement Market Prices (Summary) Murray-Darling Basin* quarterly reports December 2011 to September 2012) converted to a cost per kilolitre based on a 6-8% discount rate, 20 year time frame and long term reliability of 60-80%.

drought. Some high value crops (such as wine grapes) can have significantly higher values ($1.00 per kilolitre or more).

By comparison, the margins for water used by industrial and mining businesses are significantly higher. As an example, mining businesses in Kalgoorlie pay over $5 per kilolitre to use potable water when no other source is available. The key determinant of willingness to pay for these customers is whether there are alternative water sources available at a lower cost, such as groundwater or surface water supplies, which can often be as low as $0.20 per kilolitre for readily accessible groundwater, but may be considerably higher if the water is sourced from a potable water scheme, is difficult to extract or treat, or is transported over long distances.

For residential, commercial and many industrial customers, the default water source is typically potable water. As noted above, the value of water within this framework is the value of water *net* of the value of potable water. Therefore, there will only be a value if recycled water is valued more highly than potable water. As demonstrated by the hedonic pricing study undertaken for this study (see Marsden Jacob (2013) *Technical Report 1: The value of recycled water infrastructure to the residents of Rouse Hill*), some residential customers appear to value recycled water more highly than existing drinking water supplies – potentially due to the fact that recycled water is not subject to water restrictions and because it is perceived as a more ‘sustainable’ solution.

The Rouse Hill study identified that properties with recycled water connections commanded a premium of around $5,000[6] compared with properties with similar characteristics that were not connected to recycled water. Based on use of 100 kilolitres per year over a 50 year period, the premium translates to a unit cost of just over $3 per kilolitre.[7]

Avoided wastewater costs

Some wastewater conveyance and disposal costs could potentially also be reduced or deferred by recycling wastewater.

As with the calculation of avoided water costs, avoided wastewater costs should not include any sunk or fixed costs that will not change with the introduction of water recycling.

In practice: Many wastewater treatment costs are driven by the volume of pollutants, which may not change significantly if the water recycling process does not remove those pollutants, but returns them to the wastewater system. Costs relating to the *volume* of wastewater treated are more likely to be impacted, such as pumping (energy) costs and the capacity of pipelines and storages. In practice, pumping costs are often relatively small (less than $0.20 per kilolitre) and many existing wastewater pipelines have been installed at ultimate capacity and therefore represent sunk costs that will not be affected in the future. In new or rapidly growing wastewater schemes there is significantly more potential for distribution system cost savings.

In some areas, particularly those discharging effluent to inland waterways or environmentally sensitive coastline, the savings may also be far more extensive. There are many regional towns in which the environmental approval requirements for wastewater disposal have meant that water recycling represents the least cost method of disposal, regardless of other benefits.

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[6] 95% confidence interval is $2,900 to $6,998.

[7] Based on a 6% discount rate.

Avoided potable water costs

The economic analysis should also consider any avoided capital or operating costs associated with reduced use, reduced capacity requirements or deferral of augmentations in the potable water scheme, including supply, treatment, distribution and reticulation. The avoided potable water costs are typically dominated by water source deferrals, however some savings in distribution are also possible, particularly in greenfield schemes.

The long run value of avoided potable water source costs are often referred to as the Long Run Marginal Cost (LRMC).[8]

The calculation of avoided costs should not consider any sunk or fixed costs that will not change with the introduction of water recycling.

In practice: Recent LRMC estimates have been published by economic regulators for both Sydney ($1.82 to 2.54 per kilolitre[9]) and Perth ($1.37 to $2.86 per kilolitre[10]).

In addition to water source savings, the savings in the reticulation system can also potentially be significant. In some jurisdictions, where recycled water has been approved for fire fighting use, there size of the potable water reticulation mains can be reduced. If fire fighting can only be conducted with potable water, then the size of the potable water reticulation mains is unlikely to change.

The savings in the existing distribution network are generally less pronounced as the majority of costs are often sunk. For new distribution mains, the potential savings will depend on the risk appetite of the water service provider. Pipelines in particular are often sized to meet the ultimate requirements of the region and therefore the water service provider may prefer to install sufficient capacity to backup the recycled water scheme in case of failure. This practice will reduce the cost savings that can be attributed to the recycled water scheme.

Community willingness to pay (non-use)

Research (including the choice modelling survey undertaken as part of this study) has indicated that the broader community is prepared to contribute to the costs of water recycling, even if they do not directly use the recycled water.

When applying the community’s willingness to pay for recycled water in a cost benefit analysis, care should be taken to exclude direct benefits that have already been included in the analysis, such as avoided costs and direct use benefits.

The *non-use* willingness to pay may relate to specific benefits, such as specific avoided environmental costs, or to more general preferences, such as avoiding ocean discharges or encourage ‘sustainable’ solutions. If more than one willingness to pay estimate is included, the analysis should ensure that the estimates are not double counting the benefits.

8 We note that LRMC often refers only to water source costs; however, holistically considered, the LRMC should also include distribution and other marginal costs.

9 IPART (2012) *Review of prices for Sydney Water Corporation’s water, sewerage, stormwater drainage and other services*

10 ERA (2013) *Inquiry into the Tariffs of the Water Corporation, Aqwest and Busselton Water: Final Report*

In addition, recycled water *users* should be explicitly excluded from the estimate of the community's willingness to pay for recycled water as the benefit to those users will be separately captured under *'Willingness to pay for recycled water'* above.

As the community's willingness to pay (when calculated as described above) will exclude the direct benefits quantified elsewhere within the framework, this benefit will be additive when calculating the overall benefit of the recycled water scheme.

In practice: As part of this study, Marsden Jacob undertook a study to quantify the willingness of a community to contribute to non-potable water recycling (see Marsden Jacob (2013) *Technical Report 2: Community values for recycled water in Sydney*). To our knowledge, the survey is the first of its kind in Australia. A summary of the results of the survey is shown in Table 1.

Table 1: Average willingness to contribute to recycled water schemes by end use ($/household/year)

End use	10 GL	20 GL	30 GL	40 GL
Western Sydney homes (non-potable)	$2.65	$11.34	$20.02	$28.71
Environment	$5.62	$14.30	$22.99	$31.67
Council	$8.91	$17.59	$26.28	$34.96
Business and industry	$22.33	$31.01	$39.70	$48.38

Based on 1.70 million households in Sydney (excluding the 20,000 homes supplied recycled water at Rouse Hill),[11] these results convert to the unit cost values shown in Table 2.

Table 2: Willingness to contribute to recycled water schemes – unit cost value ($/kilolitre)

End use	Value/kL
Western Sydney homes (non-potable)	$0.45 - $1.22
Environment	$0.96 - $1.35
Council	$1.49 - $1.51
Business and Industry	$2.06 - $3.80

Note that these results represent the amount households are willing to pay for an *increase* in water recycling and are not the absolute value households place on water recycling. Respondents indicated that they were prepared to pay significantly more for *some* additional recycling, regardless of end use and volume. However, to recognise that *some* additional water recycling will be undertaken as business-as-usual, we have presented only the *incremental* values. Therefore, care should be taken when interpreting or using the results.

[11] 1.72 million in total, based on ABS 2011 Census.

Other environmental/community benefits

This final element only applies if benefits (or offsetting costs) have been identified that have not already been captured elsewhere within the framework.

Many ad hoc benefits have been identified for specific projects, but one of the most common benefits identified during the drought was the **impact on the supply reliability of the potable water scheme**. This benefit has become less relevant since the easing of the drought and the increase in climate independent water supplies, such as desalination. However, the benefit may still be relevant for smaller potable water schemes that are experiencing other pressures such as rapid growth in demand.

If the recycled water scheme removes demand from the potable water scheme then the supply reliability of the potable water scheme may temporarily improve. The benefit to potable water customers will be determined by the change in the likelihood of restrictions and by the community's willingness to pay to avoid water restrictions.

Where recycled water volumes are small, the impact on reliability may be minimal. When determining the impact, we recommend considering all potential recycled water schemes rather than considering each initiative in isolation, and then applying a unit value across each individual initiative.

Where the volume of recycled water is relatively large, the temporary impact on potable water reliability may be significant. However, it should be noted that if the recycled water scheme is large enough to defer a climate independent potable water source (such as desalination), potable water reliability may improve, but *not by as much* as would have occurred if the climate independent source was added to the potable water portfolio. Therefore, reliability for potable water customers may be either a benefit or a cost depending on the impact on potable water sources.

An additional benefit that may not be captured through the other elements of this study, but was raised a number of times in stakeholder forums, is the **health and well-being benefits** of watering sporting fields and public open space (see *In practice* below for more details).

A further benefit that is commonly described in project evaluations is the employment and other benefits to the local community or the region. These benefits are important for decision makers, particularly when assessing whether a new scheme should be subsidised. However, these 'flow on' benefits are usually excluded from a state or national cost benefit analysis because the government has limited resources and therefore to fund one project must divert funding from elsewhere or raise additional revenue from taxpayers. If funding is diverted from other projects, then the 'flow on' benefits from *those* projects would no longer occur. It is possible that a more sophisticated analysis might show that the 'flow on' benefits of recycled water projects are greater or lesser than other projects, however until such an analysis is completed it is common practice to exclude the 'flow on' benefits from the CBA entirely.

In practice:

Most environmental and community benefits are captured in one form or another through the other elements of this study, including 'intangible' benefits, which may largely be incorporated through the *Value to the customer* and the *Community willingness to pay (non-use).*

Our experience conducting Triple Bottom Line reviews of recycled water schemes has been that the magnitude of other general benefits is relatively small, although important ad hoc issues often arise on a scheme-by-scheme basis.

For a detailed review of the existing literature on environmental and social values, see Marsden Jacob (2013) *Technical Report 3: Environmental and social values associated with non-potable recycled water*.

With regard to the benefits of avoiding water restrictions, the recent rains on the east coast has dramatically reduced the likelihood of restrictions and most metropolitan water service providers are no longer planning for short or medium term water supply augmentations. Therefore, the benefit that alternative water sources can add through reducing the probability of restrictions has also fallen.

In relation to watering sporting fields and public open space, the health benefits can be estimated based on the likelihood of water restrictions and the impact of well-maintained green space on physical activity. At the present time this benefit is likely to be relatively modest due to the lower likelihood of restrictions in the near future.

We note that the water security benefits may be more significant in smaller regional schemes, particularly when the town is growing quickly and new water supplies are difficult to source. The rapid expansion of many towns in mining regions has placed considerable strain on potable water availability and recycled water schemes could potentially play a role in improving reliability in the short term.

Finally, we note that despite a widely held intuition that water recycling will provide other environmental benefits, the effective environmental regulations in Australia mean that water extraction and wastewater discharge impacts are minimised. Therefore the most significant benefits of recycled water schemes are often reflected in the avoided costs of meeting the minimum regulatory requirements (such as lower wastewater treatment costs, nutrient abatement costs or carbon prices) rather than in direct environmental benefits.

3.4 Water cycle planning

The analytic framework presented in this report recognises the role of recycled water in the broader water cycle planning framework. In particular, it identifies not only the benefits to recycled water users, but also to the environment and the broader community, including the impacts on potable water and wastewater schemes. In this way, the framework assesses the recycled water scheme against the default suite of water cycle investments, or, if required, against any alternative suite of investments that are under consideration.

It is important to note that the framework assumes that the subject of the analysis is an *individual* recycled water project which is being compared against a defined ‘base case’ (i.e. the situation that will occur by default if the recycled water scheme does not proceed).

If more than one recycled water project is being considered and each of these projects are mutually exclusive, the net cost or benefit of each project can be compared to determine the project with the highest value. When undertaking comparative analysis it is important not to double count by including the costs of one option as *avoided* costs of any other option (other than the ‘base case’).

If a *portfolio* of water cycle options is being assessed against *another* portfolio, the framework would need to be expanded to include the broader set of costs and benefits that apply to other elements of the water cycle (e.g. stormwater).

4 Commercial viability, funding and pricing

As highlighted in Section 2, one of the key issues inhibiting the development of non-potable recycled water schemes is commercial viability. Commercial viability is dependent on funding provided by the various beneficiaries and the prices each party may charge.

In this section, we examine the pricing of non-potable recycled water and the level of funding that will be appropriate for each of the beneficiaries.

4.1 Non-potable Recycled Water Pricing Framework

A number of pricing principles have been developed by regulators and government agencies across the country. The key pricing principles developed by each agency are provided in Box 2 (note that for the sake of brevity, principles relating to the regulatory framework have been excluded).

As described in Box 2, the National Water Initiative (NWI) *Pricing principles for recycled water and stormwater use* state that:

> *When allocating costs, a beneficiary pays approach — typically including direct user pay contributions — should be the starting point, with specific cost share across beneficiaries based on the scheme's drivers (and other characteristics of the recycled water/stormwater reuse scheme).*

While other organisations have adopted different principles on the basis of the particular issues facing their jurisdiction, there is a general consensus that a beneficiary pays model is appropriate.

Cost allocations for recycled water schemes are not straightforward, as the wastewater collection and treatment system can be viewed as *both* part of the wastewater disposal scheme *and* part of the recycled water scheme. Similarly, assets that are dedicated to treating and delivering recycled water could equally be viewed as part of the wastewater disposal system. In some cases, particularly for small inland towns, the disposal of the wastewater may be the primary driver of the recycled water scheme.

In accordance with the NWI principles, the Non-potable Recycled Water Pricing Framework developed for this study is based on a beneficiary pays approach, with refinements as required to address other key issues.

Box 2: Key pricing principles (excluding principles relating to the regulatory framework)

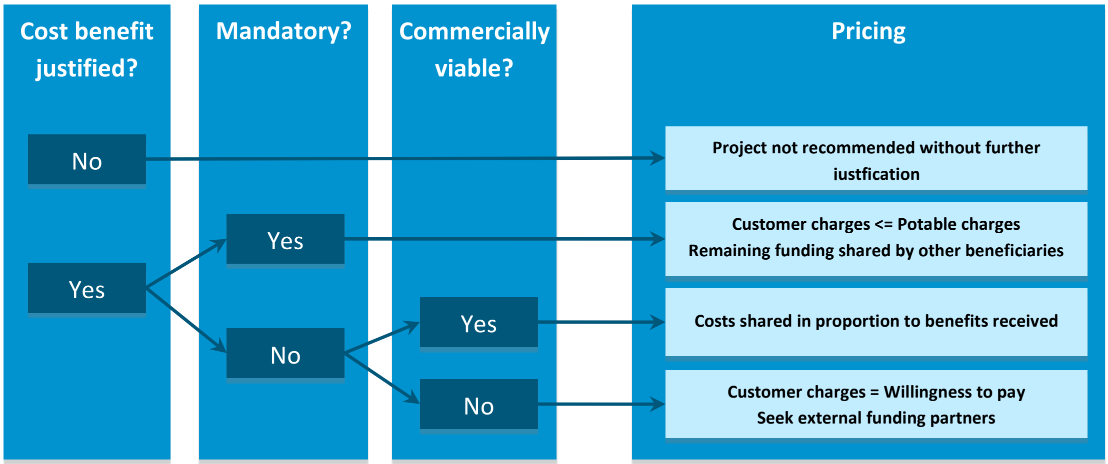
National Water Initiative	***Independent Pricing and Regulatory Tribunal (IPART)*** *(NSW)*	***Essential Services Commission (ESC)*** *(Vic)*	***Economic Regulation Authority (ERA)*** *(WA)*	***Water Services Association of Australia (WSAA)***
▪ When allocating costs, a beneficiary pays approach — typically including direct user pay contributions — should be the starting point, with specific cost share across beneficiaries based on the scheme's drivers (and other characteristics of the recycled water/stormwater reuse scheme). ▪ Prices to contain a water usage (that is, volumetric) charge. ▪ Regard to the price of substitutes (potable water and raw water) may be necessary when setting the upper bound of a price band. ▪ Pricing structures should be able to reflect differentiation in the quality or reliability of water supply. ▪ Where appropriate, pricing should reflect the role of recycled water as part of an integrated water resource planning (IWRP) system. ▪ Prices should recover efficient, full direct costs — with system-wide incremental costs (adjusted for avoided costs and externalities) as the lower limit, and the lesser of stand-alone costs and willingness to pay (WTP) as the upper limit. Any full cost recovery gap should be recovered with reference to all beneficiaries of the avoided costs and externalities. Subsidies and Community Service Obligation payments should be reviewed periodically and, where appropriate, reduced over time. ▪ Prices should be transparent, understandable to users and published to assist efficient choices. ▪ Prices should be appropriate for adopting a strategy of 'gradualism' to allow consumer education and time for the community to adapt.	▪ Pricing arrangements should reflect the specific market and other characteristics of recycled water and sewer mining schemes. ▪ Pricing arrangements for recycled water and sewer mining must be consistent with maintaining the current framework for water and sewerage pricing. ▪ Pricing arrangements for recycled water should reflect the fact that the services form part of an integrated urban water system. ▪ Recycled water prices should recover the full direct cost of implementing the recycled water scheme concerned unless: - the scheme gives rise to avoided costs that benefit the water agencies and users other than the direct users of the recycled water, and/or - the scheme gives rise to broader external benefits for which external funding is received, and/or - the Government formally directs the Tribunal to allow a portion of recycled water costs to be passed on to a water agency's broader customer base. ▪ The structure of prices should ensure that appropriate signals are sent to recycled water users and should entail appropriate allocation of risk.	Recycled water prices should: ▪ consider the price of any substitutes, and customers' willingness to pay. This includes the possibility of the substitutability, in some cases (such as sewage disposal), of potable and non-potable water; ▪ cover the full cost of providing the service (except for services related to specified obligations or maintaining the balance of supply and demand); and ▪ include a variable component. A business that does not propose to fully recover recycled water costs must demonstrate that: ▪ it assessed the costs and benefits of pursuing the recycled water project; ▪ it clearly identified the basis to recover any revenue shortfall; ▪ if the revenue shortfall is to be recovered from non-recycled water customers – the project is required to meet Government obligations – the affected customers were consulted about their willingness to pay for the benefits of increased recycling.	Wastewater from wastewater treatment plants should be priced to reflect the prices that would emerge under a competitive market. These prices would have three components: ▪ Direct Costs. A charge associated with the costs of delivering the wastewater to the customer, including any incremental costs that might be incurred in treating the wastewater to be fit for purpose. ▪ (Minus) Avoidable Costs. A negative adjustment in price to take into account any avoidable costs as a result of selling the wastewater resource. For example, the operating costs of discharging the wastewater to the environment would be part of the avoidable costs. The price of the wastewater resource should be non-negative. Thus, if avoidable costs are greater than direct costs, the price of the wastewater should be zero. ▪ (Plus) Scarcity Premium. Additionally, if the amount of wastewater available to be recycled is less than the demand for the wastewater, then an additional premium would be added to the price to reflect its relative scarcity. The premium should be determined by a neutral tendering process.	▪ Prices for recycled water should be set within a price band, with the (whole of system) incremental cost as the floor, and willingness to pay (as defined by the lesser of stand-alone cost or by-pass price of the alternative) as the ceiling. ▪ Commercial judgments should determine whether prices are set at the lower end of the efficient price band (i.e. just covering system incremental costs) or towards the higher end (where recycled water users make an increasing contribution to joint/common costs). ▪ Prices for recycled water should be set in a way that broadly tracks the prices of substitutes, but does not lock-in artificially low prices for an unnecessarily long time. ▪ Prices for recycled water should be set as part of a longer term pricing reform strategy that encompasses the suite of products provided by the water industry (rather than a short-term position based on current charges for potable water and other services). ▪ Where there are mandated targets for recycled water usage, any subsidies provided to recycled water projects at the expense of the broader (water) customer base should be fully and transparently costed. Preferably, these subsidies should be paid for from general revenue since they constitute a Community Service Obligation (CSO). ▪ If uneconomic recycled water projects are implemented to meet mandated targets (without CSO funding), it would be appropriate for regulators to accept the costs of mandatory schemes (provided the projects undertaken are the most efficient way of meeting the targets) as a legitimate 'cost of doing business', recoverable from the broad customer base. ▪ In some cases, efficient pricing may require different prices for different users, reflecting factors such as the different qualities of recycled water and associated costs of supply (which may vary by user and/or location) and willingness to pay. Failure to allow differential pricing may result in viable recycling projects not proceeding.

In addition to the beneficiary pays approach, the overarching principles for the Non-potable Recycled Water Pricing Framework can be summarised as:

- if the scheme is not cost benefit justified, then it is recommended that the project does not proceed unless justified by other (unquantified) considerations;
- if connection to the recycled water scheme is mandatory, then customers should be charged no more than the cost of a potable water supply; and
- if connection to the recycled water scheme is voluntary and commercially viable without subsidisation, then the costs should be shared amongst direct beneficiaries in proportion to the benefits they receive;
- if the recycled water scheme is cost benefit justified from a whole of community perspective, but is not commercially viable without subsidisation, then beneficiaries should contribute up to their maximum willingness to pay, with the shortfall sought from external funding partners, government or from potable water/wastewater customers if there is a demonstrable willingness to pay.

The decision framework is shown in Figure 5 and described in more detail below.

Figure 5: Pricing decision framework



Not cost benefit justified

If the costs of a recycled water scheme outweigh the benefits from a whole of community perspective, then it would be recommended that the project does not proceed unless justified by other considerations.

Cost Benefit Analysis takes into consideration quantifiable costs and benefits, but an additional subjective assessment may be required if all factors have not been quantified. As described in Section 3.2, a useful tool for decision makers when a subjective assessment is required is ‘threshold analysis’, which asks ‘*is the unquantified benefit enough to outweigh the quantified cost?*’. Otherwise, a range of other tools are available, including those discussed in Box 1.

Mandatory

Where potable water would otherwise be available, but connection to a recycled water scheme is mandatory for customers, then customers should be charged no more than the cost of a potable water supply. The remaining cost of the recycled water scheme would be shared between the other beneficiaries of the scheme, which may include the water service provider, the community and the land developer (provided that connection by the land developer was not mandatory also[12]). Costs would be shared amongst the remaining beneficiaries in accordance with the principles described under '*Voluntary and commercially viable*' and '*Not commercially viable*' below.

As has previously been noted by IPART, using the potable water price as an upper limit for mandatory schemes will protect customers from any potential abuse of monopoly power. A version of this approach was raised in IPART (2006) *Pricing arrangements for recycled water and sewer mining Sydney Water Corporation, Hunter Water Corporation, Gosford City Council and Wyong Shire Council* (see Box 7.1, p 58).

Although recycled water charges *in total* should be no higher than the potable water charge, it may be preferable in some circumstances to have both a fixed and volumetric recycled water charge (see '*Recycled Water Users*' in Section 4.2). If so, the combined charges should aggregate to no more than the potable water charge that would otherwise have been levied for the same level of consumption.

Voluntary and commercially viable

Where connection to the recycled water scheme is voluntary[13] and commercially viable without subsidisation, then the costs should be shared amongst direct beneficiaries (recycled water users, wastewater customers, potable water customers, land developers and/or government organisations) in proportion to the benefits they receive.

This approach ensures that there are incentives for all beneficiaries to pursue the recycled water scheme and provides an equitable outcome across all of the beneficiaries. The result should reflect the outcome that would be expected if an independent arbitrator were appointed to determine the cost sharing arrangements.

In practice, determining the level of benefit to each party can be complex and may be inhibited if one party has greater access to information than others. For example, industrial customers can often gain significant benefits if the recycled water is treated to a high level (e.g. reverse osmosis), which can reduce internal treatment costs, improve water use efficiency and expand the range of uses for the water. However, the customer may prefer to keep the exact extent of the benefits confidential to improve their negotiating position. Conversely, water service providers can have access to information about wastewater and potable water infrastructure benefits that are not available to customers.

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12 The discussion in this section applies primarily to recycled water end users (households and business). However we note that in some circumstances it may also be mandatory for land developers to connect to a recycled water scheme, even if potable water is available. In this case, we propose that the developer contribution should be no more than it would be if only a potable water supply were provided. If the requirement to connect to recycled water was known at the time the developer purchased the land parcel in question then it could be argued that the developer had the opportunity to voluntarily purchase and develop elsewhere. We note that the proposal to charge developers no more than the equivalent potable water charge was not countenanced in IPART (2006), but is based on extending the principle of customer protection to land developers also.

13 That is, the recycled water scheme is viable without subsidisation from government or the wider community.

The information impasse can be improved if all parties operate on an open book basis or if an independent party is engaged to facilitate the process. Where the parties do not agree to share information, it may be possible for the proponent to estimate the magnitude of the benefits based on known information. In particular, the proponent may know the alternative water supply options available to customers and, based on this information, can develop estimates of the capital and operating costs of those alternatives.

Regardless of the approach adopted, some level of negotiation between the parties will ultimately be required.

Not commercially viable

Where the scheme is cost benefit justified from a whole of community perspective but requires subsidisation, funding may initially be sought from public organisations, resource managers, governments or the wider community.

Identifying appropriate funding partners will improve the chances of success for any recycled water scheme. The Commonwealth Government has previously provided dedicated funding for water related projects, including recycled water projects, but many of these funds have been fully committed and are not expected to expand in the future.

Other sources include public organisations that are responsible for delivering environmental or community benefits. For example, Natural Resource Managers might provide funding if the scheme provides environmental benefits, while public health agencies might provide funding if the scheme provides public health benefits.

If sufficient funding cannot be raised from partner organisations then, provided the water service provider’s customers have demonstrated a willingness to contribute to the recycled water schemes, the water service provider could potentially also contribute to the scheme, recouping the contributions through increased potable water and/or wastewater charges.

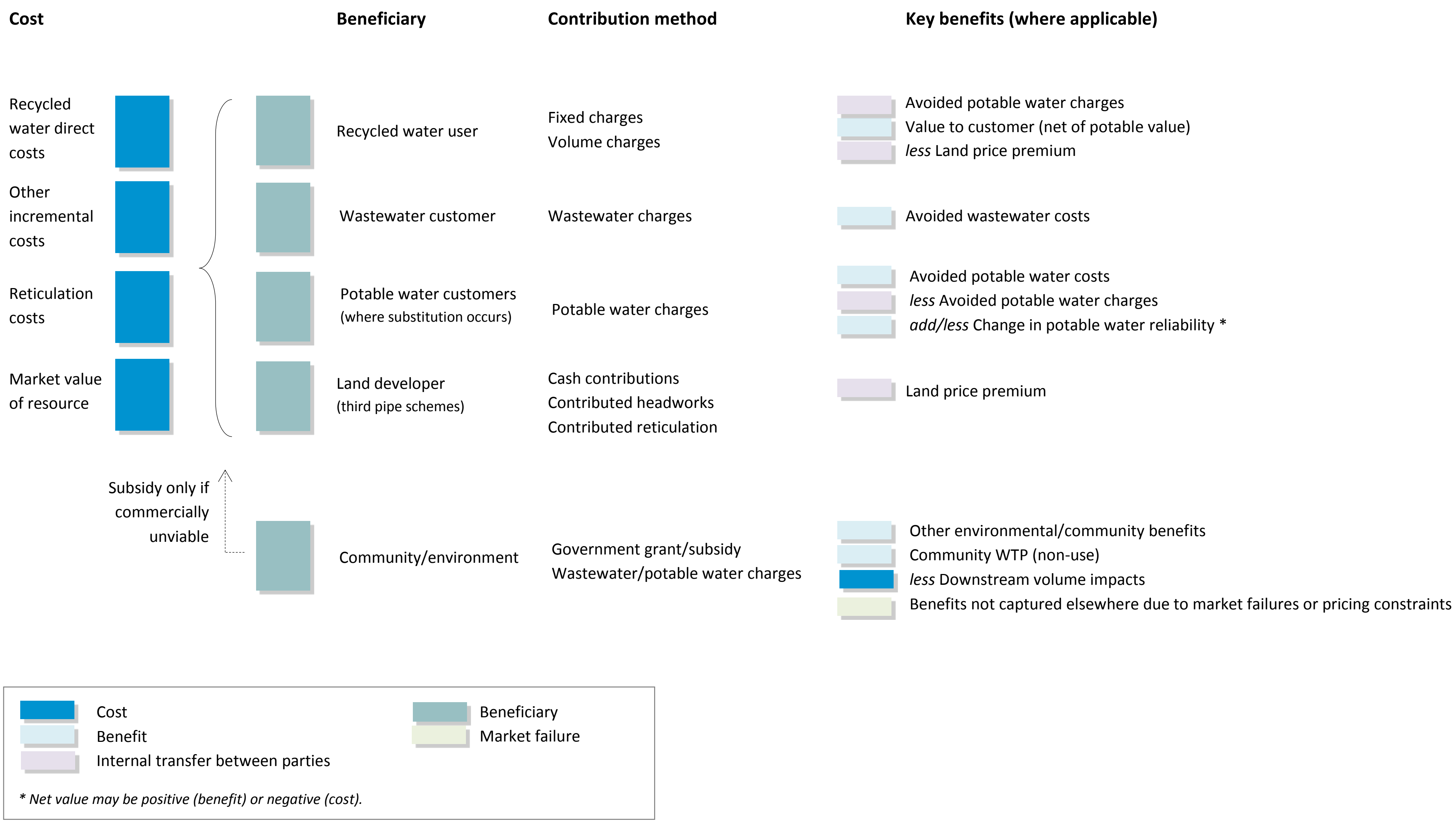
Finally, if the other funding sources are insufficient to fully fund the scheme, the state government could be approached to fund the remaining shortfall if the scheme is considered to be in the public interest.

4.2 Cost sharing among beneficiaries

The typical benefits for each major beneficiary are shown in Figure 6 (note that these are the *primary* costs and benefits that occur in *typical* circumstances only – other costs and benefits to these or other beneficiaries may also apply).

As outlined in Section 4.1, if the connection to the scheme is cost benefit justified and voluntary, costs should be shared in proportion to the benefits to each party. If (and only if) the scheme is not commercially viable without subsidisation, funding may be sought from external funding partners, the government and/or the wider community.

Figure 6: Pricing framework showing primary costs and benefits



Recycled water users

The benefit to recycled water users will be equal to their willingness to pay for recycled water (see '*Use value*' in Section 3.3 for more details). The willingness of users to pay for recycled water will rarely be directly revealed, but in some cases can be inferred.

If the recycled water substitutes for potable water, then the users' willingness to pay will be limited to the potable water price plus or minus the change in value to the customer. The change in value may, for example, result from changes in the reliability of the water supply, the different water quality characteristics or changes in the level of risk.

Where recycled water is not a substitute for potable water, the customers' willingness to pay for recycled water can potentially be inferred from the cost of alternative water sources (e.g. water trading, groundwater), from the losses that would be incurred if a water supply is forgone (e.g. through an analysis of irrigated compared with dry land farming margins) or from the cost of implementing water saving measures.

The recycled water user's willingness to pay for recycled water will also be reduced to the extent that additional costs must be incurred to access the recycled water, such as additional treatment or plumbing costs.

Recycled water charges can include fixed and volumetric charges. In accordance with established economic theory, the volumetric charge should send a pricing signal to recycled water customers regarding the marginal cost of consumption. The volumetric price should, as a minimum, reflect the short or long run marginal cost of increasing or decreasing consumption, but with more sophisticated analysis may also reflect the product's scarcity value. The fixed charge should then be determined to ensure that the total charge to the customer does not exceed their share of total costs.

For third pipe schemes, property owners may also pay an initial land price premium for land with access to recycled water, as demonstrated in the Rouse Hill hedonic pricing study conducted as part of this study. The benefit to developers may also include any present value 'premium' obtained from selling lots at a faster rate.

The land price premium will be a benefit to the developer but an additional cost to the property owner.

Wastewater customers

Wastewater customers may benefit to the extent that wastewater capital and operating costs are avoided (see '*Avoided wastewater costs*' in Section 3.3 for more details). This benefit will be particularly important in cases where the alternative wastewater disposal options are limited or costly.

Potable water customers

Where the recycled water scheme substitutes for potable water, the potable water scheme operator may benefit by avoiding capital augmentations and operating costs (see '*Avoided potable water costs*' in section 3.3 for more details). However, offsetting these benefits will be the reduction in potable water revenue that would otherwise have been paid by the recycled water customer. In practice, the reduction in potable water revenue will increase the proportion of the water service provider's costs that must be met by remaining potable water customers.

If potable water consumption charges have been set at the Long Run Marginal Cost (LRMC), the reduction in revenue should exactly offset the avoided costs, implying that potable water customers that are not supplied with recycled water will see no net impact on their water bill (see Appendix 4 for a simplified cash flow example demonstrating that potable water bills would remain unchanged). Potable water customers should only pay extra to subsidise a recycled water scheme if the water service provider has made an explicit contribution to the recycled water scheme based on the community's willingness to contribute to the scheme (see *Community willingness to contribute (non-use)'* in Section 3.3).

If potable water consumption charges have not been set at the LRMC, potable water bills will be impacted. If consumption charges are higher than the Long Run Marginal Cost (as is currently the case in many Australian cities), then recycled water schemes that remove demand from the potable water scheme will also remove more revenue that costs. If the potable water scheme is regulated, the charges to remaining customers will increase to cover this revenue 'hole'. However, the increase in water bills would be a result of misaligned (and therefore economically inefficient) tariffs rather than any underlying financial benefit to potable water customers.

Potable water customers may also be impacted by a change in potable water supply reliability, as noted under *'Other environment/community benefits'* in Section 3.3. As noted in that section, the impacts on water supply reliability could be positive or negative depending on the timing and size of potable scheme augmentations.

Community and environment

If the scheme is economically viable from a whole of community perspective, but the contributions from recycled water users, wastewater customers, potable water customers and land developers are not sufficient to fund the scheme, proponents should in the first instance seek funding from potential funding partners such as agencies responsible for the management of environmental or health services. In some cases, these agencies may directly benefit from the recycled water scheme by avoiding other environmental or health management costs, while in other cases the agency may be prepared to contribute funds as a means of achieving the broader objectives of their organisation.

Where funding remains insufficient to recover the costs of the scheme, there may be a case for government or the community to contribute the remaining funding for the scheme.

Contributions from the water service provider customers (through increased water and wastewater fixed charges) may be appropriate where the water service provider's customers have demonstrated a willingness to pay for recycled water, even if they do not directly use the recycled water themselves (see '*Community willingness to contribute (non-use)'* in Section 3.3).

In addition, subsidies from government may be appropriate, for example:

- to achieve other government objectives such as stimulating the market, encouraging research and development or protecting certain groups in society - the objectives of government should be clearly defined and ideally quantified within an economic framework wherever possible;
- if recycled water prices are constrained (e.g. through postage stamp pricing) and do not allow the scheme owner to recover the full 'willingness to pay' value from each individual customer, then government may agree to contribute to the scheme to realise the full value to the community;[14]
- if other market failures have distorted either consumption or investment decisions, leading to sub-optimal outcomes for the community.

To reflect the whole of community position, the government's contribution should be reduced to the extent that downstream users are negatively impacted by the reduced wastewater discharge volumes (see '*Downstream volume impacts'* in section 3.3).

4.3 Other National Water Initiative pricing principles

In addition to the beneficiary pays principle, the National Water Initiative also contains a number of additional pricing principles. We briefly comment on how each of these principles is addressed through the proposed framework:

- *Prices to contain a water usage charge:* The proposed framework includes a water usage charge that is equal to the marginal cost of consumption. However, we note that where the marginal cost is very small, it would be prudent to compare the cost of installing and reading meters with the benefits derived from a water usage charge.
- *Regard to the price of substitutes:* The proposed framework has regard to the price of substitutes (potable water and alternative water sources) when determining customers' willingness to pay for recycled water and therefore the upper bound of the price band.
- *Pricing structures should be able to reflect differentiation in the quality or reliability:* The framework allows for differentiation in both the cost and the willingness of customers to pay for recycled water based on differences in quality or reliability of the recycled water supply.
- *Where appropriate, pricing should reflect the role of recycled water as part of an integrated water resource planning (IWRP) system:* The role of recycled water in the IWRP system is incorporated through consideration of avoided water and wastewater costs. The framework also recommends a beneficiary pays approach that recognises the benefits across the integrated water cycle, including recycled water supplies, water and wastewater benefits, and benefits to the environment and the broader community. The framework also recommends that the benefits across the water cycle are considered in a transparent manner that supports the IWRP approach.
- *Prices should recover efficient, full direct costs — with system-wide incremental costs as the lower limit, and the lesser of stand-alone costs and willingness to pay as the upper limit:* The framework will provide a price for recycled water that shares the efficient, full

[14] In economic terms, the value to customers over and above the price they pay is known as the *consumer surplus*. To assist in realising this benefit, the government might be prepared to contribute up to the value of the consumer surplus.

direct costs of the scheme amongst beneficiaries. The customer prices calculated in accordance with the framework will necessarily be greater than the system-wide incremental costs (less offsetting benefits) but lower than the customer's willingness to pay for recycled water.

- *Any full cost recovery gap should be recovered with reference to all beneficiaries of the avoided costs and externalities:* A key element of the proposed framework is the sharing of costs by all beneficiaries, not only for the shortfall between costs and usage prices, but for the full project cost.
- *Subsidies and Community Service Obligation payments should be reviewed periodically and, where appropriate, reduced over time:* The framework does not explicitly address, but does not contravene, the principle of reviewing and reducing subsidies and Community Service Obligation payments over time.
- *Prices should be transparent, understandable to users and published to assist efficient choices:* The framework supports this principle by enabling a clear and consistent approach to costing projects and allocation of costs to beneficiaries.
- *Prices should be appropriate for adopting a strategy of 'gradualism' to allow consumer education and time for the community to adapt:* The framework does not explicitly address, but does not contravene, the principle of adopting a strategy of 'gradualism'.

5 Pricing by customer group

In this section we utilise the Non-potable Recycled Water Pricing Framework developed in Section 4 to provide more specific guidance for each customer group.

5.1 Pricing for residential schemes

Pricing for residential recycled water schemes includes consideration of developer charges, fixed annual charges and water usage charges.

Where connection to the recycled water scheme is mandatory for end users or land developers,[15] then prices should be no higher than if the customer (end user or land developer) had connected to the potable water scheme.[16]

Where connection is voluntary, it is often assumed that customers would only connect to a recycled water supply if the cost were less than potable water. However, the evidence from the research conducted for this study indicates that some home owners may be prepared to pay a land price premium for access to recycled water.

5.1.1 Pricing to land developers

The land price premium will represent a benefit to land developers. The land price premium may be due, for example, to the 'green' image of the development or to improved water supply reliability.

In practice, it is difficult to establish the land price premium associated with third pipe infrastructure in advance. The hedonic pricing exercise conducted as part of this study may assist in providing some guidance regarding the potential premium, however the premium for any particular location will vary depending on socio-demographics, the absolute level of property prices in the area and the timing of the land sales (e.g. the premium could be higher during drought or lower after flooding). Without a full hedonic pricing study, an experienced land developer may be in the best position to estimate any potential land price premium.

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15 To date, we are not aware of any proposal to serve residential customers on a voluntary price offering basis – that is, allowing individual households the option of joining the scheme or not. To date, residential water recycling schemes have connected all households based on several pragmatic considerations:

- a significant part of the cost is in the laying of the reticulation, and therefore a substantial amount of the cost will be sunk before the land is subdivided;
- savings in the potable water system, in particular the distribution system, require some level of certainty that the water savings will be permanent;
- developers are seeking to promote a 'green' image across the whole subdivision to support their contribution to the scheme;
- the funding for the scheme may require contributions from every household to render the scheme economic.

From our investigations, very few governments or water service providers are requiring developers to install recycled water schemes. However, developers and local governments are still considering the schemes, which would include connections to every home.

16 We understand that IPART has adopted a limit of 80% of the potable water price, presumably in part because recycled water has historically been seen as a 'second class' water supply. However, in recognition of the fact that recycled water also has some benefits over recycled water (in particular water supply security), we have adopted 100% of the potable water price for this paper.

Historically, it has been challenging to make third pipe residential schemes commercially viable. Therefore, for voluntary schemes, developers are often asked to contribute the maximum they are prepared to pay for the recycled water scheme.

If a third pipe recycled water scheme is commercially viable and does not require the maximum contribution from the developer in order to proceed, developers and water service providers may examine cost sharing negotiations similar to those required for non-residential recycled water supplies (see below).

Historically, developers have been required to construct and handover reticulation assets. These assets would form a part of the developer's contribution toward the scheme.

5.1.2 Pricing to end users

The price to end users should recognise the fact that a land price premium may be paid for access to the recycled water. In theory, higher recycled water charges should reduce the land price premium, however in practice property buyers may not fully appreciate the long term financial impact of different water prices and may therefore not take recycled water prices into account when purchasing a property.

While an informed customer base might potentially pay more for recycled water, it will be appropriate in most cases to set the total recycled water charge (fixed plus variable) no higher than the potable water volumetric charge for an equivalent volume to protect end use customers.

As discussed in Section 4.2, pricing for volumetric charges would be set at the long run marginal cost[17] of supplying the recycled water and the fixed charge would comprise the remainder.[18]

5.1.3 Pricing to water and wastewater customers

As discussed in Section 4.2, a water service provider may, on behalf of its wider customer base, contribute up to the avoided potable water and wastewater costs *less* the reduced potable water revenue.[19] On this basis, the prices paid by water and wastewater customers should be the same as or less than the prices that would have been required without the recycled water scheme.

5.1.4 Pricing to government and the community

As discussed in Section 4.2, contributions from the water service provider customers, through water and wastewater fixed charges, may also be appropriate where the water service provider's customers have demonstrated a willingness to pay for recycled water, even if they do not directly use the recycled water themselves.

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17 We note that partial equilibrium modelling or some other method for calculating scarcity prices could also potentially be used, however as these are not yet mainstream practice for potable water, that option has been ignored for the time being.

18 We note that IPART suggest that '*If a recycled water scheme is part of the least-cost water supply solution, the relevant price will be equal to the LRMC of water (including all sources)*.' (IPART 2006, p. 25) However, if the LRMC of recycled water is lower than potable water, it would improve economic efficiency to reduce the volumetric price and compensate with a higher fixed price for recycled water.

19 Lost wastewater revenue would also be deducted, if applicable. Most recycled water schemes still require wastewater collection by the incumbent water service provider, however it is possible that the recycled water scheme could undertake this service and only deliver bulk wastewater to the incumbent water service provider.

In addition, subsidies from government may be appropriate to achieve other government objectives.[20]

5.2 Pricing for agricultural schemes

5.2.1 Pricing to end users

The use of recycled water for agricultural schemes will be voluntary and therefore must be priced in a manner that is commercially attractive to customers.

For farms with access to groundwater or surface water, the price for recycled water would need to be comparable to, or less than, the cost of extraction plus the market value of the water (if water trading is available). For those farms currently receiving unreliable water allocations (e.g. unregulated or low security supplies) or water with poor water quality (e.g. high salinity), the pricing of recycled water might also include a premium to reflect the higher level of security and/or the improved water quality.

For farms without access to alternative water supplies, the recycled water will need to be priced at less than the benefit that will be received by switching from dry land farming to irrigated farming. There are several methods for estimating the value of irrigation, including comparing land values for similar properties with and without an irrigation supply, using water trading data for a comparable region (where available), or by comparing dry land with irrigated gross margins (‘profit’).

Crops may also gain some benefit from the additional nutrients in recycled water, although there is little real world evidence to suggest that farmers would pay a premium for this additional benefit.

5.2.2 Pricing to water and wastewater customers

As discussed in Section 4.2, a water service provider may, on behalf of its wider customer base, contribute up to the avoided potable water and wastewater costs. On this basis, the prices paid by water and wastewater customers should be the same as or less than the prices that would have been required without the recycled water scheme.

5.2.3 Pricing to government and the community

As discussed in Section 4.2, contributions from the water service provider’s customers, through water and wastewater fixed charges, may also be appropriate where the water service provider’s customers have demonstrated a willingness to pay for recycled water, even if they do not directly use the recycled water themselves.

In addition, subsidies from government may be appropriate to achieve other government objectives.

Agricultural customers typically require a ‘postage stamp’ price across all users. Therefore there may be a case for government subsidisation to achieve a whole of community benefit if the

[20] Although residential recycled water charges will use postage stamp prices, there is unlikely to be a case for government intervention to recover the full ‘willingness to pay’ value from each individual customer, as the alternative to recycled water will be a potable water supply, which will also use postage stamp prices. As customers will be trading one water product for another, the ‘willingness to pay’ value of each will offset the other when determining the costs and benefits.

benefit to individual users is greater than the cost of the scheme but if the 'postage stamp' price constrains prices such that the revenue will not adequately cover the full cost of the scheme.

Like residential pricing, volumetric prices should ideally be set at the Long Run Marginal Cost while fixed access charges should cover the remaining costs, providing the benefits of the tariff structure outweigh the costs.

5.3 Pricing for large non-residential customers

The use of recycled water for large non-residential schemes users will in almost all cases be voluntary and will be negotiated on a case-by-case basis.

In accordance with the proposed framework, a starting point for negotiations may be that each direct beneficiary contributes to the scheme in proportion to the net benefit (benefits less costs) that party receives. This approach will ensure that each party has an incentive to pursue the use of recycled water, while equitably sharing in the cost of the scheme.

To determine the benefits each party receives, it will be important to understand the costs that would be incurred if the recycled water scheme is not successful. This will establish the base case from which the costs and benefits of the scheme can be compared.

As the process involves negotiation, it should be expected that information provided by one party would need to be tested and verified by the other.

5.3.1 Pricing to end users

For most large industrial or mining customers, water is a critical but relatively small component of the overall cost to a project. While the willingness of these customers to pay for a water supply is high, the benefit of *recycled* water will depend on the availability and cost of alternative water supplies (e.g. drinking water supply, groundwater or surface water) or the cost of introducing more water efficient practices or technologies. The benefit will be reduced to the extent that the user must modify their processes to utilise a recycled water supply.

If the recycled water is highly treated (for example through reverse osmosis), some large customers may also receive an additional benefit from the lower level of nutrients and chemicals in the water compared with alternative water sources.

A customer's willingness to pay for recycled water will also be affected by the real or perceived risks that will need to be managed by the customer, such as employee occupational health and safety, competitive perceptions about the use of recycled water in production or increased water management complexity.

5.3.2 Pricing to water and wastewater customers

As discussed in Section 4.2, the net benefit to the water service provider (and by extension its customers) will be equal to the avoided potable water and wastewater costs *less* any reduced potable water revenue. Provided the water service provider's contribution is less than the net benefit, the prices paid by water and wastewater customers should be the same as or less than the prices that would have been required without the recycled water scheme.

5.3.3 Pricing to government and the community

As discussed in Section 4.2, contributions from the water service provider's customers, through water and wastewater fixed charges, may also be appropriate where the customers have demonstrated a willingness to pay for recycled water, even if they do not directly use the recycled water themselves.

In addition, subsidies from government may be appropriate to achieve other government objectives.

6 Uncertainty and risk

Commercial risk has been highlighted as one of the major concerns facing recycled water schemes. In particular, many water service providers have developed recycled water schemes on the basis of certain demand projections only to find that demand did not eventuate.

Many recycled water schemes have seen a significant reduction in demand in recent years, caused by a number of factors including:

- for agricultural schemes, the return of rainfall on the east coast of Australia;
- for industrial schemes, the change in economic circumstances associated with the Global Financial Crisis;
- for residential schemes, water restrictions and media campaigns promoting reduced water use, which reduced per capita water use during the drought but has not 'bounced back' since restrictions have been lifted.

In combination, these factors have had a significant impact on recycled water revenue, which in turn has reduced commercial returns. The concurrence of factors has resulted in a lack of confidence in recycled water investments and a reluctance to accept further demand risks.

Other important commercial risks include the risk of tightening health regulations or cost overruns due to the implementation of new technology. However, many of these risks have reduced over time as the technology has become better understood and the regulatory regime has become clearer.

6.1 Addressing demand risk

The most straightforward method that water service providers can use of to address demand risk when dealing with industrial customers, whether for a potable water scheme or recycled water scheme, is to require upfront contributions to pay for capital expenditure plus fixed or 'take-or-pay' charges to recover fixed operating costs, with usage charges reserved only to recover costs that vary with consumption. This form of charging ensures that, regardless of usage, investors will fully recover the costs of the scheme (provided they have been estimated correctly) and effectively shifts the demand risk to the customer.

If upfront charges are unpalatable to the customer, capital costs (including a return) can potentially be recovered over a longer time period based on a fixed payment schedules or 'take-or-pay' arrangements, provided the customer can provide adequate financial assurances (such as a bank guarantees), to protect the water service provider from possible payment defaults.

It is also possible to address commercial risks in multi-user developments where the land is being developed by a single developer. The key risk for land developments is typically the rate of development, with developers often forecasting optimistic land sale rates.

To minimise the risk to the water service provider, land developers can fully fund the capital costs upfront. In addition, developers could also be asked to contribute to fixed costs if the revenue from customers is insufficient to recover costs. Alternatively, developers could provide capital contributions using a performance based systems. Under such a system, which would be privately negotiated between the water service provider and the developer, developer contributions would increase or reduce depending on land sale rates (slow development rates would see the contribution increase to offset the lower customer revenue, and vice versa).[21]

In some cases, it may not be possible to address commercial risks through commercial negotiations, particularly for diverse schemes with many customers and multiple development fronts. Where the risk cannot be adequately addressed through commercial negotiations, other commonly employed methods for addressing risk include:

- ensuring that the assumptions regarding demand are adequately conservative to minimise risk;
- if benefits to the water service provider's customers can be established (which may be in the form of demonstrated willingness to pay) risks to the business can be addressed through the regulatory regime by allowing the water service provider to increase (or decrease) charges to the beneficiaries (recycled water, potable water or wastewater customers) if recycled water demand differs from the initial forecasts; or
- obtaining support from government, which may be in the form of direct funding or underwriting of the scheme.

6.2 Methods of analysing uncertainty and risk

Determining whether a recycled water scheme provides a net benefit to the community often involves consideration of the probability that a certain cost or benefit will occur. Probabilities for demand in particular can be difficult to gauge, however numerous techniques have been developed for use in Cost Benefit Analysis to assist with analysis risks, including:

- *scenario analysis*: scenario analysis is often useful when a precise estimate of probabilities cannot be determined but a subjective assessment may be possible. Scenario analysis also demonstrates the impact of extreme events or the impacts of 'getting the decision wrong'. One of the most powerful applications of scenario analysis occurs when all of the scenarios examined, including the worst case scenario, support the same decision;
- *threshold analysis:* as noted earlier, threshold analysis is a useful analytic tool when probabilities are difficult to determine. The threshold analysis essentially asks the question 'what would the probability need to be in order to justify a certain investment decision'. In many cases the threshold probability is so low or so high that the decision becomes obvious;
- *real options analysis:* a relatively recent tool being used by the water industry is real options analysis, which analyses the value of investments, even if those investments do not immediately supply water to end users. The terminology is often used to describe contingency investments – that is, investments in planning, regulatory approvals and long lead assets that will ensure that, if an unexpected event occurs (such as drought) the water service provider has the 'option' of rapidly constructing the next water source. However, the term can also apply to recycled water schemes that may only be required as a 'contingency' option in case of drought or unexpected failure of the water supply scheme. Real options analysis can also be used to understand the benefits of developing small, 'just

21 Examples of this approach have been developed for conventional water supplies, however the details are commercially confidential.

in time' water sources rather than large water sources that might ultimately be mothballed if dam storage levels improve.

Investors in a recycled water scheme should also undertake standard due diligence, including a full risk management process to identify risks, their likelihood and consequences, and potential risk mitigation strategies.

Once the risks are better understood, proponents may examine methods of reducing or managing the risks including (but not limited to):

- using staging or adaptive planning to allow the project to adjust to changes in demand or financial circumstance;
- redistributing the risk to ensure that risks are allocated to the parties that are best able to manage those risk;
- 'outsourcing' risks (e.g. hedging energy costs or foreign currency risks); or
- using contractual arrangements to reduce the risk as described in Section 6.2.

Once risk management strategies have been developed, decision makers must assess whether the benefits of the project outweigh not only the costs, but also the unmitigated risks.

7 Conclusions

A large number of non-potable recycled water schemes have been implemented over the past decade, due in part to the drought and the consequent possibility of severe water shortages. In recent years, the rush to implement new water sources has given way to a more considered approach and a desire to explore the full range of costs and benefits for each recycled water scheme.

Section 3.2 of this study provides a framework for assessing the economic viability of non-potable recycled water schemes using a broad ranging cost benefit framework. Based on well-established economic principles, we have described a general methodology for assessing both use and non-use values, and have also identified the most prominent costs and benefits that apply across all non-potable recycled water schemes. In addition to the general costs and benefits, the framework allows for the inclusion of other costs and benefits specific to each project.

Previous experience suggests that, with adequate resourcing, most costs and benefits can be monetised using an economic framework, particularly as environmental and health regulations act to minimise the adverse impacts of any 'default' water supply or wastewater disposal option. Where there are costs or benefits that cannot be described in economic terms, the analysis can be augmented through the use of complementary, but more subjective techniques.

In Sections 4 and 5 we examined the commercial viability of non-potable recycled water schemes and recommended a pricing approach that allocates the costs of a recycled water scheme to each of the beneficiaries (not just recycled water users) based on the benefit each party receives.

As part of this study we also engaged with industry and government to understand the primary impediments to the implementation of recycled water schemes. While some of the less experienced project proponents expressed frustration at the complexity of the regulatory processes, the primary feedback was that the greatest impediments to project implementation were cost effectiveness and commercial risk. In Section 2 we provided specific recommendations to facilitate the uptake of recycled water projects in the future.

In addition to the general recommendations, in Section 6 we also considered the commercial risks that face recycled water projects and examined some specific risk management strategies that can be applied to significantly reduce the risk to investors.

Appendix 1: General references

In this appendix we have collated a number of relevant academic, government and industry documents relating to the economics of non-potable recycled water projects. The references are not intended to be exhaustive, but act as an initial reference point for practitioners and project proponents.

Quantifying costs and benefits

Bennett, J. and Blamey, R. (2001) *The Choice Modelling Approach to Environmental Valuation*

Blamey, R., J. Gordon, and R. Chapman (1999) *Choice Modelling: Assessing the environmental values of water supply options*, The Australian Journal of Agricultural and Resource Economics

Bruce Aylward, Harry Seely, Ray Hartwell, Jeff Dengel, (2010) *The Economic Value of Water for Agricultural, Domestic and Industrial Uses: A Global Compilation of Economic Studies and Market Prices*, Prepared for UN FAO

Daniels, P., Porter, M., Bodsworth, P. and Coleman, S. (2011) *A Compendium of Externality Effects and their Monetary Values for Water Servicing Options: A Study Based on the South East Queensland Context*, Water Externalities Report 1, Urban Water Security Research Alliance Technical Report No. 42

Frank A. Warda, Ari Michelsenb (2002), 'The economic value of water in agriculture: concepts and policy applications', *Water Policy Journal*, 4 (pp423-446)

Gardner Brown, Jr. and Robert Mendelsohn (1984), 'The Hedonic Travel Cost Method', *The Review of Economics and Statistics* Vol. 66, No. 3 pp. 427-433

Hanley, N., S. Maurato and R.E. Wright. (2001) *Choice Modelling Approaches: A Superior Alternative for Environmental Valuation?* In Journal of Economic Surveys, Vol 15, No 15.

IPART (2011) *Assessment Process for Recycled Water Scheme Avoided Costs*

Karl-Göran Mäler, Jeffrey R. Vincent (2005), *Handbook of Environmental Economics: Valuing Environmental Changes*, Volume 2

Leggett, C. and Bockstael, N (2000) 'Evidence of the Effects of Water Quality on Residential Land Prices.' *Journal of Environmental Economics and Management*. 39(2):121-44

Marsden Jacob (2013) *Technical Report 1: The value of recycled water infrastructure to the residents of Rouse Hill*

Marsden Jacob (2013) *Technical Report 2: Community values for recycled water in Sydney*

Marsden Jacob (2013) *Technical Report 3: Environmental and social values associated with non-potable recycled water*

Schuster E, Colby B, Jones L, O'Donnell M, (2011), *Understanding the Value of Water in Agriculture: Tools for Negotiating Water Transfers*

TOZE S (2004) *Reuse of effluent water – benefits and risks, new directions for a diverse planet*, Proc. 4th International Crop Science Congress, 26 September 2004, Brisbane, Australia van Bueren, M. and Bennett, J. (2004) 'Towards the development of a transferable set of value estimates for environmental attributes', *The Australian Journal of Agricultural and Resource Economics*, 48:1, pp. 1–32

Recycled Water Pricing

Barker, A., Murray, T. and Salerian, J. (2010), *Developing a Partial Equilibrium Model of an Urban Water System*, Productivity Commission Staff Working Paper

Centre for International Economics (2010) *Pricing principles for recycled water and stormwater reuse*, Waterlines Report Series No 31 prepared for National Water Commission

Economic Regulation Authority (2009) *Inquiry into Pricing of Recycled Water in Western Australia*

Essential Services Commission (2009) *Metropolitan Melbourne Water Price Review 2009*

Frontier Economics (2011) *Externality pricing in the Australian water sector, Waterlines Report Series No. 43*, prepared for the National Water Commission

Independent Pricing and Regulatory Tribunal (2012) *Review of prices for Sydney Water Corporation's water, sewerage, stormwater drainage and other services From 1 July 2012 to 30 June 2016*

National Water Initiative, *Pricing principles for recycled water and stormwater use*

Water Services Association of Australia (2005) *Pricing for Recycled Water*, Occasional Paper No. 12

Werner, L. and Pickering. P. (2002) *Cost Reflective Pricing Study*, prepared for Water Services Association of Australia

Uncertainty and Demand Risk

McClinock, A (2010) *Investment in Irrigation Technology: Water Use Change, Public Policy and Uncertainty*, CRC for Irrigation Futures Technical Report No. 01/10

Stewart, R (2011) *Verifying potable water savings by end use for contemporary residential water supply schemes*, Waterlines Report Series No. 61, prepared for National Water Commission

Stratelytics (2008) *Real Options and Urban Water Resource Planning in Australia*, prepared for Water Services Association of Australia

Regulatory Guidelines

EPA Victoria (2003) *Guidelines for Environmental Management Use of Reclaimed Water*

Power, K (2010) *Recycled water use in Australia: regulations, guidelines and validation requirements for a national approach*, Waterlines Report Series No 26 prepared for National Water Commission

SA Health (2009) *Wastewater Fact Sheet: Recycled water systems: information guide for applicants*

Victorian Department of Health Services (2008) *Guide for the completion of a Recycled Water Quality Management Plan for Class A recycled water schemes*

Victorian Government (2009) *Review of the regulatory framework for alternative urban water supplies*

General

Brown, R. and Farrelly, M (2009) *Delivering sustainable urban water management: a review of the hurdles we face*, Water Science and Technology, Vol 59, issue 5, pp 839-846

Dimitriadis, S. (2005) *Issues encountered in advancing Australia's water recycling schemes. (Research Brief, No. 2)*, Department of Parliamentary Services, Commonwealth of Australia. 2005 06.

Marsden Jacob Associates (2012) *Progress against the national target of 30% of Australia's wastewater being recycled by 2015*, prepared for the Department of Sustainability, Environment, Water, Population and Communities

NSW Treasury (2007) *Government guidelines for economic appraisal*

Appendix 2: Literature review

This appendix provides an overview of the literature regarding the commercial and institutional impediments to the development of recycled water schemes.

Literature overview

In 2009, Brown and Farrelly investigated the institutional barriers associated with the closely related field of Sustainable Urban Water Management (SUWM).[22] The authors suggest that SUWM involves a shift away from traditional water management approaches toward a more integrated, adaptive, coordinated and participatory approach and note that these 'new' forms of management emphasise demand management and supply using non-traditional, fit-for-purpose, decentralised water resources. Although not explicitly mentioned in the study, the authors appear to be referencing sources such as water recycling and stormwater harvesting.

Brown and Farrelly suggest that while current urban water policies are beginning to reflect an understanding of SUWM, the 'rhetoric' is often not translated to implementation.

To better understand why implementation of SUWM failed to occur beyond ad hoc project interventions, the authors undertook an extensive literature review of observed and studied barriers. Drawing on local, national and international literature from the field of integrated urban water management and other similar fields, 53 studies were assessed. The authors reported that the analysis revealed the barriers to be largely socio-institutional rather than technical.

The results of the literature review produced a list of 36 barriers (not reported here for reasons of brevity), which were categorised into 12 barrier types:

- uncoordinated institutional framework;
- limited community engagement, empowerment and participation;
- limits of regulatory framework;
- insufficient resources (capital and human);
- unclear, fragmented roles & responsibilities;
- poor organisational commitment;
- lack of information, knowledge and understanding in applying integrated, adaptive forms of management;
- poor communication;
- no long-term vision, strategy;
- technocratic path dependencies;
- little or no monitoring and evaluation; and
- lack of political and public will.

[22] Brown, R. and Farrelly, M (2009) *Delivering sustainable urban water management: a review of the hurdles we face*, Water Science and Technology, Vol 59, issue 5, pp 839-846

Many of these barriers are also identified in other Australian literature on institutional and regulatory barriers, a number of which are outlined below.

A recent study[23] exploring Queensland legislative frameworks suggests that the complex nature of existing legislative frameworks and the absence of a clear overriding policy driver act as an impediment to decentralised / local alternative water supplies (LAWS) contributing to regional water supply capacity. These include recycled water projects.

A 2008 study[24] exploring onsite and decentralised systems in Australia identified inconsistent permitting and approvals processes and complications involved in private sector ownership and operations of systems. It was also noted that 'postage stamp pricing' across a water service provider's jurisdiction provided a barrier to more cost-effective localised options in higher cost service areas (although the reverse may also be true – postage stamp pricing provides greater opportunities in low cost areas).

A 2008 study identified institutional arrangements as one of the major determinants for success in urban water systems – "*…how businesses are set up to provide services and how those businesses are regulated.*" [25] The study noted that addressing decentralised systems imposes an extra burden on both the regulatory and the overall institutional arrangements, noting that 'provider of last resort' issues exist for these systems.

A recent study of Western Australian arrangements[26] identified two main factors contributing to the success or failure of non-drinking water projects, including recycled water:

- cost (capital expenditure, operating expenditure and treatment); and
- the lack of an accepted service provider that is an alternative to the Water Corporation.

Other noted issues included operational issues such as recruiting and retaining appropriate staff, asset management, maintenance and replacement, administration, meter reading, billing, customer services and complaints.

The study also noted that historical issues that were now addressed include the time and complexity of the approvals process and the level of technology and capacity within the industry to deliver projects. It was suggested that the information provided by the Department of Water, combined with the Department of Health and the Economic Regulatory Authority, "greatly demystifies the approvals process".

A NWC study in 2010 on recycled water use in Australia distinguished between small (decentralised) and large (centralised) schemes.[27] For small schemes, regulatory gaps were identified as a barrier - specifically, the potential for "orphaned" schemes for which no

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23 Hamlyn-Harris, D. *et al*. 2012. Queensland Water Commission - Study of Local Alternative Water Supplies Discussion Paper. May 2012.

24 Mitchell, C. A., Abeysuriya, K. R. and Willetts, J. R. (2008). *Institutional arrangements for onsite and decentralised systems: needs and opportunities for key players in the field of distributed wastewater management. Onsite and Decentralised Sewerage and Recycling Conference 'Coming Clean: Sustainable Backyards and Beyond!'*, Benalla, Victoria, Australia, Australian Water Association. http://www.isf.uts.edu.au/publications/mitchelletall2008benalla.pdf

25 Davis, C. (2008) 'Sustainable Urban Water Systems", in *Water,* Journal of the Australian Water Association, November 2008.

26 Essential Environmental (2012) *Opportunities and constraints to non-drinking water in WA.* Discussion paper prepared for the Department of Water. March 2012.

27 National Water Commission (2010) *Recycled Water Use in Australia.*

regulatory authority exists (for example, small wastewater recycling schemes for individual dwellings and multi-story apartments), which could prohibit their development.

The NWC paper suggests better defining a two tier regulatory system, which may as a result remove a burden on local councils to approve systems. This may improve consistency in approvals, as “councils vary in their size, location, capacity and expertise in relation to sewage and recycled water management”.[28] The study also suggested a national approach to accreditation of treatment systems for single households, which is currently being addressed through progress towards a National Validation Framework.[29]

Summary

A number of studies have explored institutional barriers to investments including recycled water projects.

It is notable that the literature review did not identify many specific examples of institutional arrangements that prevented recycled water projects proceeding, instead pointing to general complexity of institutional arrangements, and possible inconsistencies.

Regulatory arrangements will by their nature inhibit the implementation of recycled water projects, which will be justified when the benefits of protecting human and environmental health are greater than the costs of compliance. Regulation is rarely, if ever, ‘costless’.

Some of the more tangible barriers identified through the literature include:

- potentially complicated and confusing regulatory arrangements in some jurisdictions;
- the use of postage stamp pricing and its potential impact on water recycling proposals in high cost service areas; and
- the impact on the development of new schemes if regulatory ‘gaps’ exist.

[28] NWC, 2010. p46.

[29] www.australianwaterrecycling.com.au/coe/category-1/roadmap-for-a-national-validation-framework

Appendix 3: Framework components in detail

This appendix provides greater detail regarding each component of the non-potable recycled water economic framework outlined in this study, including the evaluation method, the types of assumptions and data that might be required, and an indication of the likely scale of influence each element may have on economic viability.

As the tangible costs (direct costs, indirect service delivery costs and reticulation costs) are relatively well understood by water service providers, and in some cases have been publicly documented (see for example the Development Servicing Plan for Rouse Hill), we have not expanded on these elements in greater detail. The remaining costs and benefits in the framework are addressed in turn below.

Other environment/community costs

Value of wastewater to other users

The value of the wastewater resource to other users is an opportunity cost as that value will no longer be realisable if the recycled water project proceeds.

The value to other users can in some circumstances be determined from first principles if sufficient information is available. See *Value to recycled water users* (below) for a more detailed description of calculating the value to different users.

An alternative method for determining the value to other users is to test the market by establishing a tender process. Under this system, each potential user would provide their offer or bid, much like any other release of water entitlements. In a well-designed system, the bids should reflect each organisation's willingness to pay for the recycled water and therefore the value. Once concern with a tendering process for recycled water would be the limited pool of tenderers. It is also possible that the use value will increase over time if potable water becomes more scarce.

A tendering process for alternative uses of recycled water has not been undertaken in practice, but has been discussed in detail by the Economic Regulation Authority (for more details see Economic Regulation Authority (2013) *Inquiry into the Tariffs of the Water Corporation, Aqwest and Busselton Water: Revised Final Report*). Due to the lack of precedents and the inherent complexities of a tender process, determining the value to other users from first principles (see *Value to recycled water users* below) may remain the preferred method of calculation in the short term at least.

As noted in the *In practice* section in the body of this report, the wastewater resource commonly has no value to any other user and therefore rarely has a significant impact on the viability of the scheme.

Downstream user impacts

Downstream user impacts are those impacts on users (e.g. farms, urban water supplies) that extract water from a waterway (e.g. river, groundwater) downstream of the wastewater treatment plant from which recycled water will be sourced. If the wastewater releases were previously put to beneficial use by downstream users, then diverting the wastewater to a recycled water scheme will incur an 'opportunity cost' equal to the lost benefits.

In order for there to be value to downstream users, the wastewater discharged into the waterway must be of a quality that satisfies environmental requirements and does not negatively impact downstream users. If water quality is impacted, then any increase in volume may be offset by the restrictions on water use (see *'Other environmental/community costs'*). Whether the diversion of wastewater provides a net cost or net benefit will be determined by the particular circumstances of the scheme. We note that water resource managers often act to protect the status quo, and therefore may require water service providers that are increasing discharge to ensure that water quality does not negatively impact downstream users.

The value to downstream users will be calculated in the same way as *Value to recycled water users* (below).

In addition to the value to the user, the calculation must also take account of exactly how the reduced wastewater discharge will affect water use. Water use entitlements are unlikely to change, but water resource managers may reduce water allocations to those users each year if the flows in the waterway reduce noticeably due to the reduced discharge. In some cases, allocations could be reduced pre-emptively based on advance hydrological modelling. In the longer term, the water resource manager may seek to 'claw back' water entitlements if the impact has been significant.

Therefore, the 'opportunity cost' of the recycled water will be the expected reduction in allocations (or entitlements) multiplied by the value of water to each of the users that will have their allocations reduced.

For example, an inland city that draws water from a regulated river and then discharges treated wastewater into that river may be required by the water resource manager to treat the water to a level that is acceptable for downstream agricultural use and urban water use (as occurs in many cities and towns located on the Murray Darling system). As the population of the city grows, wastewater discharges will also increase, resulting in higher downstream water allocations than would be the case if no wastewater was discharged. If a water recycling opportunity presents itself and the wastewater is diverted then the water allocation will reduce correspondingly.

As noted in the *In practice* section in the body of this report, wastewater discharges to the ocean have no downstream users. Therefore, this 'opportunity cost' is relevant only to the subset of schemes that discharge to inland waterways *and* have downstream users reliant on the water. Furthermore, wastewater discharges to inland waterways (such as the Murray Darling) are often small in comparison to the total flow through the river system and therefore would have relatively little impact on the determination of water allocations. However, larger cities or discharges to low flowing rivers can be material and therefore could potentially have a large impact. These impacts will need to be determined on a case-by-case basis.

Downstream environmental impacts

Downstream environmental impacts occur when lower wastewater discharges adversely affect the waterway downstream of an inland wastewater treatment plant. For example, reduced wastewater discharges could have a negative impact on natural or artificial wetlands that are downstream of the discharge point.

In Total Economic Value framework, the value of the environmental impacts would be determined by the willingness of the community to pay for the environmental outcome (see *Other environment/community benefits* for details on how to calculate the value - note that while the methodology in *Other environment/community benefits* is calculating a *benefit*, the same logic can be applied to calculate the benefit that would be *lost* if wastewater is no longer discharged into the river). In practice, there may be both benefits (due to better water quality) and costs (due to lower water volume) if wastewater discharge is diverted. The precise impacts would require detailed chemical and water balance modelling.

The downstream environmental impacts are likely to be small (or zero) when the treatment plant discharges to the ocean or a large river system, but the impact might be greater when the discharge volume is large compared with the river flows. As for *Downstream user impacts*, the impacts should be considered on a case-by-case basis.

Use value (net of potable use value)

Agricultural use

The value of recycled water to agricultural users is often determined by using one (or more) of three approaches:

- comparing land values for similar properties with and without an irrigation supply – this method is in theory one of the more accurate methods of determining the value of supplying irrigated water to farms. Unfortunately rural properties are rarely similar enough to make the required comparisons and therefore more complex forms of analysis (such as the Hedonic Pricing method used in Technical Paper 1) are required. However, these forms of analysis require a significant volume of sales data and data on each property's attributes, which is typically not available;
- using water trading data for a comparable region – this method is relatively easy to implement as many regions in Australia publically analyse water trading data. If water trading data is available for the specific region being examined, and the volume of recycled water is small by comparison with the total volume traded, then a relatively robust estimate can be determined. If estimates are being extrapolated from another region, or if the recycled water volume is large and therefore has the potential to significantly alter prices, then the estimate may be less robust;
- by comparing dry land with irrigated gross margins ('profit') – the comparison of 'profit' levels is possible through estimates compiled and published by government agencies. These estimates are often based on detailed farm budget models, but represent a 'typical' farm only. In addition, crops can change from year to year based on price expectations and growing conditions. The large variation in estimates for individual crops also suggests that these estimates are not fully reliable at a detailed level. Therefore, some level of aggregation and simplification is typically used when assessed gross margins for different crops. For example, crops may be aggregated into low value crops (e.g. broadacre crops), high value crops (e.g. horticulture) and very high value crops (e.g. viticulture). The gross margins for the relevant crops in the area are then determined on the basis that crops do have irrigation and then the exercise is repeated on the basis that irrigation is not available. Determining the full value of an irrigated water supply requires an understanding of the extent and type of crops in the area and also the options available to farms with and without the water supply.

The value to agricultural users will be different for each business and can vary widely. The use value will have a significant impact on the viability of the final scheme.

Industrial use

If recycled water is the only viable water supply available to an industrial user then the value of water to the business will be the full economic value of the business's product. In practice it is difficult for the proponent of a water recycling scheme to determine the value to each industrial customer unless the proponent volunteers that information.

However, it is often the case that other viable water supply options are available. In these cases, the value of the recycled water supply will be the value to the customer of avoiding the alternative water supply option. Alternative water supplies could include, for example, potable water scheme supplies, groundwater, river extraction or rainwater tanks. Each of these options has a unique set of capital and operating costs, but can often be estimated by a water service provider as many of these options are also available to supply potable water customers.

While the avoided cost estimates provide an *indication* of the value to the customer, the actual willingness of a business to pay for water will be determined by a complex range of factors that may include different 'hurdle' rates or payback periods, or the ability of the business to access capital. Therefore, the actual value to industrial users is often difficult to determine with precision unless the industrial customer provides full disclosure of their commercial costs and benefits.

The value to industrial users will be different for each business and can vary widely. The use value will have a significant impact on the viability of the final scheme.

Residential use

For a detailed discussion on the methodology and data requirements for calculating the value to residential users, see the companion report *Technical Report 1: The value of recycled water infrastructure to the residents of Rouse Hill*.

The value to residential users will be different for each location. In the case of Rouse Hill, the study undertaken in *Technical Report 1* indicates that the value is over $3 per kilolitre, indicating that the use value can have a significant impact on the economic viability of recycled water schemes.

Avoided potable water and wastewater costs

Potable water avoided costs

Avoided potable water costs are usually determined with reference to the Long Run Marginal Cost (LRMC) of augmenting the potable water supply scheme. While the LRMC often refers only to *water source* costs, for this study we are referring to the LRMC for all potable water infrastructure, including distribution and storage costs.

The LRMC is the change in total cost resulting from an increase or decrease in demand, usually expressed as a unit cost (i.e. cost per kilolitre). LRMC is a forward looking economic concept and therefore considers only *future cash flows*, excluding sunk costs and accounting costs such as depreciation. LRMC models ideally will extend into the long term (20 years or more) to reflect the long life of the assets in a potable water scheme.

LRMC is calculated according to the following formula:

LRMC = (NPC1-NPC2) / (PVD1-PVD2)

Where:

NPC1 is the present value cost of providing a level of demand D1

NPC2 is the present value cost of providing a level of demand D2

PVD1 is the present value of demand D1

PVD2 is the present value of demand D2

The calculation of LRMC requires a robust understanding of both the long term costs of the water supply system and the way in which these costs change with fluctuations in demand. To understand these impacts, the trigger point for new infrastructure must be identified and operating costs will generally need to be disaggregated into variable costs (e.g. energy and chemicals), semi-variable costs (e.g. maintenance costs) and fixed costs (e.g. some labour costs).

The LRMC will vary according to the exact increment or decrement of volume that is analysed. Therefore some judgement will be required to determine the appropriate volume, or range of volumes, to use in the calculation.

The total avoided costs are the present value of the LRMC multiplied by the volume of potable water displaced by the recycled water scheme each year.

LRMC has been studied in detail by many water service providers and regulators and is a relatively well understood concept in the water industry. For more detail on the calculation of LRMC see the recent regulatory price reviews for Sydney (undertaken by IPART) and Perth (undertaken by the Economic Regulation Authority).

Avoided wastewater costs

Avoided wastewater costs can be calculated in a similar manner to avoided water costs. However, the marginal costs of wastewater infrastructure are generally less well understood and may require a 'first principles' review of the costs that can potentially be deferred if recycled water is used as an alternative wastewater disposal mechanism. In practice, much of the wastewater infrastructure is sunk or sized for ultimate capacity and therefore avoided costs are often only relevant when a major augmentation of the scheme is planned in short or medium term (other than relatively minor variable costs such as energy and chemicals).

As noted in the *In practice* section in the main body of this report, the avoided costs for smaller wastewater schemes can often be significant where the scheme is facing growth pressure. In fact, a large number of recycled water schemes that have been implemented in regional areas have been justified on the basis of the avoided wastewater costs alone.

For more information on calculating the LRMC for wastewater see Marsden Jacob Associates (2006) *Identifying Wastewater Costs*, prepared for Water Services Association of Australia.

Community willingness to pay (non-use)

For a detailed discussion on the methodology and data requirements for calculating community willingness to pay, see the companion report *Technical Report 2: Community values for recycled water in Sydney*.

The community willingness to pay will be different for each region. In the case of Sydney, the study undertaken in *Technical Report 2* indicates that the value is in the order of $0.45-$3.80 per kilolitre depending on the volume and the end use. At the higher end, the impact on the viability of a scheme would be highly significant, while at the lower end, the impact is likely to affect only those schemes whose viability is marginal.

Other environmental/community benefits

Water quality benefits

One of the benefits cited for some recycled water schemes is an improvement in water quality for waterways that would otherwise have received treated wastewater.

Where water quality benefits exist, downstream users may gain a benefit if the improvement results in additional extraction and use by customers. If so, the benefits would be calculated in a manner similar to *Value to users* (above).

Improvements in water quality could also increase the range of uses for the water or could improve the productivity of water use. In these cases, the valuation would depend on the changes in water quality and the value of the new water uses to each business. Such an analysis would require consideration on a case-by-case basis.

In addition to commercial uses, water quality improvements could also have environmental benefits. For example, it is possible that, for a wastewater scheme discharging to a river, that a reduction in wastewater discharge could reduce the nitrogen levels in the river, which in turn could reduce the occurrence of algal blooms. Algal blooms have potential health impacts on people and animals that come in contact with the water, and can affect the fish stock in the river. Reduced algal blooms might represent only one of a number of benefits of improved water quality. Once the full range of impacts are understood, the value to the community can be gauged using techniques such as willingness to pay surveys. See *Technical Report 2: Community values for recycled water in Sydney* for more information on the conduct and data required to conduct such as study.

The impact on the viability of the scheme will differ depending on the specific benefits identified. As noted in *In practice* in the main body of this report, most environmental regulators in Australia have powers to protect the environment and therefore the likelihood of environmental impacts is minimal. However, in some cases it is possible that the quality of receiving waters could be improved and could in turn benefit the environment or downstream users.

Potable water reliability

If the recycled water scheme removes demand from the potable water scheme then the supply reliability of the potable water scheme may temporarily improve. The benefit to potable water customers will be determined by the change in the likelihood of restrictions and by the community's willingness to pay to avoid water restrictions.

Where recycled water volumes are small, the impact on reliability may be minimal. When determining the impact, we recommend considering all potential recycled water schemes rather than considering each initiative in isolation, and then applying a unit value across each individual initiative.

Where the volume of recycled water is relatively large, the temporary impact on potable water reliability may be significant. However, it should be noted that if the recycled water scheme is large enough to defer a climate independent potable water source (such as desalination), potable water reliability may improve, but *not by as much* as would have occurred if the climate independent source was added to the potable water portfolio. Therefore, reliability for potable water customers may be either a benefit or a cost depending on the impact on potable water sources.

As a simplistic example, assume potable water customers currently have access to a surface water supply that just meets their 100GL water needs in most years. However, 1 in 10 years the supply reduces to 80GL (20% reduction) and 1 in 25 years the supply reduces to 60GL (40% reduction). By constructing a 20GL desalination plant, potable water customers' supply reliability is improved to a 1 in 10 year chance of a 20% reduction. If a 20GL non-potable recycled water supply is constructed and the desalination plant is avoided, the recycled water customers will receive a non-potable water supply that will never be restricted (captured under the recycled water 'use value' benefit) but potable water customers (using the remaining 80GL) now have a 1 in 10 year chance of a 20GL / 80GL = 25% reduction. This situation effectively represents a transfer of reliability benefits from potable customers to recycled water customers.

Once the change in supply reliability is known, the value to potable customers can be determined by multiplying the change in the probability of restrictions by the willingness of customers to pay to avoid water restrictions.

Estimates of willingness to pay may be obtained from realised costs attributable to drought restrictions, from revealed preference methods such as demand functions estimated over periods that include drought restrictions, or via stated preference surveys that measure willingness to pay (WTP) for improved resilience to future droughts or willingness to accept (WTA) for lower resilience.

A number of studies have estimated the willingness to pay to avoid water restrictions. These studies include:

- studies conducted in South East Queensland by ACIL Tasman (2007) using a contingent valuation approach and DBM Consulting (2007) using a choice modelling approach, concluded (amongst other results) that consumers were willing to pay an average of $180 and $174 per year respectively to reduce Stage 4 water restrictions from 50% of the time to less than 1% of the time (approximately $7.70/kL);
- a study conducted in the ACT by Hensher et al (2006) found that water consumers were prepared to pay relatively little to avoid low levels of restriction, but up to $239 per year to avoid longer and/or more severe restrictions (e.g. total sprinkler bans lasting for the whole of summer). assuming average outdoor use of 50 kL per year, this translates to approximately $4.80/kL;
- a choice modelling survey was also previously conducted in the ACT by Gordon et al. (2001) in the late 1990's. In contrast to the study by Hensher et al, this study concluded that residents were willing to pay an average of only $10 per year (in 1997 dollars) to prevent a 10 per cent reduction in water use ($0.52/kL); and
- a study conducted in Perth by Tapsowan et al (2007) using choice experiments found that water users would pay relatively little to avoid low level restrictions, but that they would be willing to pay $130 per year to finance a new source of supply instead of enduring severe water restrictions ($2.80/kL).

A number of other studies also exist, but these are typically older studies, utilise methods that are considered less robust (e.g. out-of-pocket expenses), or relate to water consumers in other countries. These studies have not been reproduced here.

As shown above, the literature provides a diverse range of results, ranging from $2.80 per kilolitre to $7.70 per kilolitre (the lowest result, $0.52 per kilolitre, appears to be an aberration and is therefore excluded). The variation in results is likely to reflect the differences in the specific questions asked in each study, in addition to the different attitudes and circumstances of individuals responding to each study.

Furthermore, these results are only a subset of the overall cost of water restrictions. While some studies have also attempted to elicit a willingness to pay from business, the studies did not examine the flow-on impact of water restrictions on the turf and garden industry.

We note that the potential benefits of avoiding water restrictions have become less relevant since the recent easing of the drought and the increase in climate independent water sources, such as desalination. However, the benefit may still be relevant for smaller potable water schemes that are experiencing other pressures such as rapid growth.

Health benefits

For a worked example that calculates health benefits, see *Box 3: Scenario estimation of health impacts* in *Technical Report 3: Community values for recycled water in Sydney*.

As noted in the *In practice* section in the main body of this report, the health benefits are likely to be low as the probability of restrictions has fallen dramatically in recent years.

Appendix 4: Water business cash flows - worked example

Recycled water example - water business perspective

Scenario 1 (no recycling): 100,000 existing customers using 18GL plus growth of 10,000 customers using 2GL
Scenario 2 (with recycling): 100,000 existing customers using 18GL plus growth of 10,000 customers using 1GL potable water plus 1GL recycled water

Funding shortfall / developer contribution required

Calculation of deveper contribution required	
Recycled water scheme costs	$14,241,354
+ Avoided potable water charges	$12,801,692
- Avoided potable water costs	$12,801,692
- Recycled water charges	$10,241,354
Developer contribution required	$4,000,000

	Scenario 1	Scenario 2
PV water business revenue	$322,067,691	$323,507,353
PV water business costs	$322,067,691	$323,507,353
Net water business position	$0	$0

Assumptions

	Scenario 1 (no recycling)	*Scenario 2 (with recycling)*
Total number of customers	110,000	110,000
Existing customer potable volume	18,000,000	18,000,000
New customer potable volume	2,000,000	1,000,000
New customer recycled water volume	0	1,000,000

Fixed potable water costs - existing scheme	$20,000,000	per year (simplified example - assume recovers fixed operating, depreciation and ROA on existing assets)
Variable operating cost - potable water	$1.00	/kL
Variable operating cost - recycled water	$0.80	/kL
Capital cost for extra 2GL potable water	$10,000,000	
Capital cost for extra 1GL potable water	$5,000,000	
Capital cost for extra 1GL recycled water	$8,000,000	
Discount rate	6%	
Potable water - volume charge / LRMC	$1.64	/kL
Potable water - annual fixed charge	$76.95	per customer (balancing item to achieve potable water revenue reqt)
Recycled water volume charge	$1.31	/kL

Scenario 1 (no recycling) cashflows

Year	PV	1	2	3	4	5	6	7	8	9	10
Number of customers	858,186	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000
Water demand (kL)	156,033,845	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000
Revenue (potable only)											
Consumption charge	$256,033,845	32,817,732	32,817,732	32,817,732	32,817,732	32,817,732	32,817,732	32,817,732	32,817,732	32,817,732	32,817,732
Fixed charge	$66,033,845	8,464,041	8,464,041	8,464,041	8,464,041	8,464,041	8,464,041	8,464,041	8,464,041	8,464,041	8,464,041
Total water business revenue	**$322,067,691**	**41,281,773**	**41,281,773**	**41,281,773**	**41,281,773**	**41,281,773**	**41,281,773**	**41,281,773**	**41,281,773**	**41,281,773**	**41,281,773**
Costs (potable only)											
Fixed costs	$156,033,845	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000
Variable operating costs	$156,033,845	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000
Capital cost for extra 2GL	$10,000,000	10,000,000	0	0	0	0	0	0	0	0	0
Total water business costs	**$322,067,691**	**50,000,000**	**40,000,000**	**40,000,000**	**40,000,000**	**40,000,000**	**40,000,000**	**40,000,000**	**40,000,000**	**40,000,000**	**40,000,000**

Scenario 2 (with recycling) cashflows

Year	PV	1	2	3	4	5	6	7	8	9	10
Number of customers	858,186	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000
Potable water demand (kL)	148,232,153	19,000,000	19,000,000	19,000,000	19,000,000	19,000,000	19,000,000	19,000,000	19,000,000	19,000,000	19,000,000
Recycled water demand (kL)	7,801,692	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Revenue											
Potable water revenue											
Consumption charge	$243,232,153	31,176,845	31,176,845	31,176,845	31,176,845	31,176,845	31,176,845	31,176,845	31,176,845	31,176,845	31,176,845
Fixed charge	$66,033,845	8,464,041	8,464,041	8,464,041	8,464,041	8,464,041	8,464,041	8,464,041	8,464,041	8,464,041	8,464,041
Total potable water revenue	$309,265,999	39,640,887	39,640,887	39,640,887	39,640,887	39,640,887	39,640,887	39,640,887	39,640,887	39,640,887	39,640,887
Recycled water revenue											
Consumption charge	$10,241,354	1,312,709	1,312,709	1,312,709	1,312,709	1,312,709	1,312,709	1,312,709	1,312,709	1,312,709	1,312,709
Developer contribution	$4,000,000	4,000,000	0	0	0	0	0	0	0	0	0
Total recycled water revenue	$14,241,354	5,312,709	1,312,709	1,312,709	1,312,709	1,312,709	1,312,709	1,312,709	1,312,709	1,312,709	1,312,709
Total water business revenue	**$323,507,353**	**44,953,596**	**40,953,596**	**40,953,596**	**40,953,596**	**40,953,596**	**40,953,596**	**40,953,596**	**40,953,596**	**40,953,596**	**40,953,596**
Costs											
Potable water costs											
Fixed costs	$156,033,845	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000
Variable operating costs	$148,232,153	19,000,000	19,000,000	19,000,000	19,000,000	19,000,000	19,000,000	19,000,000	19,000,000	19,000,000	19,000,000
Capital cost for extra 1GL	$5,000,000	5,000,000	0	0	0	0	0	0	0	0	0
Total potable water costs	$309,265,999	44,000,000	39,000,000	39,000,000	39,000,000	39,000,000	39,000,000	39,000,000	39,000,000	39,000,000	39,000,000
Recycled water costs											
Variable operating costs	$6,241,354	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000
Capital cost for 1GL	$8,000,000	8,000,000	0	0	0	0	0	0	0	0	0
Total recycled water costs	$14,241,354	8,800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000	800,000
Total water business costs	**$323,507,353**	**52,800,000**	**39,800,000**	**39,800,000**	**39,800,000**	**39,800,000**	**39,800,000**	**39,800,000**	**39,800,000**	**39,800,000**	**39,800,000**