WATER SERVICES ASSOCIATION
of Australia

Pricing for Recycled Water

Occasional Paper No. 12 - February 2005

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for

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Pricing for Recycled Water

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Executive Summary

Background

In recent times there has been considerable focus on how to manage our water resources to balance supply and demand in a way that is economically, environmentally and socially sustainable. Amongst other measures, various types of water recycling projects are now being explored and developed.

For the purposes of this project recycled water is taken to mean reusing treated wastewater for beneficial (non-potable) purposes. To date, recycled water in Australia has been used for agricultural and horticultural irrigation, industrial applications, non-potable urban and residential uses (eg toilet flushing, garden watering, irrigation of golf courses and sporting fields), and supplementing environmental flows in rivers. Recycled water is a heterogeneous product, with the range of suitable uses and the costs of supply varying widely on the quality (class) of recycled water in question.

The reuse of wastewater represents a significant departure from the conventional water supply paradigm as it involves viewing wastewater as a potentially valuable resource to be utilised as a substitute for potable water in certain uses, rather than simply as a waste product. Proponents of recycled water point to the benefits of this alternative source of water in:

- reducing the need for future water resource development (and associated economic and environmental costs) by substituting for (original source) potable and/or irrigation water in various uses;
- improving the health of rivers and aquifers by reducing extraction;
- reducing the negative environmental impacts that in some settings accompany discharges from treatment plants into waterways; and
- providing economic development opportunities based on utilisation of a previously unused resource.

The emphasis to date has been on managing the technical aspects of recycled water and establishing risk management measures to safeguard public safety and the environment in the supply, use and disposal of these products. There has been little or no guidance or consistency on the methodology used for pricing recycled water. This has led to a range of concerns including:

- If the price of recycled water is set too high, its use will be discouraged but if set too low, it may result in profligate use with similar adverse environmental impacts associated with excessive water use in general;
- Since the financial costs of supplying recycled water that meets public health standards may be higher than the costs of providing potable water, even though recycled water is generally of lower quality, many projects may generate financial shortfalls that need to be recovered. This is a particular issue where direct competition in the supply of water and wastewater services is emerging as a real possibility.

This study was commissioned to assist WSAA members in dealing with recycling issues raised by governments, regulators and customers, and in planning for the longer-term delivery of cost-effective water supply within a changing regulatory environment. Taking care to develop principles and guidelines will facilitate a more consistent industry-wide approach to pricing for recycled water at a time when many schemes are still at the embryonic planning stage.

Key issues

While there are a number of objectives for pricing, this report takes the stance that the objectives most relevant to pricing of recycled water are those that relate to ensuring that society's resources are used efficiently. Efficient prices for recycled water and other water services will be those that balance supply and demand at the lowest long-term net community cost. This means prices that encourage the efficient and beneficial use of the most sustainable, fit-for-purpose source of supply – regardless of source.

A key theme of this paper is that, from an economy-wide or social perspective, the pricing of recycled water cannot be sensibly addressed in isolation – it needs to be seen within the context of other services provided by the industry. This is because the introduction of a recycled water project can reduce costs of supplying fresh water (particularly in relation to the need for new capacity), or treating wastewater and reduce the impact on the environment.

Recycled water as a product has some particular characteristics that need to be recognised in developing approaches to pricing. For most services the incremental costs of supplying users of those services are appropriately attributable to them under a 'user pays' principle. Taking a broader view, however, a recycled water project can be seen as one element of a total water and wastewater supply system. Where there are sufficient cost offsets, it would then be appropriate (and efficient) for all customers to contribute to the costs, rather than forego the project.

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The economic viability of a recycled water project can only be determined by reference to its alternatives – demand management, alternative supply augmentation (eg new dams, desalination plants etc). This implies that recycled water will be the optimal 'economic' solution to balancing supply and demand in some cases, but not in others. In effect, the cost of the next best alternative means of supplying – or saving – a unit of demand represents the value of the recycled water to the authority (and is the maximum price an authority would pay if purchasing a recycled water service from another party).

To the extent that the recycled water projects bestow benefits on other parties (eg environmental benefits) a case could be made under 'beneficiary pays' principles for a contribution from the broader community (ie taxpayers) or from the overall customer base. However, an approach that simply presumes that any financial shortfall on recycled water projects can be passed on to the remaining customer base as a 'cost of doing business' may not be sustainable where competition for services to those customers becomes feasible.

At the same time, prices to users should reflect the fact that recycled water is an increasingly valuable resource, for which users will be willing to pay. Particularly in the early stages of the recycled water market, the price setting context is likely to be more one of commercial negotiation between the utility and potential users of recycled water, rather than one of determining a tariff for a generally homogeneous water/wastewater service supplied through an integrated network. Both the actual costs of supplying recycled water and the willingness of end users to pay for it will tend to be specific to the project and location in question.

The perceived subsidisation of potable and irrigation water has led to calls for recycled water to also be subsidised so as to provide better signals to users as to the true relative costs of these alternatives. A key policy question that decision makers face in these circumstances is whether to purposely introduce another distorted price knowing that (a) this could be a temporary fix or (b) worse than that, it might end up impeding progress towards the removal of the other distortions.

The first best response, in terms of economic pricing principles, is to remove the original distortion by eliminating any subsidies for potable and irrigation water – preferably by a levy on the abstraction of bulk water. Setting a very low price – or at least a low price relative to the alternative (eg potable water) may encourage the use of recycled water and assist water authorities to meet re-use or demand management targets. However, there is a risk that it may also encourage perverse behaviour, such as profligate use of water, which may have adverse external impacts (eg salinity). It may also encourage use of recycled water for inappropriate uses (eg illegal and potentially dangerous cross-connections). Such outcomes would of course be quite inimical to the key objective of more sustainable water resource management to which recycling is intended to contribute.

COAG and other reforms are leading to more efficient pricing for water and progressive removal of subsidies, and there is a strong expectation of further increases in water prices in the future in some systems. A blanket approach of providing subsidised recycled water at low cost runs the very real risk of repeating the mistakes of the past.

Guiding principles

The discussion in this report leads to a number of principles for the pricing of recycled water:

- Prices for recycled water should be set within a price band, with (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 (ie 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 not locking in artificially low prices for an unnecessarily long time into the future.
- Prices for recycled water should be set as part of a longer term pricing reform strategy encompassing the suite of products provided by the industry (rather than a short-term position based on current charges for potable water and other services).
- In the case of mandated targets, 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 mandated (without CSO funding), it would be appropriate that regulators 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.

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- While regulators have a legitimate interest in overseeing prices of recycled water and the efficiency of these schemes, such regulation should be light-handed to provide appropriate flexibility in pricing (eg an approach where regulators require adherence to specified principles rather than prescribing specific prices or directly intervening in commercial arrangements), particularly where users have alternative sources of supply or considerable countervailing power as a buyer.
- 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.
- Policies towards recycled water and towards competition and regulatory reform should be developed by governments and regulators in an integrated fashion.

While the particular circumstance of each recycling project will vary, the key elements of determining an approach to pricing will involve the steps below:

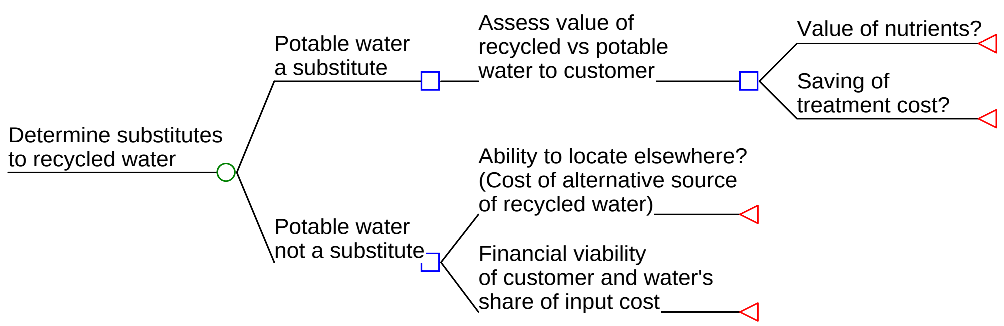
Understanding the market and willingness to pay

In order to gain a good sense of the likely upper bound of the efficient price band, water authorities will need to clearly understand the willingness to pay of users, by having regard to:

- The value of the product or activity to which the particular class of recycled water is being used as an input;
- Any other costs that the user must incur in order to be able to use the recycled water;
- The price ceiling provided by substitutes;
- The value placed on particular attributes of recycled water (that in some cases may even make it more valuable to users than potable water);
- The surety of users having access to the water over a sufficient period to enable recovery of their investment; and
- Attitudes and perceptions of users.

A schematic representation of some of the key considerations is shown below.

Assessment of willingness to pay



It also needs to be recognised that willingness to pay' is not necessarily a fixed ceiling. The experience of many water authorities to date suggests that education of the potential users, consumers of products produced using recycled water, and the broader community can often significantly increase users' willingness to pay. Assessments of the market also need to incorporate robust risk analysis of forecast demands for recycled water.

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continued

Understanding key elements of the costs and benefits of the recycled supply

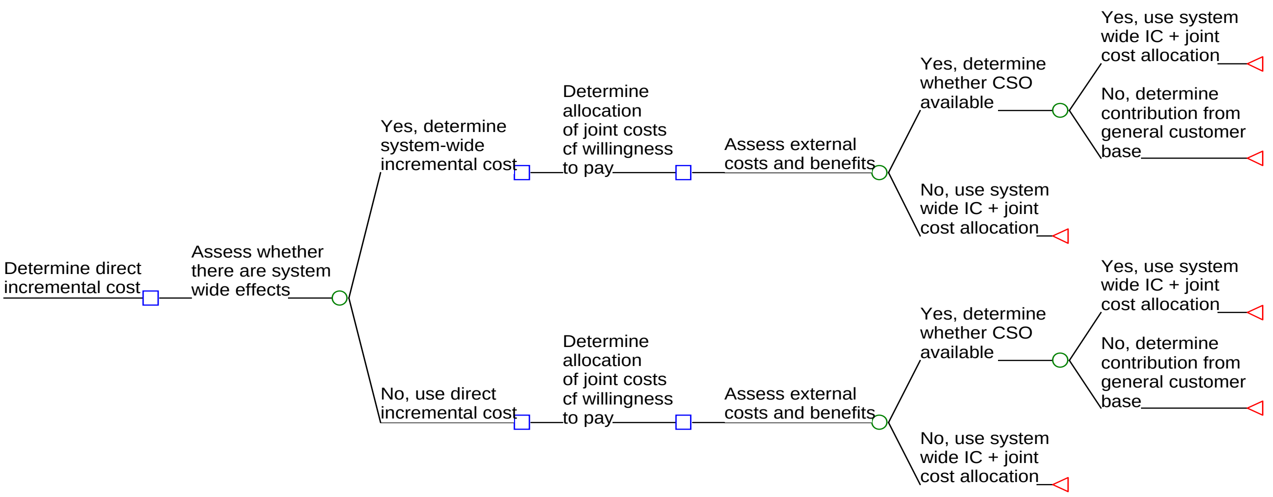
The second broad aspect is to have a sound understanding of key cost elements involved in the recycled water project and the cost of alternatives. In particular, this includes:

- The direct incremental capital and operating costs for the construction and operation of the recycled water infrastructure (generally, the higher the level of treatment, the higher the cost);
- Any system-wide costs or benefits associated with the recycled scheme (eg ability to defer or avoid costs of upgraded wastewater treatment);
- Any external costs or benefits accruing beyond the authority and its customers as customers (eg environmental benefits) and the availability of CSO funding; and
- The costs associated with the alternative scenarios without the recycled water scheme.

Any risks that may ultimately translate into higher costs also need to be factored into the analysis (eg contingent liabilities for claims arising from inappropriate use of recycled water).

The figure below indicates the key steps in assessing the incremental costs of the recycled scheme.

Assessment of incremental cost



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Comparison of incremental cost and willingness to pay

Willingness to pay determines the upper bound on the price of recycled water, and the lower bound is assessed by the relevant incremental cost for the particular scheme under consideration, taking into account any system-wide impacts.

Together these determine the band within which prices are able to be set, and whether the price that can be charged will result in a contribution to joint and common costs, at least cover the direct incremental costs, or require a recovery from other customers and/or a CSO or shareholder contribution.

Thus the willingness to pay ceiling from the first figure can be compared with the various decision points in the second figure. These diagrams are presented as a simplified characterisation of what in practice will be a more complex decision-making process.

Determine an appropriate structure of changes

Once the broad level of costs to be attributed and subsequently recovered in recycled water charges has been determined, the next question to address is the structure and incidence of recycled water charges.

Key considerations here include:

Providing appropriate signals as to the cost of providing additional water (ie the long run marginal cost of potable and recycled water);

Ensuring customers have sufficient control over the level of their bill (which assists with equity considerations);

Ensuring an appropriate relationship between the volumetric rates for potable and recycled water, to avoid perverse incentives (eg using the recycled water for inappropriate purposes); and

Appropriate management of risk via the structure of prices and nature of contractual agreement.

In order to provide guidance on the practical application of these principles and guidelines, the report provides some illustrative examples by way of three hypothetical case studies encompassing different water recycling scenarios with different drivers and uses for the recycled water.

1 Introduction

1.1 Purpose and scope of this paper

ACIL Tasman together with GHD has been engaged by the Water Services Association of Australia to develop guidelines and methodologies for pricing recycled water. This study was commissioned to assist WSAA members in dealing with recycling issues raised by governments, regulators and customers, and in planning for the longer-term delivery of cost-effective water supply within a changing regulatory environment. Taking care to develop principles and guidelines will facilitate a more consistent industry-wide approach to pricing for recycled water at a time when many schemes are still at the embryonic planning stage.

Pricing considerations

In developing principles and guidelines for pricing recycled water, the terms of reference for this study specifically require consideration of:

- Supply of recycled water as one of a suite of products and services provided by the urban water industry;
- Different drivers for the use of recycled water;
- The current arrangements for pricing of recycled water and the various types of recycled water;
- 'Risk prevention' measures;
- The nature of the market for recycled water projects relative to mainstream markets both now and in the future;
- The pricing perspective of a utility (as an incumbent supplier) compared to a new supplier in the market (eg under an access regime);
- Any benefits arising from delaying or avoiding water supply augmentation and wastewater treatment;
- Externalities (eg environmental costs and benefits) associated with recycled water.

Scope of study

The scope of the term 'recycled water' has been interpreted broadly to encompass the re-use of wastewater from a range of sources for beneficial purposes. Pricing of stormwater captured for reuse has not been specifically addressed in this project.

The study is about pricing and cost recovery arrangements for recycled water projects rather than technical, legal or marketing aspects of the supply of recycled water[1], which have been covered elsewhere. In addition, the focus here is on developing generic pricing principles and methodologies rather than prescribing prices for specific schemes. The study is however required to establish practical (rather than dogmatic) implementation guidelines. In addition, the study includes several case studies to illustrate the application of principles and methodologies to several hypothetical recycled water projects.

While the project focuses on the development of guidelines for pricing of recycled water to end users by supply authorities, any costs incurred by end users are also to be identified. In addition, the framework espoused in the report is applicable to the situation where water and wastewater, and recycled water services were provided by separate entities

Finally, the project focuses on how recycled water should be priced, rather than the cost-benefit assessment of recycled water projects, although there is inevitably some linkage between the two.

1.2 Structure of report

The following chapter presents a high-level overview of recycled water and briefly outlines the current status of recycled water use in Australia. Chapter 3 provides an analysis of the economics of recycled water as a prelude to considering approaches to pricing. Current arrangements for the pricing of recycled water and other urban water and wastewater services are summarised in chapter 4. Broad principles and alternative pricing methodologies are developed and assessed in chapter 5. Chapter 6 discusses key issues in developing pricing guidelines and strategies under various scenarios and brings together our conclusions and recommendations. Finally, chapters 7 to 9 contain case studies illustrating the application of these principles in different scenarios.

[1] Except to recognise that these impact upon both the cost of supplying recycled water and the willingness of users to pay.

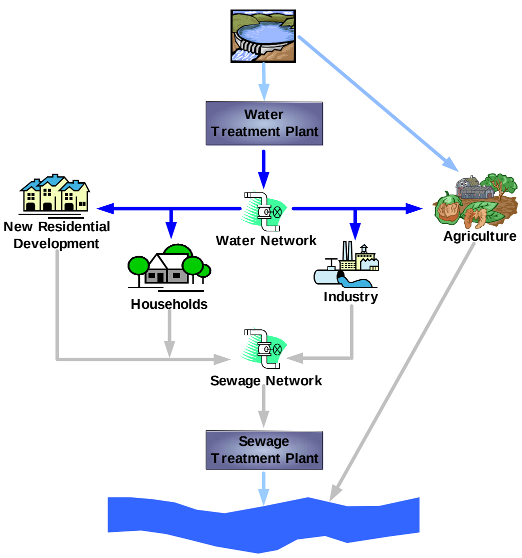
2 Background

2.1 The conventional water supply paradigm

Urban water supply and sewerage systems in Australia have been largely based on a paradigm that entails complete and deliberate separation of potable water supply from wastewater treatment and disposal (see Figure 1).

Under this approach, water authorities provide potable water to all urban users (after transportation from supply catchments and treated as necessary) via a distribution network to individual households and commercial and industrial users. Water authorities also supply non-potable water for agriculture and other non-potable uses. Once used, wastewater from households, industry and other users is transported through a sewage network to a sewage treatment plant. There the wastewater is treated to standards required by environmental regulators and discharged: in essence wastewater is regarded as a 'problem' to be disposed of.

Figure 1 Traditional water supply paradigm



Data source: *Figures from "Clip Art"*

Under this model, the suite of products or services provided by the urban water supply industry can be categorised as:

- Water harvesting, storage, transfer and treatment;
- Wastewater treatment and disposal;
- Acceptance of trade waste;
- Provision of infrastructure to service new developments;
- Retail services (eg billing, metering, customer queries etc);

Miscellaneous services. One of relevance here is the production of bio-solids as a by-product of wastewater treatment processes.

Undoubtedly this conventional supply paradigm has served the community well and been a major contributor to improved public health outcomes over the last century.

Challenges to conventional paradigm

In more recent years however the traditional supply paradigm has been challenged and questions raised as to whether it is sustainable into the future. In the past, increases in urban water demand were accommodated by water resource supply augmentation (eg new dams) and consequent increases in sewerage treatment plant capacity and wastewater volumes discharged to the environment. As attention began to focus on managing Australia's limited water resources in a more efficient and sustainable manner, and concerns grew about the financial and environmental costs of further water supply development, user pays pricing of water was progressively introduced from around the 1980s as a mechanism to ration demand.

More recently, with renewed focus on sustainable water resource management and also on environmental impacts of wastewater discharges, a broader range of measures to balance supply and demand has emerged. Amongst other approaches to increase efficient use of water resources, various types of water recycling projects are now being explored and developed. This is consistent with trends in other countries, where water recycling is particularly prevalent in regions of water scarcity (eg the Middle East, the South-West United States, parts of Asia), or where there are severe restrictions on disposal of treated effluents (eg Florida, coastal or inland areas of France and Italy, and densely populated countries such as England, Germany and Japan)[2].

[2] See ATSE (2004) for an overview of recycling in other countries.

2.2 What is recycled water?

While there are various definitions and terminologies in common use, for the purposes of this project recycled water is taken to mean reusing treated wastewater for beneficial (non-potable) purposes. Typically, this will entail utilising effluent treated at a centralised treatment plant to a quality appropriate to its intended use.

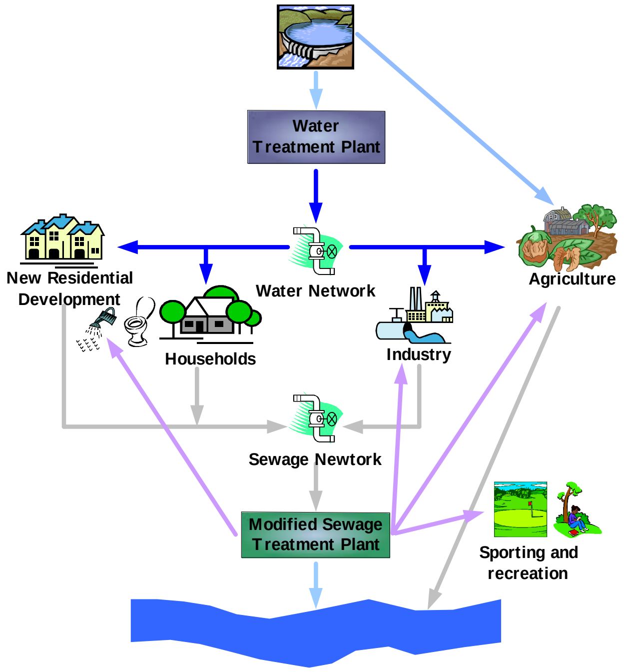
Sewer mining and treatment at decentralised purpose-built plants provides an alternative where recycled water demand is remote from centralised plants.

At a household level grey water can be reused either treated or untreated but this type of recycling is not considered under this project as it does not entail direct pricing by a water supplier.

Recycling a significant departure from conventional paradigm

The reuse of wastewater represents a significant departure from the conventional water supply paradigm as it involves viewing wastewater as a potentially valuable resource to be utilised as a substitute for potable water in certain uses, rather than simply a problem to be disposed of. Reuse of wastewater could, however, equally be seen as providing a wastewater treatment and disposal service, and may reduce environmental impacts of wastewater discharges to the environment. Thus the provision of recycled water represents a new service in the suite of products provided by the water industry (see Figure 2).

Figure 2 Water supply with recycling



Data source: *Figures form Microsoft Clip Art*

2.3 Key drivers of recycled water

Proponents of recycled water point to the benefits of this alternative source of water in:

- reducing the need for future water resource development (and associated economic and environmental costs) by substituting for (original source) potable and/or irrigation water in various uses;
- improving the health of rivers and aquifers by reducing extraction;
- reducing the negative environmental impacts that in some settings accompany discharges from treatment plants into waterways; and
- providing economic development opportunities based on utilisation of a previously unused resource.

Recognising these and other potential benefits, governments across Australia see recycled water as playing a growing role in balancing water supply and demand. Several have developed formal policies and/or action plans to promote recycled water projects, often with financial subsidies, public education and awareness programs, and in some cases through mandating specific targets for recycled water. Under the National Water Initiative (NWI), signed by most States and Territories[3] in the most recent COAG round, parties have agreed to encourage the reuse and recycling of wastewater where cost-effective.

2.4 Recycled water sources and the water cycle

Recycled water as defined for this project is one of a number of sources of water that are either "competitors" or "associates" in the total water cycle. The emerging concepts of Water Sensitive Urban Design (WSUD) and Integrated Water Cycle Management (IWCM) acknowledge the need to integrate the conservation and sustainable use of these various water sources in urban planning and development.

[3] Excluding Western Australia and Tasmania

2 Background
continued

Box 1 Alternative recycled water sources

Treated wastewater: where an individual sewerage treatment plant (STP) receives raw or partially treated wastewater, which is then treated to an appropriate level for specific re-use purposes

Sewer mining: the process whereby the sewage flow in a main trunk sewer is accessed, and the sewage effluent is separated and treated, with the solids returned to the main for treatment at the end point STP (sewage treatment plant)

Rainwater: rainfall run-off collected in onsite tanks for subsequent use.

Stormwater: rainwater collected from the stormwater drainage system. (Note this is separate from the sewage network)

Greywater: household water which has not been contaminated by toilet discharge.

Industrial effluent: effluents of industrial processes including intensive rural industry effluents.

Source: AATSE

2.5 Uses of recycled water

Recycled water is a heterogeneous product, with the range of suitable uses and the costs of supply varying widely on the quality (class) of recycled water in question. To date, recycled water has not been considered appropriate for direct potable use in Australia, although it has for many years in a number of other countries. Instead recycled water in Australia has been used for:

- agricultural and horticultural irrigation;
- industrial applications (eg cooling;
- non-potable urban and residential uses (eg toilet flushing, garden watering, irrigation of golf courses, sporting fields and open spaces, washing cars); and
- supplementing environmental flows in rivers.

The variable nature of the sources of water for recycling and the types of uses (either in place or being considered) imply that there are public health, amenity and environmental risks that need to be managed through both treatment regimes and usage protocols. There are also public perception issues in overcoming the "yuk" factor associated with the use of recycled water.

Table 1 Uses of Recycled Water

Types of Uses	*Example*
Residential uses	Toilet & Urinal flushing Residential gardens Fire protection
Landscape irrigation:	Irrigation of parks, Schoolyards, Landscaping Irrigation of cemeteries, Highway landscaping Irrigation of nurseries Landscape impoundment
Agricultural and horticultural Irrigation:	Crops and pastures Orchards and Vineyards
Commercial and Industrial uses:	Cooling and Air-conditioning with cooling towers Structural fire-fighting Commercial Car Washes Commercial Laundries Aquaculture
Environmental and other uses:	Recreational pools Environmental flows
Groundwater Recharge:	Seawater Intrusion Barriers Replenishment of potable aquifers

Source: *"Water Recycling in Australia" Australian Academy of technological Sciences and Engineering, p19*

Wastewater and sewage must be treated to make it suitable for discharge or reuse. The level of treatment may depend on the intended use of the recycled water. Thus secondary treatment may be sufficient for recycled water to be used in agricultural activities, whilst treatment beyond tertiary to Class A (unrestricted non-potable) standard is generally required for use in urban settings.

Recycled water quality is defined in various ways across the Australian water industry. For the purposes of this report the following range of recycled water products have been defined in terms of the additional treatment required above a secondary effluent, typical uses and recycled water treatment processes.

2 Background
continued

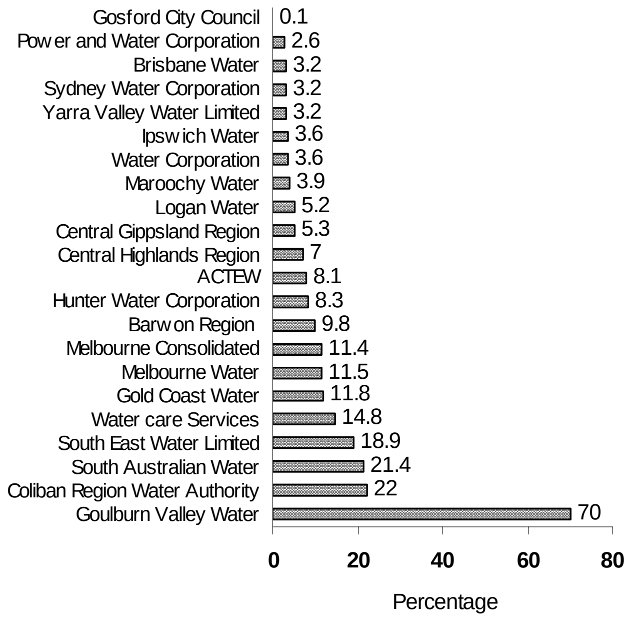
Table 2 Categorisation of recycled water

Class	Treatment above secondary	Typical uses	Typical treatment processes
AAA	Deionised Water	Very low salinity (0 - 5 mg/L TDS) high purity water for boiler feed and industrial processes	Microfiltration, Reverse Osmosis, Ion Exchange, Disinfection
AA	Equivalent to Potable	Low salinity (50 - 500 mg/L TDS) suitable for most industrial processes and aquifer recharge	Microfiltration, Reverse Osmosis, Disinfection
A	Tertiary & Disinfection	Suitable for unrestricted uses ie garden watering and toilet flushing and uncooked vegetable irrigation	Microfiltration or Media Filtration and Chlorination
C	Secondary & Disinfection	Suitable for pasture irrigation and irrigation of public areas with controlled public access	Chlorination, Ultraviolet, Detention Storage

2.6 Current status of recycled water

The volume of water recycled in Australia has increased in recent years. Between 150GL and 200 GL of effluent is now being recycled each year, and over 500 sewage treatment plants across Australia recycled at least some of their treated effluent[4].

Figure 3 Percentage of Water Recycled 2003-2004



Data source: *WSAAfacts 2004*

$$\text{Percentage of water recycled} = \frac{\text{Volume of reclaimed water x 100\%}}{\text{Volume of wastewater influent – net evaporation}}$$

The level of recycling undertaken by individual WSAA members is shown in Figure 3 below. The proportion of water that is recycled[5] ranges from none to just below 80 per cent (Goulburn Valley Water).

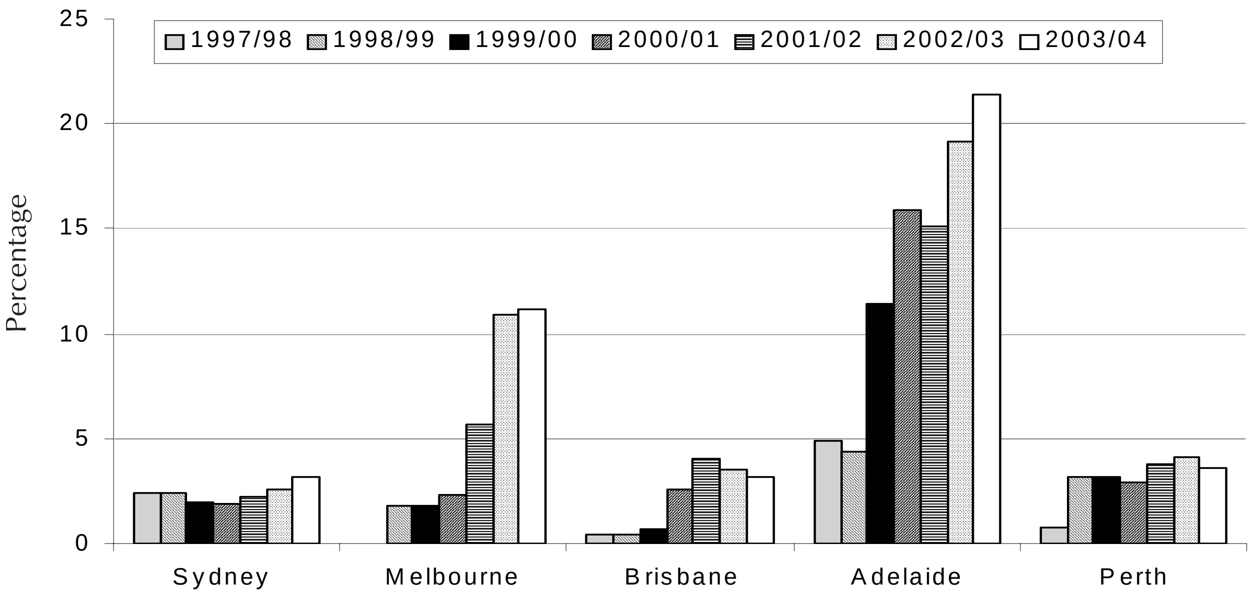
In general, the proportion of water that is recycled is higher in rural areas than in capital cities, although the volumes involved are smaller. This reflects the closer proximity of users able to utilise wastewater from local treatment plants. It should be noted, however, that there is an upward trend in the adoption of recycled water in the capital cities (see Figure 4).

[4] ATSE (2004), p.iv

[5] The percentage of all wastewater collected that is treated and actually reused by either the water business itself or a business supplied by the water business

2 Background
continued

Figure 4 Percentage of Water Recycled in Capital Cities 1997-2003



Data source: *WSAAfacts (various editions)*

2.7 Regulatory framework

The supply and use of recycled water is still relatively new, at least in Australia. Unlike mainstream water and wastewater services, the policy and regulatory framework for recycled water is not well developed. The emphasis to date has been on managing the technical aspects of recycled water (the framework for pricing regulation is discussed in chapter 4).

Technical regulation has typically been overseen by environment protection and health authorities. It has focussed on defining different classes of recycled water suitable for different end uses (eg Class A, B, C, D), and establishing risk management measures to safeguard public safety and the environment in the supply, use and disposal of these products.

Health risks are an important and high profile issue of water from any source, and this is especially true for recycled water produced by wastewater treatment plants. There are two general types of health risk to humans in wastewater: microbiological contaminants and chemical products. Microbiological contaminants can cause out breaks of viral, bacterial and parasitic diseases, while long-term exposure to chemicals can have varying effects.

Guidelines on the use and treatment of recycled water have been set out in *The National Water Quality Management Strategy*, under *Australian Guidelines for Sewage Systems – Reclaimed Water*. These guidelines refer to the extent of monitoring which could be anticipated in the treatment process and the acceptable level of concentration of thermotolerant coliforms for different uses of the recycled water (Table 3). The thermotolerant coliform level is a typical water quality indicator test. It correlates with the presence of bacterial pathogens.

Table 3 Thermotolerant coliform standards for various recycled water use application

Purpose of use	Thermotolerant coliforms per 100 ml (median)
Non-human food chain	<10,000
Low contact, eg irrigation of open spaces with controlled public access	<1,000
Medium contact, eg. Drinking water for stock, except pigs	<100
High contact, eg. Urban residential garden watering	<10

Source: AATS, p17

3 The economics of recycled water

The purpose of this chapter is to provide an overview of the economics of recycled water, as a pre-requisite to considering how it should be priced.

Recycled water has some particular characteristics as an economic good that need to be recognised in developing approaches to pricing. Recycled water is a joint product in terms of water supply and wastewater management. It is also a potential alternative to potable and a range of other water sources in terms of consumption. In addition, the production and use of recycled water is often characterised by external effects on other parties.

This chapter examines key aspects of the demand for recycled water, the supply of recycled water, and possible external impacts associated with its supply and use.

3.1 Demand for recycled water

It is important to recognise that access to and use of recycled water may be valued both by those who use it for specific non-potable purposes and by non-users as an alternative to system augmentation (dams etc) and wastewater treatment and discharge. The discussion here focuses on demand by direct users, with non-use demands covered below under 'externalities'.

Markets for recycled water are clearly in their early stages. While recycled water has been used in some applications (eg golf course watering) for many years, its use in urban and industrial settings is relatively new. Market demands for recycled water can and do vary widely. In these circumstances estimating accurately the future demands for recycled water and likely take-up rates can be a difficult exercise.

Value of use

The willingness of an end user to pay for a particular quality of recycled water will be driven by factors such as:

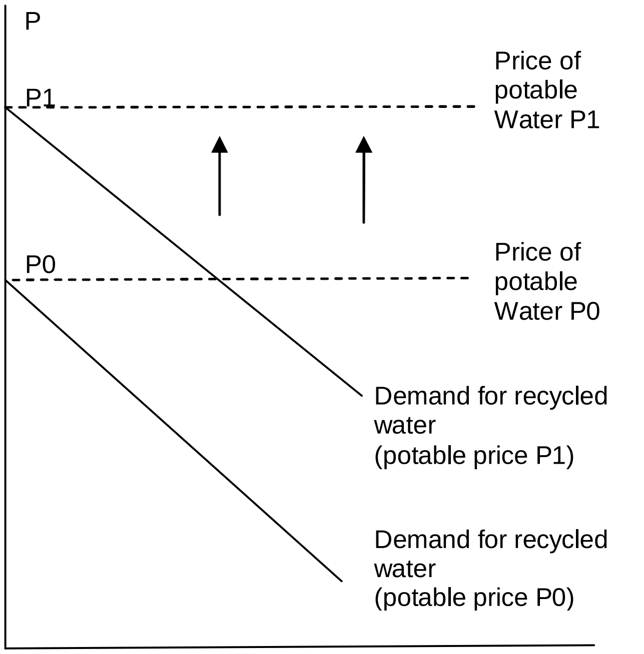
- The value of the product or activity to which the particular class of recycled water is being used as an input (value of marginal product):
  - Taking account of any regulatory restrictions on use that reduces its value to its user (eg delays needed between application and crop harvesting).
  - Typically agricultural and horticultural users represent the lower priced end of the market, whereas industrial and household users are prepared to pay higher prices (noting that the latter group generally require water of a higher quality than the former).
- Any other costs that the user must incur in order to be able to use the recycled water:
  - The more a user must pay to install necessary equipment or appliances or otherwise comply with regulatory requirements to be able to safely use the recycled water, the lower will be the willingness to pay for the water itself.

Price of substitutes

- The price ceiling provided by substitutes:
  - Since recycled water is typically of a lower quality than potable water, the price of potable water may often (in the absence of regulatory constraint) place an upper limit on willingness to pay for recycled water as a potable water substitute (see Figure 5). There will however be some circumstances as noted below where recycled water may be of more value to the user than potable water.
  - Similarly, where a low cost surface or groundwater irrigation supply alternative is available, the willingness to pay for recycled water as an input to agriculture will also be low.
  - As discussed in more detail later, many observers have suggested that demand for recycled water has been inhibited by artificially low or subsidised water prices. Recent and foreshadowed increases in potable water prices in many cities could be expected to increase willingness to pay for recycled water (see Figure 3).
  - Similarly the willingness to pay for recycled water is likely to be higher if there are limited alternatives or if there is uncertainty as to the ongoing security, price and/or quality of alternative water supplies in the future.

3 The economics of recycled water
continued

Figure 5 Pricing of potable and recycled water and willingness to pay



Value to users

- The value placed on particular attributes of recycled water (that in some cases may even make it more valuable to users than potable water):
  - Certain nutrients present in some recycled water may be of benefit to agricultural production.
  - The more reliable availability of recycled water (where it is used at levels readily satisfied by base potable water demand and less subject to restrictions on its use at times of drought) may be particularly valued by some users (eg golf courses).
  - In some industrial production processes, recycled water may be of a more consistent standard, require less "polishing" than potable water, and/or be able to be re-used within the production process more times than potable water.
- Guarantee of long term availability:
  - Where users have to commit to substantial long term investments in order to utilise recycled water (eg capital equipment), their willingness to pay will depend heavily on the surety of having access to the water over a sufficient period to enable recovery of their investment.
- Attitudes and perceptions of users:
  - Willingness to pay is influenced by attitudes towards it by users – which can itself be influenced by education and awareness programs.
  - Residential customers' perceptions about the quality of recycled water and potential health risks will influence how much they are prepared to pay (or even whether they will accept recycled water at all.)
  - Some customers may be prepared to pay a premium for using an "environmentally friendly" water product, in the same way that energy consumers can elect to pay a premium to purchase 'green electricity'. Similarly, there is some evidence that house purchasers may be prepared to pay a premium for house/land packages in greenfields developments utilising water sensitive urban design.

While all the factors listed above clearly influence the willingness of users to pay for recycled water, the ability of other parties (eg suppliers of recycled water) to accurately estimate what prices different users are actually willing to pay for particular classes of recycled water is challenging.

Moreover, 'willingness to pay' is not necessarily a fixed ceiling – the experience of many water authorities to date suggests that education of the potential users, consumers of products produced using recycled water, and the broader community can often significantly increase users' willingness to pay.

3.2 Supply of recycled water

A number of aspects of the costs of supply of recycled water are pertinent to subsequent consideration of pricing.

3.2.1 Direct costs of recycled water supply

Recycled water is a heterogeneous product, with the range of suitable uses and the costs of supply varying widely on the quality (class) of recycled water in question. The direct costs of providing recycled water will depend on the specific nature of the project and the use to which the recycled water will be put.

However, the costs can be broadly categorised as those associated with:

- project planning and regulatory approvals;
- marketing, public education and consultation programs;
- capital costs for new or upgrading of treatment plants, and subsequent operating costs;
- installation and operation of reticulation and trunk delivery systems;

3 The economics of recycled water
continued

- storage capacity where needed to match seasonal variations in production and demand;
- capital and operating costs of any additional treatment and wastestream treatment following recycled water use;
- ongoing monitoring and compliance with regulatory requirements and other risk management measures;
- contingent liabilities for possible legal claims arising from inappropriate use of the recycled water;
- metering, billing, and other customer-related costs; and
- costs incurred by users in accessing recycled water (eg conversion of equipment, plumbing, additional on-site storage or treatment etc).

Influences on direct cost

The nature and importance of these costs can vary considerably across recycling projects.

The capital and operating costs of treating wastewater to a standard suitable for its intended use will depend upon factors such as the quality of the influent, the quality of the recycled water required, the technology adopted or required for the appropriate level of treatment, and the extent of economies of scale. Generally, the higher the level of treatment, the higher the cost. If the influent has particular characteristics (eg high levels of salt), costs of treatment to make the wastewater 'fit for purpose' will often be higher than they would otherwise be.

Changes are also occurring in the costs and feasibility of different treatment technologies. Membrane processes are commonly being adopted for the treatment of wastewater. They include microfiltration, ultrafiltration, nanofiltration, and reverse osmosis, each of which removes respectively smaller particles/molecules/ions. The advancement in membrane technologies that has occurred over the past four decades has increased the efficiency of membrane processes and significantly reduced costs. It is likely that these and other technologies used in the treatment of wastewater will continue to improve, increasing the economic feasibility and reliability of the process.

The capital and operating costs of any transfer pipelines and distribution network to transport the wastewater to the site of use can vary significantly depending mostly on the proximity of the end user to the source of the wastewater. For agricultural or other landscape irrigation uses located close to wastewater treatment plants, for example, these costs can be relatively low. Conversely, the need for major pipelines or a distribution/reticulation network to transport recycled water through urban areas or to greenfield urban developments may entail high capital and operating (eg pumping) costs. Moreover, retro-fitting of third pipe systems into existing urban areas is considerably more costly and disruptive to communities than doing so as a greenfields development. For example, it has been estimated that retro-fitting third pipe systems into existing Melbourne households would cost in the order of $15 billion[6].

The nature and extent of costs incurred by users at the site of usage (eg on-site treatment, plumbing etc) in being able to utilise recycled water also varies significantly. User costs (eg plumbing) tend to be particularly high for use of recycled water in urban developments.

The costs of marketing and retailing recycled water also vary, but typically will be higher than for potable, groundwater or irrigation supplies.

3.2.2 Interrelationships with other services and system-wide costs

A full understanding of the economics of recycled water, however, requires going beyond the direct costs of projects to an examination of the effects of the provision of recycled water on the urban water and wastewater system as a whole. As illustrated in Figure 2, recycled water injects an additional 'feedback loop' into the conventional water supply system. These interrelationships occur at a number of levels. The possible implications for pricing of these interrelationships are examined in more detail in chapter 5.

Joint product with potable water

An obvious but perhaps easily overlooked point is that almost by definition recycled water is a joint product with first-use (potable) water. Recycled water would not be available if it were not for a water resource and supply system that provides first-use water. In economic terms, many of the costs of producing recycled water are 'joint' with those of producing first-use water. Similarly, on the wastewater side, many of the costs of treating wastewater for re-use could be considered 'joint' with wastewater treatment and disposal service provision (or at least those costs necessary to treat to the standard required by environment regulators before discharge).

[6] State of Victoria, Department of sustainability and Environment (2003). Green Paper 'Technical Paper No.1, Water Recycling scenarios for Melbourne'.

3 The economics of recycled water
continued

System wide perspective

Importantly, the ability to re-use wastewater could be seen as providing some 'cost offsets' viewed from a total system-wide perspective. As noted earlier, one of the possible benefits of the use of recycled water is that it may enable substitution for potable water thereby avoiding or deferring the need for water resource supply and distribution network augmentation (dams etc) and/or enabling a higher reliability of supply for other users (eg less restrictions) than would otherwise be the case. Similarly, being able to divert wastewater to beneficial uses may enable a water authority to avoid additional investment in treatment plants in order to comply with discharge licence obligations imposed by environment protection agencies. Thus, the 'incremental costs' of recycled water supply may even be negative from a total system cost viewpoint.

A number of other inter-relationships between the costs of recycled water and other services in the suite provided by water authorities are worthy of mention:

- As noted above, the costs of treating wastewater for re-use will depend on the presence in the influent of potentially removable contaminants.
- In third pipe greenfield urban developments, while the use of recycled water for certain indoor and outdoor uses does not remove the need for a pipe providing potable water, there may be economies from the reduced size of required potable water mains (although this could depend on pressure requirements for fire).

Impact on other customers will vary

To the extent that the use of recycled water contributes to minimising the long-term costs of meeting demand, potable customers can benefit indirectly- although the immediate impact on existing customers' average bills of such potable water substitution may be less clear-cut. As illustrated in the case studies later in this report, the impact of recycled water projects on existing customers will depend on the incremental costs and revenues from such schemes compared to standard potable supply alternatives. If there are severe constraints on or high costs of developing new water sources, or significant wastewater treatment expenditures to meet regulatory requirements in prospect, then recycling schemes that allow these costs to be avoided may offer major benefits to share amongst all customers. In contrast, where there is ready access to low cost water sources and excess capacity in existing delivery systems, provision of recycled water may offer few benefits for the system as a whole.

Clearly, benefits to existing customers are likely to be highest when:

- the recycled supply is in fact the most economic option amongst the range of alternatives for achieving the supply-demand balance while meeting other regulatory obligations (eg environmental discharge standards), and
- when there is a high willingness to pay for recycled water by users so that recycled users make a contribution to the joint supply costs or at least do not leave a large financial shortfall that needs to be recouped.

3.3 External costs and benefits

In addition to the impacts on other water and wastewater customers within an urban supply system, the supply and use of recycled water may entail other impacts beyond the end users themselves (termed 'externalities').

Environmental benefits

In particular, the use of recycled water may benefit the wider community by ameliorating or avoiding adverse environmental impacts through reduced wastewater discharges to waterways. Indeed, the need to meet increasingly stringent environmental requirements has been a key driver for many recycled water projects.

Learning options

Another broader public benefit might be any lessons learned from pilot recycled water projects that add to global knowledge about the effective and safe use of recycled water.

Adverse external impacts

There is however also potential for some adverse external impacts to arise from the supply and use of recycled water. These include the possibility of danger to human health if recycled water is used inappropriately (eg by illegal cross-connections or mistake) or of adverse environmental impacts from over-application of re-use water for irrigation or through accidental mixing during big storms.

Other indirect impacts on the environment (eg greenhouse gas emissions) could arise from the (sometimes significant) energy requirements associated with the additional treatment or pumping associated with the production and delivery of recycled water.

3.4 Overall economic and financial viability

The above discussion of the economics of recycled water has a number of implications for the financial and economic viability of such projects.

Financial viability

In some cases, recycled water projects may be financially viable as projects in their own right in the sense that users' willingness to pay is sufficient to recoup the direct financial costs associated with the project. For example, where agricultural or other irrigation users located in close proximity to treatment plants are able to access wastewater without the need for significant additional treatment or transport costs, a project may be commercially and economically viable in isolation.

Often a revenue shortfall

In many cases, however, the financial costs of supplying recycled water that meets public health standards may be higher than the (direct) costs of providing potable water, even though recycled water is generally of lower quality. Given that willingness to pay is generally bounded by the price of the alternative (eg potable water), this means that there will be a revenue shortfall from direct users. However, such a project could still be considered financially viable if it entailed sufficient cost offsets to make up the difference. Such cost offsets could include the deferral or total avoidance of the need to augment wastewater transfer systems or new capacity in potable water delivery in growth areas where local reuse schemes are developed (say, via sewer mining or the decentralisation of treatment and disposal).

May be justified by public benefits

In yet other cases, a project may be not financially viable from the point of view of a water authority and its customers, but may be economically justified if it provides broader public benefits (eg improved environmental outcomes) valued by society.

Of course, with any project, whether for recycled or potable supply, the gap between financial and economic viability may be narrowed as the price of potable water increases as part of policies aimed at conserving water.

The economic viability of a recycled water project can only be determined by reference to its alternatives – demand management, alternative supply augmentation (eg new dams, desalination plants etc). This implies that recycled water will be the optimal 'economic' solution to balancing supply and demand in some cases, but not in others. Some recycled projects will proceed anyway by virtue of government mandates based on broader judgments as to the inherent desirability of water reuse, and will need to be funded as a 'cost of doing business'.

4 Current pricing and regulatory arrangements

In order to develop guidelines for how recycled water should be priced in future, it is useful to know the broad frameworks currently governing pricing in the industry, and the current pricing arrangements for both recycled water and other products.

4.1 Broad framework for pricing in the water and wastewater industry

Arrangements for urban water pricing still vary considerably between jurisdictions, but there is broad agreement about where they should be heading.

COAG water reform

At the national level, States agreed in 1994 to the COAG water reform framework. This framework established principles for the pricing of water based on the principles of consumption-based pricing, full cost recovery and removal of cross-subsidies not consistent with efficient and effective service, use and provision (see Box 2).

Consistent with the National Competition Policy commitments, some States have or are about to have independent regulators setting prices. Typically these regulators have a mandate to protect interests of customers of monopoly suppliers, while ensuring prices enable an efficiently operating business to be viable and sustainable in the long run.

Evolving regulatory environment

Water authorities are facing significant changes in the regulatory and competitive environments in which they operate. For example:

- There has been an increasing involvement of independent regulators, with water businesses required to justify the level and structure of their charges, included those for recycled water. For example, as discussed in more detail below, both the ESC and IPART are developing/assessing principles by which to regulate the prices of recycled water.
- Direct competition in the supply of water and wastewater services via third party access to distribution networks is emerging as a real possibility. The National Competition Council (NCC) has recently issued a draft recommendation to accept an application for an access declaration by a private firm to Sydney Water's sewerage network.
- The National Water Initiative commits signatory governments to a range of further water sector reforms with implications for pricing of water services including the development of appropriate principles for pricing of recycled water. Among other things it calls for more cost-reflective pricing for trade waste and greater incorporation of resource management costs into the price of water.

Box 2 COAG water pricing principles and related reforms

1. The adoption of charging arrangements for water services comprising an access or connection component together with an additional component or components to reflect usage where this is cost-effective.
2. Water and wastewater businesses are to set prices to earn sufficient revenue to ensure their ongoing commercial viability but avoid monopoly returns:
   a) To be viable, a water business should recover at least the operational, maintenance and administrative costs, externalities, tax or tax equivalents (not including income tax), the interest cost on debt, dividends (if any) and make provision for future asset refurbishment/ replacement.
   b) To avoid monopoly rents, a water business should not recover more than the operational, maintenance and administrative costs, externalities (defined for the purpose of the pricing obligation to be the natural resource management costs attributable to and incurred by the water business), taxes or tax equivalent regimes, provision for the cost of asset consumption and cost of capital, the latter being calculated using a weighted cost of capital.
3. Cross-subsidies should be transparently reported and ideally removed where they are not consistent with efficient and effective service, use and provision.
4. Where service deliverers are required to provide water services to classes of customers at less than full cost this cost is to be fully disclosed and ideally paid to the service deliverer as a community service obligation.
5. As far as possible, the roles of water resource management, standard setting and regulatory enforcement and service provision be separated institutionally.

4.2 Current pricing practices

4.2.1Determination of revenue requirements

Particularly with the increasing jurisdiction of independent economic regulators over the water industry, prices for water and sewage services are being set within the context of an overall maximum revenue requirement for the water authority.

Typically, this entails application of a 'building blocks' methodology whereby the overall revenue requirement is based on key components principally comprising (efficient) operating expenditure, an appropriate return on assets, and a return of assets (regulatory depreciation). Prices for individual services are then set in a way designed to yield these revenues given demand forecasts.

Water authorities also typically disaggregate the overall revenue requirement between services/customer groups according to an allocation methodology (sometimes within regulatory guidelines), usually based on some form of cost attribution.

4.2.2 Current pricing of mainstream services

Although the focus of this study is on the pricing of recycled water, the demand and supply interrelationships between recycled water and the other services provided by the urban water supply industry also require consideration of the pricing of these services.

While a detailed description of the prices of these services for every urban water authority is beyond the scope of the project, a broad overview is presented here[7]. One common general feature is that many urban water authorities adopt 'postage stamp' water and sewerage tariffs within cities and towns (ie uniform charges regardless of differences in the cost of service provision reflecting factors such as distance from water source/treatment facility, topography, geology etc).

[7] More detail on tariff structures for urban water authorities may be found in WSAA*facts*

4 Current pricing and regulatory arrangements
continued

Water tariffs

Consumption based tariffs

Most authorities have moved towards consumption-based charges for water as required under the COAG reforms (ie the greater the consumption, the bigger the charge). Two-part tariffs for water (comprising a fixed service charge and a charge per kilolitre of water consumed) are now commonplace throughout the industry. Some authorities have adopted increasing block tariffs, whereby the per-kilolitre charge increases in steps as additional water is consumed. The fixed charge is generally either a uniform amount per customer, or based on inlet pipe diameter (or so-called meter size).

Significantly, in the context of a study on the pricing of recycled water as an alternative to potable water, there are signs of increases in volumetric prices to residential customers as regulators and governments seek to send signals as to the costs of supply (including externality costs). For example, the Victorian Government is now introducing a multi-part tariff for urban water supply in Melbourne whereby domestic customers are charged 75c per kilolitre for the first 40 kilolitres per quarter, 88c for the next 40 kilolitres, and $1.30 for all consumption in excess of 80 kilolitres per quarter. In New South Wales, the Minister has recently canvassed the possibility of increasing the volumetric price of potable water up to $1.80 kilolitre for residential consumption over the next few years.

Pricing externalities

In some jurisdictions, prices for water have been increased to incorporate explicit charges to reflect environmental externalities. For example, in Victoria, the Government has imposed an environmental levy on water authorities based on a percentage of its existing revenues, with the funds to be directed towards initiatives to promote the sustainable management of water and to address adverse impacts on the environment associated with water use. Similarly, in the ACT, there is a water abstraction charge of 20 cents per kilolitre. The Queensland Government has recently released a discussion paper on water resource charges[8].

In some other countries, particularly in Europe, effluent charges are levied on water utilities to discourage the discharge of effluent and wastewater, which indirectly encourage water recycling.

Wastewater tariffs

There is more variation in the structure of wastewater tariffs. In some cases charges for handling wastewater (ie receiving it from the client for disposal) comprise solely a fixed charge (with bases ranging from per fixture, per customer, or per dollar of property value). In other (rarer) cases a charge also applies based on the proportion of metered water volume deemed to enter the sewerage system.

Thus to date in Australia, wastewater tariffs have generally been related to the average costs incurred by the water authority in treating wastewater to the standard stipulated by relevant environmental regulatory agencies rather than related to actual wastewater volume handled for each client. It follows that they are not directly related to any negative environmental effects an effluent discharge might have had, treated or untreated, but they might be regarded as proxies for such charges.

Trade waste

Trade waste is usually of higher strength than domestic sewage and can contain toxic substances. It is also more heterogeneous so that the combinations of the trade waste from different customers may create problems. Its treatment and disposal is therefore priced differently from residential sewage. Pricing for trade waste is generally based on some combination of volumes and nature and content of contaminants. However, practices for pricing of trade waste vary widely between authorities.

The National Water Initiative calls for the review and development of pricing policies for trade wastes that encourage the most cost-effective methods of treating industrial wastes, whether at the source or at downstream plants, by 2006.

The pricing of trade waste can have important implications for recycled water in that the more that the costs of treating such waste are sheeted home to those producing the waste, the lower are the costs of supply of recycled water (either because of greater incentives for on-site pretreatment or because a greater share of treatment costs are borne by trade waste customers rather than recycled water customers).

[8] See Queensland Department of Natural Resources, Mines and Energy (2004).

4 Current pricing and regulatory arrangements
continued

Developer charges

Developer charges are charges that water agencies levy developers for the provision, or upgrading, of water supply, sewerage and drainage facilities for new developments. In addition, it is common for developers to build and contribute reticulation assets within a development, to be subsequently operated and maintained by the water authority. The methodology for determining developer charges varies across the industry.

Where the use of recycled water as a substitute for potable water is proposed or the development "opts out" of the centralised sewerage system, developers may receive credits against a proportion of the water supply and wastewater charges that would otherwise apply.

4.2.3 Current pricing practices for recycled water

The arrangements for recovering the costs of providing recycled water vary widely. In broad terms, the costs are recovered from a combination of:

- Various charges levied on users of recycled water
  - These charges may include not just a volumetric price per kilolitre of recycled water but also charges for subsequent treatment and disposal of any recycled water after use, and up-front capital or developer charges in relation to the particular project.
- Higher charges on the general customer base and/or;
- Direct financial contributions/subsidies from government.

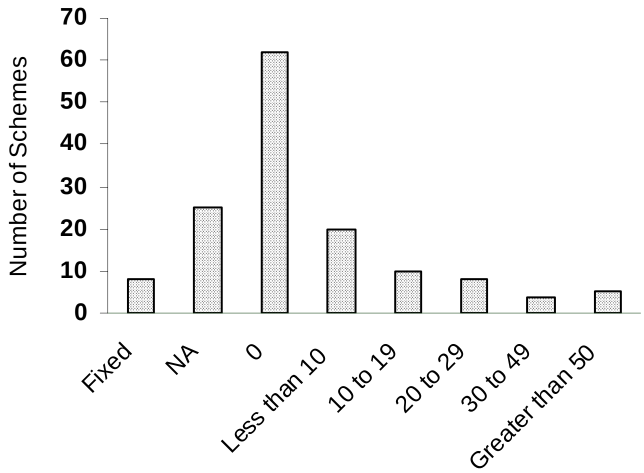
Pricing of recycled water to users

To date there has been little or no guidance or consistency on the methodology used for pricing recycled water. Prices have tended to be set in an ad hoc way for each project. Moreover, sensitivities about posting prices that are much lower than potable water prices have sometimes resulted in prices being set on a commercially confidential basis.

As part of this consultancy, ACIL Tasman undertook a survey of WSAA member's pricing practices. The survey sought information on the key drivers, uses of water, number and nature of users, pricing methodology, the level and structure of prices, the process for review of prices and length of supply contracts for existing recycled water schemes. Fourteen WSAA members responded to the survey, providing information on 142 schemes. The water from these schemes is used in households, industry, sporting fields, and agriculture.

The survey results indicated that in a significant proportion (44%) of schemes, users are not charged for recycled water. In respect of the zero charging schemes, many water authorities indicated an intention/hope to charge for water in the future. There was a significant positive relationship between the use of water in agriculture and non-zero pricing. Only a small proportion of schemes charge more than 50 cents per kilolitre.

Figure 6 Distribution of Prices of Recycled water (cents per KL)



Note: 25 schemes did not provide a price, eight were fixed and could not be converted into cents per KL

These results confirm that in many of the earliest schemes, particularly those involving reuse of treated sewage effluent for agricultural and municipal irrigation (eg golf courses), recycled water has often been provided free of charge or for a nominal fee. These schemes were often driven by the need to find a secure means of disposing of effluent rather than to achieve an economic return.

4 Current pricing and regulatory arrangements
continued

The survey undertaken for this project indicated that a range of methodologies is currently used to establish prices for recycled water (see Table 4). Some 45 percent of schemes cited both 'assessment of willingness to pay' and 'cost analysis' as the basis of pricing methodology. The consideration of the environmental benefits in determining the price level of recycled water was also noted.

The survey indicated a relationship between the assessment of willingness to pay and a zero charge – that is if the basis for pricing was 'assessment of willingness to pay', it was more likely that the scheme would charge for water There is also a positive relationship between methodology being based on competing product and non-zero pricing. Of the 26 schemes for which the price of a competing product was indicated as a basis of pricing methodology, only one charged at a zero rate.

Table 4 Basis of Pricing Methodology

Assessment of willingness to pay	Specified percentage of potable water price (specify percentage)	Cost analysis	Competing product (e.g. irrigation supply)
57%	4%	58%	19%

Approaches in other countries

A similar diversity of approaches to pricing recycled water appears to apply in other countries. A 1997survey of 23 authorities in the USA revealed that 11 based their reclaimed water rates on some percentage of the potable water rate (varying between 50% and 100%, averaging 75%), while only six based their rates on the cost of service[9].

Recycled water pricing structures

The most common pricing structure of schemes reported in the WSAA survey is pure-volumetric (55% of schemes), while nearly a quarter of the schemes have a fixed annual charge. Only 4% of schemes utilised seasonal charges. The survey indicated no relationship between structure of pricing and use of recycled water.

Capital contributions/developer charges have been an important element of the charging structure for many recycling projects. In some cases, for example, the costs of new infrastructure required for a recycled water supply has been levied on a major user/s as an up-front charge. In other cases, the developer charges have incorporated an offset to the 'standard' developer charge to reflect the fact that recycled water developments are not placing demands on headworks assets.

Of the 142 schemes, information on the process of reviews for pricing was provided for 82 schemes. Of these over 50% have an automatic adjustment for CPI. Also, a number of schemes have predetermined price paths set into the contract. The most common length of contract was 10 years, while 38 schemes had either an ongoing or standing contract. A number of contacts had an option for extension at the end of the period.

Use of contracts

Particularly in the early stages of the recycled water market, the price setting context is likely to be more one of commercial negotiation between the utility and potential users of recycled water, rather than one of determining a tariff for a generally homogeneous water/wastewater service supplied through an integrated network. Both the actual costs of supplying recycled water and the willingness of end users to pay for it will tend to be specific to the project and location in question.

Funding of shortfalls

In many cases, the financial costs of supplying recycled water that meets public health standards may be higher than the costs of providing potable water, even though recycled water is generally of lower quality.

Recovery of cost shortfalls from customers and owners

Typically, any shortfall between revenues and the costs of supply is made up by government payment[10] and/or by recovering costs from the utility's total customer base. In either case, the shortfall in effect becomes a cost of operating in the potable supply business, to be shared between asset owners and (non-recycled) potable supply customers.

[9] See Cuthbert and Hajnosz, 1999

[10] For government owned businesses, such government payments could be in the form of reduced dividends and/or lower asset values.

Government partnerships

In Queensland and NSW subsidies for recycled water projects have been made available under various State Government schemes – for example a 50% capital works subsidy.

In Victoria, partnerships between government and the major water authorities provided a fund (Smart Water Fund) to assist the development of water recycling schemes in Metropolitan Melbourne and a rural counterpart (Water for Growth) fund. The Victorian Government has signalled in its recent White Paper that it will consider investing in strategic water recycling programs that provide significant community benefits at a State or regional level.

In the past, Commonwealth Government funding has supported some water recycling schemes (eg the Virginia Scheme in South Australia received some $10 million under the Building Better Cities program), although this has been less so in recent years.

4.3 Emerging trends in the regulation of recycled water prices

As noted above, there is an increasing involvement of independent regulators in the setting of prices in the water industry, included those for recycled water.

IPART – Independent Pricing and Regulatory Tribunal (NSW)

The first involvement of an economic regulator in the setting of prices for recycled water was the special determination by IPART for prices of recycled water for the Rouse Hill Development Area. Rouse Hill properties pay a fixed access charge for the availability of recycled water and a user charge of 28c/kl[11] (potable water is 98c/kl).

The pricing policy was developed with the intent to "maximise the use of recycled water where applicable"[12]. Indeed, over the summers between January 2001 and December 2002, total water consumption at Rouse Hill was approximately 20% higher than the Sydney average[13]. Noting this, some commentators have suggested that setting the price of recycled water too low has in fact encouraged its over-use.

Excluding the Rouse Hill Development Area, IPART has not set prices for metropolitan recycled water; although they are currently seeking comment for the 2005 determination on the appropriate principles for future regulation of recycled water prices[14]. It has however given some direction for the pricing of recycled water in the *Review of Metropolitan Water Agency Prices, Issues Paper*, stating:

> Increasing the use of recycled water as a substitute for potable water will benefit all customers by reducing the impact of urban development on the environment and freeing up potable water for other uses. For this reason, where indicated as part of a least cost framework for addressing supply/demand imbalances, spreading some of the cost of recycled water schemes across the broader customer base may be warranted.[15]

ESC – Essential Services Commission Victoria

The ESC in Victoria recently commenced its first review of water prices. Under its mandate, it is required to regulate recycled water by application of appropriate pricing principles (rather than direct price control). It has indicated its preliminary views on the regulation of recycled water prices[16]:

> Where recycled water services are commercially viable, it would be reasonable for prices to reflect any direct or exclusive costs associated with the provision of services. The Commission would therefore expect businesses to recover the efficient cost of providing recycled water, including an appropriate return of and on the recycled water assets, plus the incremental administration, operations and maintenance costs of providing those services.

The ESC recognises however that in meeting mandated targets for recycling, it is likely that water businesses will need to undertake recycling projects that deliver recycled water "at less than cost". However, it also states that:

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[11] As at July 1, 2003

[12] Government Pricing Tribunal of NSW, *'Prices for Special Water, Sewage and Drainage Services for the Rouse Hill Development Area'*, 1993.

[13] AATSE, Water Recycling in Australia, p59

[14] IPART, Review of Metropolitan Water Agency Prices, Issues Paper

[15] IPART, Review of Metropolitan Water Agency Prices, Issues Paper

[16] ESC, Workshop Discussion Paper, Economic Regulation of the Victorian Water Sector, Approach to Pricing

4 Current pricing and regulatory arrangements
continued

- While some recycled water services may be non-commercial in the short term, it the long term, recycled water is expected to become increasingly competitive and so prices would expect to become more cost-reflective with any contributions by non-users to be phased out.
- In the interests of minimising any impacts on customers in general, it would be prudent for the businesses to prioritise recycling projects to meet any mandated targets on the basis that new schemes should only proceed where it can be demonstrated that they provide net benefits to the community (having regard to social and environmental costs and benefits) or achieve explicit targets set by Government at lowest net cost.
- In recovering costs for recycled water schemes, a combination of polluter-pays, user-pays and beneficiary-pays principles should apply whereby:
  - Costs of treating wastewater in order to comply with discharge licence standards should continue to be met on a polluter-pays basis through sewage tariffs and charges;
  - Prices for recycled water should be based on an assessment of demand and supply including what the market will bear; and
  - Any revenue shortfall arising from schemes required to meet mandated targets should be recoverable from the broader customer base (as indirect beneficiaries of recycled water schemes) based on usage.

ICRC – Independent Competition and Regulatory Commission

The ICRC (ACT) has also shied away from directly setting prices for recycled water, focusing instead on appropriate principles:

Currently, the Commission has not set the price for reuse water taken from the outfall of the LMWQCC (after treatment) and used for irrigation purposes, other than to note that it should at least meet the incremental cost of supplying the water from the treatment works. However, should there be further implementation of water reuse projects, the Commission will need to consider the need to directly regulate the price of reuse water as well as assess the cost-efficiency of alternative reuse projects designed to meet the ACT Government's objectives[17].

4.3.2 Conclusion

While there has been limited regulatory intervention in setting prices for recycled water the past, there is now a clear trend for independent regulators to get more involved in ensuring prices for recycled water – even if specified in contracts – adhere to certain principles. In doing so, regulators may increasingly seek access to terms and arrangements of recycled water supply contracts. In undertaking their roles, regulators may also require water authorities to demonstrate the triple bottom line benefit of such projects.

The increasing involvement of independent economic regulators in the industry underscore the need for water authorities to develop sound underlying principles for pricing of recycled water, that are likely to be acceptable to regulators. Further impetus for this has come from the National Water Initiative (NWI), signed by most States and Territories[18] which requires jurisdictions to develop pricing policies for (metropolitan) recycled water and stormwater that are congruent with pricing for potable water, and stimulate efficient water use no matter what water source, by 2006.

[17] ICRC, Inve3stigation into prices for water and wastewater services in the ACT, Final Report and Price Direction, March 2004.

[18] Excluding Western Australia and Tasmania

5 Pricing principles

5.1 Pricing objectives

The development of principles and guidelines for pricing recycled water first requires that the underlying objectives be clearly articulated and any trade-offs between them understood.

The objectives most relevant to pricing of recycled water are those that relate to ensuring that society's scarce resources are used 'efficiently'. Among the objectives that flow from this are the desirability of signalling costs to users to encourage appropriate consumption and investment decisions, revenue adequacy and simplicity of administration (as nominated in the brief).

Also in the efficiency category are aims such as appropriate management of risk and the maintenance of incentives for improving performance. Appropriate environmental care fits generally under the efficiency heading too.

In addition to being efficient and ensuring financial viability, it is often argued that pricing structures should be fair or equitable.

Economic Efficiency

Economic efficiency is commonly seen as comprising:

- Productive efficiency: that firms have incentives to provide services at the lowest possible cost or inputs are minimised for a certain level of output.
- Allocative efficiency: that resources are utilised in such a way as to provide the maximum benefit to society.
- Dynamic efficiency: that firms have the appropriate incentives to invest, innovate, improve the range and quality of services, increase productivity and lower costs over time in response to technological change and innovation in management

In the context of the current study, efficient prices for recycled water and other water services will be those that balance supply and demand at the lowest long-term net community cost. This can also be thought of as ensuring that water services are provided in a manner that maximises the value of water and other resources (eg the environment) to society. In this sense the frequently cited objective of encouraging the efficient and beneficial use of the most sustainable, fit for purposes source of supply – regardless of source – is one about economic efficiency.

Marginal cost pricing

In order to ensure economic efficiency, prices for services need to signal the efficient economic cost of their production, so that consumers will only purchase an additional unit of that service (eg water) if they value it sufficiently to justify the extra costs associated with its supply. This leads to the principle of marginal cost pricing: that prices for an additional unit of usage should be set to reflect the change in total cost that results from increasing production or supply by an additional unit. If prices are set below (above) the marginal costs of supply too much (little) of that service will be consumed, in the sense that an opportunity to increase net benefits by consuming less (more) of the service would be lost. As discussed further below, however, defining the appropriate concept of and measuring marginal cost in practice is not straightforward.

Another complication is that marginal cost pricing may exacerbate distortions in consumption decisions where the price of a close substitute diverges from its marginal cost. Thus suggestions have been made that because potable and irrigation water alternatives are often priced below their true costs of supply, recycled water should also be subsidised in order that efficient choices between alternative sources of water are not distorted (Some counter-arguments are discussed later.)

Suffice to say for now, however, marginal cost pricing will on the whole ensure efficient use of existing water resources and associated infrastructure, and appropriate long-term investment in the water industry. It is these objectives that underpin the focus of the NCP pricing principles and those of independent economic regulators on ensuring that water users face appropriate signals as to the costs of supply (eg through consumption-based charging and removal of subsidies and cross-subsidies).

Revenue adequacy

In any pricing regime, it is important that sufficient revenue is generated by water businesses to ensure the financing of the efficient supply of water services. This means that the pricing arrangements should cover the ongoing operating and maintenance costs as well as a return on and of (ie depreciation) the assets over the life of those assets.

In the water industry (and other utilities), the nature of costs arising from economies of scale gives rise to particular challenges in balancing efficient pricing with revenue adequacy, since only pricing at marginal cost (especially short run marginal cost) will typically lead to deficits. That

5 Pricing Principles
continued

is, in industries subject to significant economies of scale, at existing levels of demand, marginal cost is everywhere below average costs[19]. Marginal cost pricing alone will therefore not allow total revenues to exceed total costs. The issue then becomes how to recover the fixed costs while minimising any efficiency losses. The widespread adoption of two or multi-part tariffs has been one response to this issue.

A further complication in addressing this objective is that, in the water industry, assets tend to have long lives and minimising long-run cost will often require assets to be installed in advance of demand (eg sizing of mains to cope for anticipated demand, rather than upsizing later as demand grows).

Administrative simplicity/transparency

Clarity and simplicity is another important criterion for pricing – an excessively complicated pricing system will increase administrative costs and potentially blur any price signals to users. It follows that there can be good allocative efficiency reasons for simplicity – eg to avoid pricing arrangements that are so complex that consumers do not appreciate the consequences of individual consumption decisions.

The objective is especially important where prices are regulated. Minimising the information required for the determination of prices will minimise information gathering costs, the scope for strategic behaviour and the potential for error.

Equity

Various social objectives that relate to the personal distribution of resources (embracing concepts such as equity, fairness, support for the disadvantaged etc) are often seen as justifying intervention in pricing. However, there may be many differing and conflicting concepts and views as to what is 'fair', for example equity between different classes of consumers, concerns about ability of low-income customer to pay, minimising incidence impacts of changes from current prices, inter-generational equity etc.

The orthodox economic view is that pricing policy should primarily focus on achieving economic efficiency, with distributional objectives handled separately from the pricing mechanism. There are two main considerations: (a) the trade-off or compromise between the two objectives will be less if distributional concerns are pursued separately from efficiency concerns and (b) distributional aims are usually better pursued with targeted instruments such as means-tested social security payments than through water pricing adjustments. Accordingly, distributional concerns will be regarded as of secondary interest for guiding purposes in this report, with recognition that it is a role for governments to address any concerns about equity via mechanisms such as community service obligations.

Where the pricing separates fixed from marginal costs, there can sometimes be scope for some discretion in respect of the allocation of the fixed costs, for reasons discussed further below. In principle, this may offer scope for achieving some distributional objectives on equity grounds without compromising the prime efficiency requirement of marginal cost pricing of marginal usage. In effect, much of the concerns in item (a) above might be addressable. It does not follow that to do so would be the best approach to an equity objective, for the reasons set out in item (b).

Other objectives

A number of other objectives for pricing can be identified, although they are generally subsets of the objectives identified above.

One that impinges on both the efficiency and revenue adequacy objectives is that the pricing arrangements should reflect an appropriate allowance for risk. In the provision of recycled water, these include the risks of demand not materialising, risks (eg public health) to consumers and, analogously, potential liability in the event of inappropriate use of recycled water that results in adverse public health or environmental outcomes. Estimating future demand growth is likely to be a particular issue in the case of recycled water where markets are immature – and raises important questions of where the risks of misjudging this demand growth should be allocated.

As discussed further in chapter 6, there are various approaches to addressing risk in the pricing of recycled water. Ideally, the price would be a 'risk adjusted" price set on the basis of expected demands and costs based on robust probability assessments. An alternative would be for some or all of the risk to be allocated to users through the contract, such that their costs fall as other user demand grows.

Compliance with the COAG pricing principles and other regulatory requirements could also be viewed as an important objective in its own right. If prices are efficient, they would satisfy CoAG principles.

[19] This is not to say that over the longer run, the next resource augmentation may entail a higher cost source of water.

5.2 General pricing principles

Before considering specific pricing principles and methodologies for recycled water, it is helpful to outline some well-established general pricing principles designed to achieve the foregoing objectives.

5.2.1 Key cost concepts

Marginal costs

Marginal costs can be defined as the total costs of supplying one extra unit of the relevant output. However, marginal cost can vary depending on the time frame in question, and the location and timing of the output (eg peak or off-peak). Marginal cost is best seen as a forward-looking concept in that it looks at what the costs of producing one extra unit would be.

Short run marginal cost (SRMC) is the cost of supplying an extra unit of output when capital is fixed. When there is excess capacity, SRMC will tend to be relatively low, and rise as capacity constraints are reached (reflecting the value placed on the foregone consumption of the displaced customer).

In the water industry, the dominance of fixed infrastructure costs that vary little with output means that short run marginal costs are generally seen as being very low – comprising only variable chemical and pumping costs – at times when capacity constraints are not binding.

Long run marginal cost (LRMC) is the cost of supplying an extra unit of output when capital is variable. Long run marginal cost is often approximated by long run incremental cost (LRIC). LRIC is the present value of costs incurred in meeting a small but permanent increment in demand, relative to the preset value of the demand increment. It reflects the present value of bringing forward or introducing new schemes plus short run marginal costs. LRIC will vary according to the length of time until the next major resource is required.

Average measures of LRIC have also been developed. For example, the approach developed by OFWAT identifies the least cost solution for balancing demand and supply over a given period of time (such as 30 years). The approach recognises that these measures may involve a mixture of capacity augmentation and demand reduction. Average LRIC is defined as the present value of the cost of this optimal mix of schemes, divided by the present value of their contribution to the demand/supply balance.

Both these concepts of marginal cost should take into account not just the direct financial costs of producing the service in question, but also any network and/or broader external effects.

In a multi-product firm, the marginal cost of one extra unit of a product or service can be defined as the change in total costs of producing *all* services arising from producing one extra unit of the service in question. To the extent that producing an extra unit of one particular product or service impacts on the costs of producing the others, its marginal cost may vary from the costs of the resources directly associated with its production.

In addition, from an economic perspective as opposed to a financial or private perspective, the marginal cost of supply should incorporate any external costs or benefits not reflected in the financial costs to the supplier. For example, in the water industry it is often suggested that there are 'negative externalities' associated with the supply and/or use of water that have not been reflected in assessments of marginal cost.

Avoidable costs

Avoidable costs are defined as those that would no longer be incurred if the good or service were not produced. Avoidable cost will be lower than marginal or incremental cost to the extent that there are irreversible costs (such as depreciation and a return on the assets that have no alternative use). As with short and long run marginal cost, the avoidable cost will vary depending on the dimension, scale, and time period of the output in question.

Joint and common costs

Joint and common costs are those that are not directly related to producing any one service or supplying any one or group of users, and are pervasive in most networks. For example, dams and major treatment plants service all types of customers (eg residential and industrial), regardless of location, whereas local distribution assets may be specific to subsets of customers. Similarly, corporate overheads (eg billing and information systems) typically represent a joint cost.

Average/fully distributed costs

Average costs are the total costs of the utility in supplying all customers divided by a defined volume of output.

Where a network provides multiple services to a range of customer groups, fully distributed cost is the direct cost attributable to the customer plus the allocation of the joint/common costs to service categories/customers. This allo-

5 Pricing Principles
continued

cation could be done in such a manner as to equalise average costs, or could be based on an alternative methodology (eg an activity/cost driver analysis). There is however no uniquely acceptable allocation rule from an efficiency perspective. Fully distributed costs are essentially an accounting device that has little to say about the economics of variations in system usage. For the reasons outlined earlier, unit pricing based on either average or fully distributed costs would almost certainly not post efficient price signals.

Stand-alone costs and bypass price ceilings

Stand-alone costs can be defined as the minimum efficient costs of supplying one customer or group of customers alone. In the context of an existing network, stand-alone costs would comprise the costs related only to providing that service or supplying that customer/s, plus allocating *all* the joint/common costs associated with that supply to those customer/s.

Where a customer has an alternative supply to that provided by an existing network, stand-alone cost can be defined as the cost of that alternative - termed here the 'bypass price ceiling'. As discussed below, stand-alone cost represents a ceiling in that prices above this level will induce the customer to by-pass the network supply for the alternative.

Sunk costs

Sunk or unavoidable costs are those that have already been incurred and cannot be avoided by future decisions. The past costs of assets already in the ground are sunk costs that cannot be reversed.

Stranded costs

Stranded costs arise when the (historical) costs associated with existing assets cannot be recovered – most commonly because a more cost-effective means of satisfying demand has emerged, or because growth has not lived up to expectations at the time the scale of the system was determined. An asset may be stranded in this sense, and still continue to operate as planned – with the stranding being implemented in an effective write-down of the asset value and reduction in the associated return on capital. (As long as the sunk costs are such that it is more efficient to use the asset than to incur the new fixed costs of an alternative).

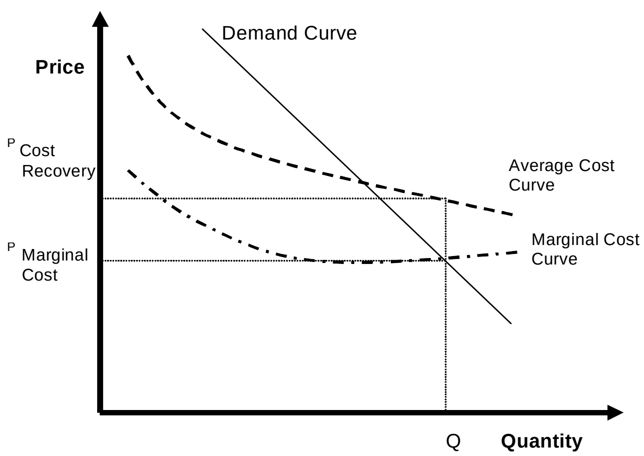
5.2.2 General network pricing principles

In recent years a considerable literature has emerged on pricing principles for services provided by networks that simultaneously promote economically efficient outcomes and ensure the financial viability of efficient suppliers.

Marginal cost pricing and revenue shortfalls

Even before the deregulation and introduction of competition into previously monopolistic utility industries, it was recognised that there were particular challenges in meeting these dual objectives in network industries characterised by economies of scale. In particular, it has long been recognised that marginal cost pricing in these decreasing cost industries, while providing appropriate price signals in relation to short-term consumption decisions, would fail to recover the total costs of the network operator.

Figure 7 Marginal cost pricing in decreasing cost industries



Remedies for revenue shortfalls

Thus, where there are significant economies of scale, marginal cost will lie below average cost, which implies that the infrastructure provider is unable to recover its total costs under SRMC pricing. In order to overcome this problem, a number of alternative pricing approaches have been considered, including lump sum subsidies, two part tariffs, LRMC pricing, Ramsey pricing and average cost pricing.

Two part tariffs

While the water industry has adopted a number of these approaches in the past, as noted in Chapter 4, there is now a convergence towards the adoption of two or multi part tariffs, with the volumetric component increasingly being set with an eye on long-run rather than short-run marginal cost. The fixed component of the tariff is increasingly being based not on property value but as a uniform charge or some indicator of capacity costs (eg meter size). The two-part tariff is designed to send an appropriate price signal to users about the costs of using an extra unit of water, while at the same time allowing recovery of total costs (as determined by the regulator).

A second dimension of the cost recovery issue relates to the allocation of costs between multiple services provided by the network. Typically, water authorities divide their overall revenue requirement at the product level, through some form of allocation methodology based on the assets and other costs attributable to the service in question and some allocation of common and overhead costs. In broad terms, the fixed part of the tariff is based on the residual revenue requirement after estimating the revenue to be received for the volumetric charge in line with demand forecasts. Provided the fixed charge is not set so high as to motivate a user to disconnect from the network (not generally an option with regard to potable water supply), each user will cover the marginal costs of supply and make at least some contribution to the joint/common costs and overheads.

Efficient pricing bands

The so-called Baumol-Willig conditions set out the principles for pricing of services including the allocation of the joint/common costs inherent in networks where there are economies of scale and scope. They are designed to mimic the constraints placed on firms by contestable markets, and state that:

- No price, or set of prices, should exceed the stand-alone costs (SAC) of providing the service or services, where stand-alone costs are determined as the costs that an efficient competitor would incur in providing just that service or group of services.
- No price, or set of prices, should be less than the incremental (or avoidable) costs of providing the service or services, where incremental costs are the additional costs incurred by the monopolist in providing just that service or group of services[20].

These conditions define the 'efficient pricing band' that prices should be set within. The floor price ensures that all services cover their incremental or avoidable costs – which in economic terms means that they are free of subsidy. The ceiling of stand-alone cost ensures that users are not artificially priced off the network.

[20] See Baumol and Sidak (1994)

Importantly, where there are several services these conditions must be applied combinatorially, so that no service, or subset of services, is priced so that total purchase costs exceed stand-alone costs for that subset. If the conditions are not satisfied for any group of services, this will imply either a true subsidy, or incentives for a group of services to break out of the joint supply arrangements and to unravel the revenue adequacy. This requires the network provider to pass on the benefits of economies of scope, and prevents the "double charging" of shared inputs.

5.3 Pricing principles for recycled water

How do these principles apply to the pricing of recycled water?

Clearly, recycled water is one of a suite of products provided by a water and sewerage network, with many costs joint and common with potable water and wastewater treatment services. The question arises as to how these costs should be borne by users of recycled water and how these prices should be structured.

5.3.1 Key cost concepts applied to recycled water

Stand-alone cost and by-pass price ceiling

Stand-alone cost

At the extreme, stand-alone costs could be defined as the costs of servicing recycled water customers only, and attributing all common/joint costs with water and wastewater services to them (including the costs associated with headworks and the potable supply system). This would result in an unsustainable proportion of the total costs of the authority being attributed to recycled customers as opposed to potable water and wastewater customers

By-pass ceiling

A more relevant measure of the threshold price for recycled water customers is the cost of their next best alternative – or the bypass price ceiling as determined by maximum willingness to pay (see chapter 3). The alternative may be potable or irrigation water supply, or indeed no supply at all.

Incremental or avoidable cost

At the other end of the efficient price band, recycled water users should be charged at least the incremental or avoidable costs of their supply. However, defining the relevant measure of incremental or avoidable costs of recycled water supply is complex.

5 Pricing Principles
continued

SRMC

As is the case with potable water, the short run marginal cost of producing a unit of recycled water will also typically be low, reflecting the economies of scale in wastewater treatment and transfer. Most costs are fixed, although some will vary to some extent with output (eg energy costs). As uptake by recycled water users occurs, capacity constraints (in either treatment plant or delivery infrastructure) may eventually be reached. However in many cases the availability of influent is not a constraint (so the long run marginal cost of recycled water does not reflect the costs of bringing forward supply augmentations as for potable water).

LRMC and capital costs

While it is important to give appropriate price signals to users of recycled water about their decisions to use recycled water once a scheme is established, in most cases the critical decisions on prices are made at the time the project is being developed. In that context the relevant incremental or avoidable costs are those associated with the entire project including capital costs.

One way of looking at the incremental costs of a recycled water project would be to attribute all the capital and operating costs associated with treatment of wastewater (over and above the costs required to treat to the standard for discharge required by environmental regulators), together with any other infrastructure specifically required to supply recycled water users (eg transfer pipelines, holding storages etc) to those users.

System wide costs

Taking a broader view, however, a recycled water project can be seen as one element of a total water and wastewater supply system. Under this approach, the incremental costs of a recycled water scheme can be defined as the change in total costs of supplying all the outputs of the system consequent on the additional recycled water project. In this case, the relevant incremental costs of the project may vary depending on whether the project affects the cost of supplying other services – and could, in theory, be negative.

Joint and common costs

As already discussed, it may be quite legitimate for some of the costs of recycled water supply projects to be viewed as joint/common costs to both recycled and mainstream services.

Similarly, many of the costs of the mainstream water and sewerage system could also be viewed as joint/common costs in providing services to recycled water users, given that the supply of recycled water does depend on the availability of influent ultimately sourced from the water and wastewater system.

5.3.2 The efficient price band for recycled water and implications for pricing

Influences on the efficient price band

The economic principle that prices for services provided as part of a network should be within a price band with incremental cost as the floor and stand-alone cost as the ceiling is well established. However, several considerations relating to the nature of recycled water and its interrelationships as part of an overall supply system may both widen and narrow the range of this band (see Figure 8). A number of scenarios are examined in Box 3 and in the case studies.

System wide cost offsets

For most services, the incremental costs of supplying users of those services are appropriately attributable to them under a 'user pays' principle. In the case of recycled water, it is possible that the incremental cost to the system of supplying those users is below that of the direct incremental cost to supply them (or is even negative) because of cost offsets (eg avoiding the need for a treatment plant upgrade).

Environmental impacts

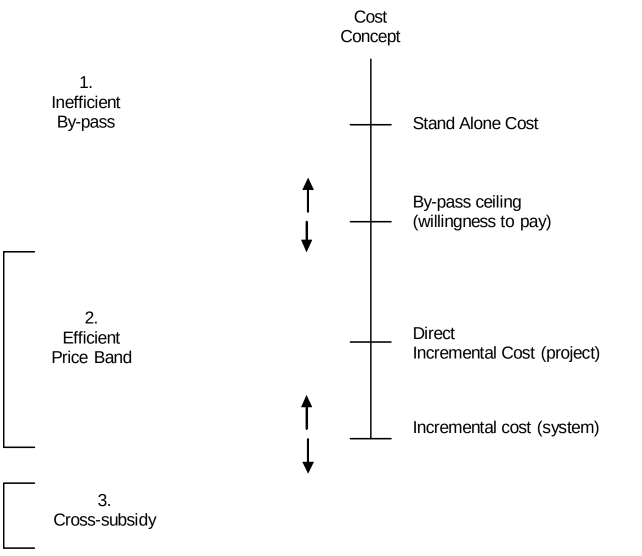
Extending the analysis beyond the business to encompass broader environmental impacts might reduce the "economically efficient" floor even further where there are significant positive environmental impacts due to the recycled water option. It should be noted here that there may of course be other policy options for addressing adverse environmental impacts associated with fresh water extraction, including environmental levies etc. The above 'cost offset' for recycled water would have an effect similar to a levy on non-recycled water in terms of relative incentives to use the two sources. However, they have quite different revenue implications and are quite different in their attribution of environmental costs on a polluter pays basis, discussed further below.

Presence of substitutes

At the top of the efficient price band, the stand-alone cost ceiling may be replaced by the bypass ceiling price and hence be lower than is usually the case for monopoly utility services in that there may be more alternatives to the monopoly product (ie recycled water) that constrain the price which users are prepared to pay before being unwilling to purchase.

5 Pricing Principles
continued

Figure 8 The Efficient Price Band



Polluter pays versus user pays

These considerations also have implications for the incidence of pricing and the applicability of 'user pays', 'beneficiary pays' and 'polluter pays' principles. For example, if the costs of wastewater treatment are seen as part of the wastewater collection and treatment services provided to mainstream users, they would be recoverable from them under 'polluter pays' principles. However, if they are seen as attributable to recycled water users as part of the costs necessary to supply them with appropriate quality water, they would be treated as incremental costs of recycled water supply and recoverable from those users under 'user pays ' principles.

Box 3 The efficient price band for recycled water under various scenarios

Substitution for potable supply with extra treatment required

The first scenario is where recycled water is used to meet a demand that would otherwise be met from normal potable supply. Under the traditional approach, the water supply authority may incur additional costs associated with the bringing forward of new water supply and wastewater treatment capacity, and potentially also in new delivery infrastructure. Under current regulatory frameworks, these costs (possibly excepting new delivery infrastructure which may be funded by customers/developers directly) would be rolled in to the costs recoverable from the general customer base. Thus the incremental costs of meeting the new demand would be met by all water and sewerage users, with

Box 3 (continued)

the effect on average prices depending on whether the cost per kilolitre/customer of the supply augmentations are higher or lower than average costs of the current system. Over the longer run, it could generally be expected that average cost will increase as the lowest cost sources have already been utilised. In addition to these financial costs, supply from traditional sources may also have adverse environmental impacts arising from both additional water resource development and increased wastewater disposal.

In contrast, if the new demand is met by recycled water, the cost of augmenting the water supply and wastewater treatment assets may be avoided, but new costs incurred in upgrading of wastewater treatment and recycled water transfer assets. If the recycled water scheme is seen as an alternative to potable water supply in meeting overall system demand, then the incremental total system costs will depend on the difference between the costs of the two approaches. It is possible that the total system cost of meeting all demand is lower with the recycled water project than it would be with supply system augmentation. Moreover, adverse environmental impacts may be ameliorated that reduce the incremental costs of recycled water at least from a broader society viewpoint.

Using recycled water to meet increasing effluent discharge standards

A second scenario is where wastewater can be diverted to users (treated to existing levels) thereby avoiding the need to upgrade sewerage treatment facilities to met higher effluent discharge standards being set by environmental regulators.

There would be a need for investment in improved treatment in the absence of recycled water customers to take the existing waste. Thus, the incremental costs of the recycled water supply – viewed from a total system perspective – may very well be negative. In this case the floor of the efficient price band would also be negative - it may actually make sense for a water supplier to pay users to take the wastewater, rather than have to invest in upgraded treatment facilities to comply with the regulatory requirements. Even if the standards for effluent discharge are not being increased at present, the likelihood is that they will in the future. Again, there may also be broader environmental benefits under the recycled water option.

Use of recycled water to meet mandated target

Yet another scenario is where recycled water projects are being driven by a requirement to meet a mandated target (eg a specified percentage of reuse). Such targets are being imposed in some jurisdictions. Under an extreme but potentially defensible interpretation, even the costs of the direct recycling assets could be seen as a sunk cost in that meeting the target is mandatory.

5 Pricing Principles
continued

Beneficiary pays

To the extent that the recycled water projects bestow benefits on other parties (eg environmental benefits) a case could be made under 'beneficiary pays' principles for a contribution from the broader community (ie taxpayers) or from the overall customer base. This is really an issue about starting points. If we view the problem as starting with a degraded environment, then the wider community benefits from the recycling project, and may sensibly be a participant in covering the incremental costs of the project – under a 'beneficiary pays' principle. On the other hand, if the starting point is a less degraded environment that has been or will be made or kept worse without the recycling scheme, then a 'polluter pays' logic is more likely to emerge.

In terms of economic principles, there is not a uniquely correct resolution to this problem. As with the earlier discussion of Baumol-Willig bounds, there is a range of cost allocations that might justify the recycling scheme, benefit at least one of the groups and have no group worse off.

Provision of joint products

Indeed, if there is a broader triple bottom line justification, then it may be more appropriate to view the recycling activity as delivering multiple services (joint products) to multiple 'customers' (some as direct parties to a supply contract, others not) – with a need, explicitly or implicitly, to recover enough from this set of beneficiaries to justify the costs. Indeed, this way of looking at the problem is fundamental to finding a sound resolution in the form of an approach to pricing that delivers efficient outcomes. This formulation of the problem leads directly back to the principles developed earlier, with analogous bands for cost allocation across these 'customers'.

System wide perspective

The point here is that any rules for the attribution and recovery of costs of recycled water projects need to take a system-wide perspective in seeking to meet the dual objectives of efficiency and revenue adequacy.

Thus the cost of producing recycled water (ie treating water to the standard required for use) could be viewed as a 'system-wide' cost akin to an augmentation of a dam and part of the costs attributable to all system users, reflecting growth in demand to which all consumers contribute. After all, no-one would suggest that the costs of a new dam should be attributed to the last set of new demand that triggers the need for the capacity expansion. The cost of then transporting this water to end users may however be seen more as directly attributable to those users to reflect the differential locational costs of supply.

Subsidy free if revenue covers incremental cost

Provided that revenue from a service is covering at least the incremental costs of providing that service, it can be said to be subsidy-free. This implies that even if a recycled water project does not generate sufficient revenue from recycled water users to cover the total (accounted) costs of the project it may still be financially viable for the water supply authority from a system viewpoint. Where there are sufficient cost offsets, it would then be appropriate (and efficient) for all customers to contribute to the costs, rather than forego the project.

CSOs

However, where the project is not financially justified from the authority's point of view (but is potentially economically justified because of positive environmental impacts and/or is otherwise deemed appropriate and/or mandated), there is an in-principle case that it be considered a community service obligation. If this cost is instead recovered from the general customer base as a 'cost of doing business', then consideration needs to be given to how this affects the efficient price band for those customers. This approach may only be sustainable because of the monopoly provision of water and sewerage services by the authority. This has implications when these services themselves may become subject to competition via third party access (discussed in more detail in the next chapter).

5.4 Pricing methodologies

Against the background of these principles, a number of alternative approaches to pricing of recycled water can be assessed.

5.4.1 Willingness to pay

Under this approach, prices for recycled water are essentially set on the basis of "what the market will bear", or the 'bypass ceiling price', rather than with reference to the cost of supply, other than the requirement to cover system incremental costs (unless the project is mandated anyway).

As discussed above, this is one variant of stand-alone cost that seeks to extract all the 'consumer surplus' or value placed by users on utilising the recycled water. It will generally entail price discrimination between users, or groups of users, as some will be prepared to pay more than others. In some cases, this may require different prices for different users of the same recycled water (eg where recycled water from a treatment plant is used by one or more of industrial, agricultural and residential users.

While often seen as an exploitation of market power, this may in fact be an economically efficient means of recovering the costs of supplying recycled water.

In practice, discovering 'willingness to pay' is likely to be an iterative process. It is also likely that 'willingness to pay' will change over time in line with growing acceptance of recycled water, increases in the price and/or availability of potable water and other factors as discussed in chapter 3.

5.4.2 Defined percentage of potable price

There are a number of variants of this approach.

Arbitrary percentage of potable price

One is to simply set the price for recycled water as some arbitrary percentage (eg 50%) of the current potable price, in recognition of the fact that users will generally (but not always) require some discount for the usually lower quality and restrictions associated with recycled water.

While administratively simple, one problem with this approach is that it might result in prices outside the efficient price band. It is possible, for example, that the proportion will be set too high, choking off demand even though users would have been prepared to pay a price that at least covered the incremental costs of supply. It is also possible for the proportion to be set too low, encouraging excessive demand that does not cover its incremental cost.

Subsidies and second best

As noted previously, a number of commentators have suggested that the use of recycled water has been impeded by the availability of subsidised potable and irrigation water alternatives. In accordance with the economic theory of 'second-best'[21], it is then argued that recycled water should also be subsidised in order that efficient choices between alternative sources of water are not distorted.

A risk with this approach, however, is that low prices for recycled water may be locked in through long-term contracts while any subsidies for potable and irrigation water are phased out, leaving opposite distortions in the future. Another problem is that water, from whatever source, is but one input into a production process and that subsidised water can distort the choice of technology towards water intensity and also result in excess resources being allocated to water intensive economic activities.

Risk of locking in inappropriately low prices

This highlights the general issue that basing the recycled water price on the current potable price at the time of contract formation may become increasingly inappropriate over time, particularly if the price of potable water increases significantly (as suggested by current policy directions). This may give rise to concerns that an increasingly valuable resource is being "given away" to private interests – particularly if contracts for supply extend well into the future and/or recycled water users have rights to on-sell or trade the recycled water.

One alternative is to link the price of recycled water to the price of potable water, so that increases in the price of potable water automatically feed through into prices of recycled water. However, this may expose users to considerable risk given that the supply authority may have the ability to set its potable water price and/or future movements in price may become highly uncertain.

5.4.3 Full commercial return on project

This approach seeks a full economic return on the recycled water project in its own right (covering a commercial rate of return on all assets associated with the project, operating and maintenance cost etc) directly from recycled water users.

The ability to do so will depend heavily on the willingness of users to pay relative to the direct costs associated with the specific project. In practice, many recycled water projects have to date been unable to achieve this. It could be expected, however that more recycled projects will become commercially viable in their own right as recycled water becomes more accepted and as the price and scarcity of alternative water sources increases.

In any event, it is not necessarily appropriate to seek full commercial returns on a discrete project basis – this gets back to which costs are appropriate to attribute to recycled users. Attempts to recover the full costs of the individual project may in effect result in prices above the efficient price band (ie above the recycled water users' willingness to pay). This might result in recycled water projects not proceeding even though they would benefit the water authority and its existing customers, particularly over the longer term.

To an extent this problem can be addressed by defining the project in terms of the incremental system activities, including consequential changes in the non-recycled system. This essentially results in the floor-ceiling price band solution discussed below.

[21] 'Second best' relative to the textbook 'first best' solution of removing the subsidies. The theory does not however, establish that matching subsidies is necessarily more efficient, than ignoring them. There are situations in which matching subsidies results in a less efficient resource use outcome.

5 Pricing Principles
continued

5.4.4 Fully allocated/distributed cost

A fully distributed cost approach involves allocating the total cost of a business to the different services it provides, including those costs not directly attributable to particular activities.

In usual circumstances the fully distributed cost of a service will lie somewhere between incremental cost and stand-alone cost, depending on the allocation of joint/common costs.

In applying fully a allocated/distributed cost approach to a water supply system that includes recycled water, the outcome may vary widely depending on the categorisation of costs as either directly attributable to recycled and/ or mainstream users and which costs are treated as joint or common to the whole system.

The application of 'rules of thumb' for allocating the joint costs between recycled and other customer groups without reference to willingness to pay may run a very real risk of pricing recycled users out of the market.

To date, typically there has been little attempt to include a contribution towards the common costs of the mainstream water and sewerage network in the prices of recycled water because of constraints on willingness to pay. However in principle there is no reason why such a contribution may not be sought in future as acceptance and willingness to pay increases.

Provided this method yields a solution within the price bands discussed below, it may offer a rationale for the choice of a price point within these bands – it resolves an arbitrariness – but attempting to do so via hard and fast rules may undermine the effective ability to exercise discretion as part of the cultivation of market demand. The effect may be to reduce dynamic efficiency.

5.4.5 Floor-Ceiling price bands

Under this approach, prices are set in the band between incremental cost and stand-alone cost or bypass price ceiling, consistent with the principles discussed previously. Indeed, some of the models discussed above may yield outcomes consistent with the efficient price band.

While consideration of what the relevant floor and ceiling prices may be in relation to the specific recycling project in question can provide useful information within which to frame negotiations, there may be a large gap between the floor and ceiling price and hence many alternative price structures consistent with this approach. Therefore, some further principles and judgments are required to determine where within the band prices are set.

6 Towards pricing guidelines and strategies

6.1 Key considerations in setting the level of recycled water prices

While the principles discussed above provide some broad guidance for the pricing of recycled water, and will generally provide some bounds within which prices should be set or negotiated, they nevertheless leave significant room for judgment or other considerations in determining specific prices to apply in practice (eg where within the efficient pricing band prices should be set). The following discussion identifies some of the key considerations to be addressed in developing approaches to pricing recycled water in practice.

6.1.1 Interrelationship with prices and revenues for other services

A key theme of this paper is that, from an economy wide or social perspective, the pricing of recycled water cannot be sensibly addressed in isolation – it needs to be seen within the context of other services provided by the industry. This is because the introduction of a recycled water project can reduce costs of supplying fresh water (particularly in relation to the need for new capacity), of treating wastewater and the impact on the environment.

Price of substitutes

Perhaps the most frequently cited interrelationship is that of the pricing of recycled water and its direct substitutes – potable water or irrigation water. As was discussed earlier, the perceived subsidisation of potable and irrigation water has led to calls for recycled water to also be subsidised so as to provide better signals to users as to the true relative costs of these alternatives.

While the existence of subsidised alternatives (eg where the price of water does not incorporate externality costs associated with the diversion and use of water) may provide some justification for departing from full marginal cost pricing for recycled water, at least in the short term, several considerations suggest caution with such a policy. A key policy question that decision makers face in these circumstances is whether to purposely introduce another distorted price knowing that (a) this could be a temporary fix or (b) worse than that, it might end up impeding progress towards the removal of the other distortions.

The first best response, in terms of economic pricing principles, is to remove the original distortion by eliminating any subsidies for potable and irrigation water, rather than to introduce a further distortion by subsidising recycled water. Encouraging excessive use of recycled water (as arguably occurred at Rouse Hill) may itself result in adverse impacts associated with salinity, wastewater disposal etc. As observed earlier, COAG and other reforms are leading to more efficient pricing for water and progressive removal of subsidies, and there is a strong expectation of further increases in water prices in the future in some systems. This suggests an approach of pricing for recycled water in a way that broadly tracks the prices of substitutes, but not locking in artificially low prices for a long time into the future.

This does not mean that 'demonstration sites' and 'loss leading' pricing cannot have a legitimate function, where there is an acceptance barrier that might take time to eliminate – though the risks should be recognised and subject to a sound 'business' case.

Overall revenue requirement

Another link between prices for recycled water and mainstream services comes via the process for recovering the overall costs or revenue requirements for the water business, whereby any financial deficit on an individual recycled water project is often then rolled in (perhaps with a lag) to the revenue to be recovered from the general customer base. Thus, to the extent that regulators allow the costs of recycled water projects to be included in the cost base, any shortfall in funding from recycled water users not offset by other savings would flow through to higher water and sewerage charges in the next period. If this were not the case, the substitution of recycled water for existing potable water use could result in the loss of revenue associated with the potable water user – including a contribution to the joint/common costs of the system, raising questions about revenue adequacy. Provided that these arrangements leave the mix of service prices within the Baumol-Willig bands, the outcome can still be efficient and financially viable.

6 Towards pricing guidelines and strategies *continued*

Impact on general customer base

Where the supply of recycled water represents a relatively small proportion of the total supply, and where financial deficits are low (because recycled water users have a relatively high willingness to pay and/or because the schemes do in fact represent the most cost-efficient means of meeting demand) then the impacts on prices for the general customer base are likely to be small (ie little or no subsidy is needed for the project).

In general, where there is potentially significant loss of revenue from existing potable water customers, where recycled water is a larger share of total supply, and where recycled water schemes are being mandated because of benefits that fall outside the authority and its customers), then the price impacts on potable water customers may be significant. Where the general customer base is captive to an incumbent monopoly supplier, these costs will be ultimately borne by those customers. However, as is discussed in more detail below, if there are opportunities for by-pass via competition from alternative supplies, a ‘stranded asset’ risk may emerge for the water authority.

6.1.2 Commercial, market development and risk management strategies

Long term strategies to grow market

The market for recycled water (and that for bio-solids as a possible by-product) is still in its infancy. This needs to be reflected in approaches to pricing. In particular, pricing of recycled water needs to address commercial, market development and risk management considerations, rather than a mechanistic application of an inflexible methodology.

In the early stages of this market, recycled water schemes are often characterised by significant uncertainties and inherent conservatism on the part of users or potential users. For water authorities, this translates to significant risk in forecasting the extent and speed of uptake of demand for recycled water and, as a result, in commitment to significant up-front investments.

The state of the market is likely to be a key determinant of whether prices are set at the lower end of the efficient price band (ie just covering system incremental costs) or towards the higher end (where recycled water users make an increasing contribution to joint/common costs). Such judgments, however, will need to be made on a case-by-case basis.

In making such decisions, it would seem sensible to take a long-term view or strategy that plans to help grow the recycled water market and thereby maximises throughput over time to enable recovery of the cost of the assets over their lives. Commercial judgments will be important here. In some cases this might suggest erring on the side of lower rather than higher prices in the early stages of a market (eg where recycled water is to be used in new uses) in order to encourage first comers as a way of engendering broader market confidence. In other cases, where the use of recycled water in particular uses or locations is already well accepted, higher prices may be more readily achievable. In this sense, the upper bound or bypass ceiling determined by willingness to pay can itself be significantly influenced by the actions of the water authority in its marketing and consultation activities.

In the early stages of a project, there is likely to be a ‘surplus’ supply of recycled water relative to demand. Over time, however, if demand can be cultivated, competition for the recycled water resource may emerge, implying a greater scarcity value and higher willingness to pay. Clearly, development of the market is in the interests of both the water authority in recovering its costs and also ultimately of potable water customers in minimising any financial burden of funding projects that generate significant deficits or whose future might be threatened.

Risks to water authorities

There are nevertheless likely to be some significant risks for water authorities (and hence their customers) associated with many recycled water projects. Such risks should of course be factored into cost-benefit and financial assessments as part of evaluation of the project in the first place. In some cases, of course, the high risks may (appropriately) render the project non-viable.

Stranded assets

These include the risks of ‘stranded assets’ reflecting the fact that recycled water projects may entail commitment to substantial capital investments – both by the water authority and by the recycled water user – that are dependent on the other. Thus the recovery of costs of treatment plant and distribution assets installed by a water authority may depend on the development and maintenance of a given level of demand for recycled water. For some forms of water recycling these risks can be exacerbated by the rate of technology development that could undermine the competitiveness of even a recent technology.

6 Towards pricing guidelines and strategies *continued*

Moreover, if users stop taking recycled water, and the authority cannot find an alternative market, it may be left with the problem of how to dispose of the additional wastewater – and the cost of doing so. For example, a water recycling project may be built as part of a total water cycle management approach. Because of the recycling project, there is less capacity to deal with the treatment of unwanted wastewater. However, if demand for the recycled water ceases, the wastewater needs to be diverted to the wastewater treatment plant which may then have insufficient capacity to appropriately treat the wastewater before disposal. This is particularly likely where the planned uses for the recycled water involved substantial use that would not return ultimately through the sewerage system – such as irrigation usage.

For water users also, recovery of investments in production assets that utilise recycled water may depend on the ongoing supply and cost of recycled water.

Potential liability

Another risk relates to potential liability in the event of inappropriate use of recycled water that results in adverse public health or environmental outcomes – mirrored by the risk to users of such adverse outcomes.

Long-term contracts for supply represent one way of managing some of these risks and providing some certainty and stability. In this regard it has been suggested that it is important that a positive price be paid for reclaimed water from a legal point of view in order that the provision of such water constitute a legal contract[22]. Arguably however, if the water authority actually paid the recycled water customer to take the wastewater, this could be presented as the recycler performing a waste treatment service for the water utility.

Commercial contracts to manage risk

This again highlights the earlier observation that, particularly in the early stages of the recycled water market, the price setting context is likely to be one of commercial negotiation between the utility and potential users of recycled water. This stands in contrast to one of determining a tariff for a generally homogeneous water/wastewater service supplied through an integrated network. In this sense, the 'price' for recycled water needs to be seen in the context of the overall supply agreement as a mechanism for managing risk over the life of the project. Take or pay contracts with variable take are common in long term contracts where both parties are subject to sunk costs and opportunistic behaviour.

Some of the key issues that arise here in considering the price of recycled water include not simply the initial price for taking recycled water but also the length of the contract, the provisions for adjustments to prices (ie a price path) during the contract, and the rights of ownership attaching to the recycled water. Contracts would also need to be consistent with competition policy principles.

As noted in chapter 4, typically contracts for the supply of recycled water have been set for ten years or more, often at zero or low prices. Long-term contracts are an appropriate means of managing risk, particularly for recycled water schemes where the scheme involves commitment to capital assets where there are few or no alternative uses/users for the recycled water should contract customers cease taking it. However, locking in artificially low prices for recycled water for a long time into the future may result in significant windfall gains to recycled water users if the value of this resource increases significantly over time.

Property rights

A related issue here is whether the supply of recycled water connotes ownership of the resource and whether the recycled water user has the right to re-sell the product. Property rights over recycled water may be less clear than those for water. From a pricing point of view this is also important because ability to charge different users according to what they are willing to pay – and potentially the viability of the project - will be substantially undermined if a user has the ability to on-sell. The ability to on-sell though is an important method of introducing competition through the development of secondary markets. Restrictions on resale may be inconsistent with the Trade Practices Act, although in this case there may be issues relating to public health and safety that dictate the need for a direct contractual relationship between the supplier and the user.

Capital contributions

Another means of managing risk is the levying of up-front payments or capital contributions to the funding of the infrastructure. This has been a common practice in a number of areas. Inclusion of early termination payments into a recycled water supply agreement can also help a water authority manage the risks of stranded assets. Take or pay provisions are also an important method of reducing demand risk, although price will be lower in order to compensate the customer for bearing this risk.

[22] Russell Kennedy, The Reclaimed Water Agreement Manual, May 2004

6 Towards pricing guidelines and strategies *continued*

6.1.3 Mandated recycling targets versus ‘voluntary’ or ‘commercial’ schemes

The brief for this project specifically require consideration of the implications for pricing of different drivers of the use of recycled water and in particular if recycled water is offered voluntarily by the water supplier as an alternative product or is being undertaken in response to a regulatory target.

Cost effective means of meeting voluntary targets

In the absence of mandated regulatory targets for reuse (such as the 20% target for metropolitan Melbourne espoused by the Victorian Government), a water authority pursuing its commercial interests would have incentives to implement recycled water solutions only where these added to the profitability of the utility. That is, a recycling scheme would only be introduced if it represented the most efficient long-term option for balancing supply and demand while meeting its general regulatory obligations (eg effluent discharge licence conditions). In effect, the cost of the next best alternative means of supplying – or saving – a unit of demand represents the value of the recycled water to the authority (and is the maximum price an authority would pay if purchasing a recycled water service from another party).

Revenue adequacy

From an efficiency viewpoint the prices for recycled water – and indeed for water and sewage services – should be set to fall within their relevant efficient price bands while together recovering the overall costs of the business.

Significantly, however, as discussed previously, this does not necessarily imply that prices for recycled water should be set in a way that recovers the ‘full economic costs’ of the specific project solely from recycled water users. Rather, the extent to which a project recovers its own financial costs will depend on how far towards the bypass price ceiling prices are set and how the resultant revenue compares to the financial cost of the project.

Social benefits can justify subsidy

Clearly, many recycling projects to date have been encouraged by governments and would not have been undertaken by the water authority on its own volition because they are not justified solely in terms of the costs and benefits accruing to the authority and its customers (as customers). Implicitly at least, there are seen to be broader (social) benefits (eg improved environmental outcomes) that justify the difference – and which could be cited in support for a case for explicit government subsidy ideally as a community service obligation.

Targets may lower the floor price

While an assessment of the merits of such policies is beyond the scope of this project, the fact remains that such schemes may impose additional costs on water authorities and their customers relative to alternative approaches to balancing supply and demand. This does not alter the basic principles for pricing of recycled water (and other services). It may, however, lower the floor of the efficient price band for recycled water users (since all costs associated with meeting the recycled water use target could be viewed as ‘sunk’). The existence of specific targets may also give strong incentives for potential users to understate their willingness to pay if they anticipate that the authority will have to proceed with the scheme anyway in order to comply.

Passing costs to general customer base

A possible consequence is that where projects are primarily driven by the need to meet regulatory targets, there is a greater likelihood that more of the costs will be passed onto the general customer base. In the absence of direct government funding (see below), it would be appropriate that regulators 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’. To the extent that the schemes are seen as providing a broad public benefit (eg improved environmental outcomes), such an approach might also be seen as consistent with a ‘beneficiary pays’ principle.

The broad customer base may be seen as a reasonable proxy for the ‘public’ – except that water use varies significantly across customer groups. In some cases, of course, there may be a significant mismatch between those who consume water and sewerage services and those who are most impacted by environmental impacts downstream of these activities. Moreover, unless care is taken to square this with policies towards competition (eg third party access conditions), the transfer of costs to the broad customer base raises potential for inefficient outcomes and commercial risks to water authorities (see below).

Direct funding through CSOs

Alternatively, water authorities may legitimately seek direct funding from government for such schemes as a ‘community service obligation’ (CSO). The recycling projects could be interpreted as supplying an environmental service appropriately charged to the beneficiary – the general public. This approach too may have problems as different levels of subsidy are provided to schemes based on whether they are classified as ‘commercial’ or ‘mandated’ or whether they are scheduled for implementation before or after reaching the target.

6.1.4 Competitive sustainability and third party access

The principles and guidelines for pricing recycled water – and hence other services – also need to be robust to changes in the regulatory and competitive environment, particularly the increasing prospect of competition in supplying services traditionally provided by vertically-integrated monopoly suppliers.

While the water and sewerage industry has not been subject to the restructuring and competitive market reforms that governments have undertaken in the energy, transport and telecommunications sectors, it nevertheless is subject to the general provisions of competition legislation.

Competition through access

In particular, Part IIIA of the Trade Practices Act establishes a national access regime whereby new entrants in contestable segments of the industry may be able to compete with incumbent suppliers by gaining access to the services provided by the 'bottleneck' facilities characterised by natural monopoly (eg trunk mains). Indeed, the National Competition Council has recently issued a draft recommendation to accept an application for an access declaration by a private firm to Sydney Water's sewerage network (see Box 4).

Box 4 Third party access in the water and sewerage industry

Services Sydney, a private infrastructure development company has for some years been canvassing a proposal for wastewater treatment and management known as Sustaining the City. The key elements of its proposal claimed to offer significant environmental benefits are:

- The establishment of a state-of-the-art water reclamation plant with integrated biosolids handling and additional wet weather overflow storage facilities;
- New trunk main sewers for the transmission of sewage to interconnect with Sydney Water's reticulation network at points just before the main trunk sewers connect with each of the North Head, Bondi and Malabar sewage treatment plants; and
- The construction of water conduits to return tertiary treated water to Sydney's catchment dams or for other uses such as agricultural or environmental flows.

In March 2004 Services Sydney submitted an application to the NCC for third party access to Sydney Water's wastewater infrastructure under Part 3A of the Trade Practices Act in order to be able to compete for the provision of retail sewage collection services in Sydney. This part of the Act enshrines the national access regime designed to promote competition in upstream or downstream markets by providing rights of access to monopoly 'bottleneck' infrastructure (such as transmission grids).

Under the Act, a service can only be 'declared' if:

- Access, or increased access, to the service would promote competition in at least one market other than the market for the service;
- It would be uneconomical for anyone to develop another facility to provide the service;
- The facility is of national significance (having regard to the size of the facility, the importance of the facility to constitutional trade or commerce, and the importance of the facility to the national economy);
- Access to the service can be provided without undue risk to human health or safety; Access to the service is not already the subject of an effective access regime; and
- Access to the service would not be contrary to the public interest.

If a service is declared, the access seeker has the right to negotiate terms and conditions for access with the facility owner. If agreement cannot be reached, the access seeker can seek binding determination by the ACCC.

In its draft recommendation in August 2004, the NCC found that the criteria were met and recommended that the nominated services for the transportation of sewage and for connection of new sewers be declared for a period of 15 years.

6 Towards pricing guidelines and strategies *continued*

The real prospect of competition from new entrants has potentially far-reaching implications for the incumbent water suppliers in the industry[23]. In particular, the key issues raised by the possibility of access concern the existence and sustainability of cross-subsidies and interaction with the regulatory regime.

Competition puts pressure on cross subsidies

Cross-subsidies may exist between different classes of customers, customers in different geographic locations, and possibly between customers of different sizes. The adoption of pricing reforms that lead to more cost-reflective tariffs may help to protect against "cherry-picking" of customers by third party competitors solely on the basis of pricing cross-subsidies rather than underlying efficiency. However, they may also open controversy over the unwinding of existing cross-subsidies.

Risk of stranded assets

Also relevant is what implication the introduction of competition carries for the operation of the existing regulatory regime. A "building blocks" revenue requirement is essentially an average cost approach whereby costs are averaged over the customer base as a whole. Competitive systems carry the possibility of "stranded assets", whereby assets installed to serve one set of customers have to be written down should those customers, or a significant proportion of those customers, be lost to another supplier. They also raise the possibility that these assets values will need to be written down pre-emptively, as a commercial response to the threat of competition based on a different technology or cost structure.

Competition inconsistent with cross subsidies

In respect of the pricing of recycled water, one issue of potential concern is that an approach that simply presumes the financial shortfall on recycled water projects can be passed on to the remaining customer base may not be sustainable where competition for services to those customers becomes feasible. The concern here is that if there is not a 'level playing field', a new entrant supplying water or wastewater treatment (eg via third party access) may be able to undercut the incumbent simply because they are not carrying the costs of meeting the mandated recycled targets. This may lead to both inefficient outcomes, possibly including artificially 'stranded assets'. It could be the case that a vertically integrated incumbent has a customer base over which to spread the costs of the recycled water project and thereby subsidise recycled water prices to thwart competition from new entrants.

There are several possible ways of addressing these concerns:

- Arguably the cleanest is to provide direct funding (via community service obligations) for the cost imposts of such mandated schemes.
- Another option is to ensure that other potential competitors are subject to similar regulatory obligations, or that prices for access to water/sewer networks incorporate a contribution to the financing of these costs via adopting the efficient component pricing rule for access or by simply having an industry levy as in Australia's telecommunications industry.
- Unbundling or ring-fencing of potentially competitive elements of the supply chain from the monopoly network components is another option.

The key point, however, is that policies towards recycled water and towards competition and regulatory reform should be developed by governments and regulators in an integrated fashion.

Need integrated policies

The NCC decision underscores the importance of the water businesses retaining flexibility within the regulatory frameworks within which they operate to respond to competitive challenges. At the same time, the prospect of direct competition – now more likely as a result of the NCC's draft decision – suggests that the existing industry participants may benefit from being more proactive in preparing for such an eventuality. In particular, water authorities need to be able to 'unbundle' the costs and prices of different elements of services (including recycled water) that are currently 'bundled' together as final products delivered to the end customer.

Of course, the same competition may lower the upper limit of the recycled water efficient price band.

[23] For a fuller discussion, see WSAA (1999)

6.2 Structure of recycled water prices

Once the broad level of costs to be attributed and subsequently recovered in recycled water charges has been determined, the next question to address is the structure and incidence of recycled water charges. As noted in Chapter 4, charges for recycled water include those for the ongoing supply of recycled water itself, charges for subsequent treatment and disposal of any recycled water after use, and up-front capital or developer charges in relation to the particular project.

Several considerations are relevant to determining the appropriate balance between the fixed and variable components of ongoing charges and up-front charges. In essence, the challenge is to structure prices so that as far as possible appropriate signals are sent to users about the cost implications of their consumption, location and other decisions, while meeting revenue adequacy requirements. An important part of these considerations relates to the allocation of risk between various parties, including the authority and particular customers and customer groups.

6.2.1 Recurrent charges to users for the supply and disposal of recycled water

Considerations in setting tariffs

In determining the level of the volumetric rates, considerations include

- Providing appropriate signals as to the cost of providing additional water (ie the long run marginal cost of potable and recycled water);
- Ensuring customers have sufficient control over the level of their bill (which assists with equity considerations); and
- Ensuring an appropriate relationship between the volumetric rates for potable and recycled water, to avoid perverse incentives (eg using the recycled water for inappropriate purposes).

The level of services charges will need to be determined in the light of:

- The level of revenue needed to cover costs and ensure financial viability; and
- Providing an element of revenue stability.

Volumetric tariffs to reflect LRMC

As discussed in Chapter 5, efficient pricing generally requires that usage prices for services reflect the marginal costs of their supply. In principle, this would suggest that the volumetric price for recycled water should approximate marginal cost in order to send appropriate signals to recycled water users about their decisions to use recycled water.

As is the case with potable water supply, many of the costs associated with provision of recycled water are fixed, at least in the short term. Some costs –such as energy for treatment and pumping – may vary to some degree with output, while over the longer term the cost of expanding capacity (eg the next modular addition to treatment capacity) may become important as demand increases.

Where costs are driven by peak demand (eg the size of mains), there may be merit in considering seasonal tariff structures that distinguish between the marginal costs of supplying recycled water at peak and off-peak times/seasons.

There may be a range of factors that affect the cost of supplying particular users with recycled water services that are appropriately reflected in the structure of tariffs. These might include differential locational charges (eg based on proximity to pipelines to deliver the recycled water), capacity-based charges reflecting the impact of users' demands on overall capacity, different prices to reflect different levels of service (eg reliability of supply, pressurized versus gravity-fed supply etc).

Avoid perverse incentives

Sending the appropriate signals to users in the volumetric price may need to consider costs or potential costs of using recycled water that extend beyond the direct supply costs to the authority. Setting a very low volumetric price – or at least a low price relative to the alternative (eg potable water) may encourage the use of recycled water and assist water authorities to meet re-use or demand management targets. However, there is a risk that it may also encourage perverse behaviour, such as profligate use of water (counter to broader water conservation objectives), which may have adverse external impacts (eg salinity). It may also encourage use of recycled water for inappropriate uses (eg illegal and potentially dangerous cross-connections). Such outcomes would of course be quite inimical to the key objective of more sustainable water resource management to which recycling is intended to contribute.

6 Towards pricing guidelines and strategies *continued*

Two part tariffs

To the extent that there is a shortfall between the revenue to be recovered directly from recycled water users and that generated (or expected to be generated) via volumetric charges, there is a case for a two-part tariff including a fixed component not based on metered volumes. In determining such access charges, willingness to pay will be a key consideration.

In cases where recycled water is returned to the wastewater treatment and disposal system after use, there is a case for similar charges to apply to recover the incremental costs and a contribution of common/joint costs of the system shared with mainstream sewerage customers – again with willingness to pay being a key consideration.

Risk and revenue stability

Another consideration in the balance between fixed and variable charges is the issue of risk and revenue stability. As noted above, investments in recycling assets may entail a higher degree of risk than those for standard water and sewerage services, particularly in relation to demand risk. Various ways of addressing these risks in the pricing of the product have been suggested.

One possibility would be to factor in a higher cost of capital (WACC) to apply to the assets associated with recycling projects. However, adoption of differential WACCs to reflect specific risks rather than systematic market risks has not been favoured by regulators.

The preferred approach is to factor in the demand risks into the forecasts of volumes that underpin the calculation of unit prices. In particular, use of expected values for demand forecasts reflecting the probabilities of different demand scenarios is a more appropriate way of dealing with asymmetric risks than use of most likely (ie modal) values.

Where a failure of the forecast demand to eventuate would lead to major losses, the incorporation of the cost of an insurance premium into the costs attributable to the project is another mechanism to reflect the risks in prices.

Risk considerations may favour tilting the balance of fixed and variable charges to recover a higher proportion of costs in fixed charges (or up-front payments as discussed below). At the same time, however, care should be taken not to set the volumetric pries so low as to encourage inappropriate behaviour as noted above.

The ultimate incidence of the risk associated with recycling projects will depend heavily on the regulatory framework within which the business operates. In many cases, any shortfalls resulting from unfulfilled demand forecasts for the uptake of recycled water may end up being recovered from the broader customer base, rather than the shareholder.

6.2.2 Developer charges for recycled water projects

As noted in Chapter 4, developer charges and other up-front capital contributions are often delivered by water authorities in respect of both potable and recycled water infrastructure required to service a new development/project.

The appropriate role and level of developers charges for recycled water schemes needs to be considered in the context of both the role of developer charges generally, and the balance between developer charges and recurrent charges to users in recovering costs for specific recycling schemes.

Role in signaling locational costs

Although there is considerable variation in the application and calculation of developer charges in different jurisdictions, typically they are seen as having a role in signaling to potential developers the costs associated with developing in different locations.

Particularly in an environment where 'postage stamp' pricing has been imposed, developer charges can be seen as bridging the gap between tariff revenue derived from these 'average' prices, and the incremental costs associated with a new development. While the case for incorporating the costs of new link mains etc within developer charges has been generally accepted by regulators, the inclusion of upstream assets (particularly in relation to 'sunk' assets) has been more controversial.

Assists in managing risks

Up-front charges may also represent an effective means of managing the risks associated with supply of services (including recycled water) to a new development/project. From a water authority's point of view, the risk of 'stranded assets' may be significant when the extent and pace of future demand associated with a particular development or project is uncertain.

Need for consistent approaches for mainstream and recycled services

While it is beyond the scope of this project to determine the appropriate role and content of developer charges generally, some general statements of principle for developer charges for recycled water projects can be made. In particular, there is a strong case for consistent approaches to developer charges for mainstream services and developer charge for recycled water schemes in order to maintain appropriate locational signals. This may mean differential developer charges depending on location relative to potable water supplies and relative to wastewater treatment plants and consequent need for and scale of new transfer infrastructure.

Justification for discounting developer chares for recycled schemes

Developer charges for developments serviced by traditional potable and wastewater systems often include the costs of advance capacity and new capacity of upstream assets.) Without examining the merits of this approach for standard developments, it would not seem appropriate to include these in relation to recycled water schemes. While these schemes may entail new capital in terms of treatment plants and delivery infrastructure, typically they have minimal impacts on the need for additional capacity in the headworks and potable water supply system. This provides justification for the practice of 'discounting' standard developer charges in the case of developments utilising recycled water.

Avoid double counting

As with developer charges generally, there is also a strong case for the relationship between up-front capital contributions and recurrent user charges to be made clear and to avoid 'double-counting' in the recovery of costs.

6.2.3 User costs

A range of user-related costs may be incurred in order to access and utilise recycled water depending on the nature of the scheme, including conversion of equipment, internal house plumbing, installation of water tanks etc.

Generally these costs are borne by the users themselves, which create incentives for them to be minimised and factored into willingness to pay and for the most cost-effective solutions to be adopted. It is however possible that there may be a case for these costs to be subsidised in some cases (by government or by the water authority), particularly if these user costs are barriers to the implementation of schemes that are likely to represent effective long-term options for meeting the supply-demand balance. This would be analogous to the subsidy arrangements that some utilities apply to demand management investments.

6.3 Implications for regulation of recycled water

Both the level and structure of prices for recycled water will be increasingly affected by the approach adopted by independent regulators. A key question is when and how regulators should intervene in the pricing of recycled water.

The basic rationale for economic regulation stems from concerns about the scope for the exercise of market power in respect of the prices and services provided by monopoly suppliers.

In many cases, users or potential users of recycled water will have no alternative other than to deal with a monopoly incumbent supplier. This may justify a role for regulators in overseeing prices of recycled water, for example to protect against arbitrary increases in prices charged by the authority once a user has committed capital dependent on access to the recycled supply. In other cases, however, users may have alternative sources of supply or may have considerable countervailing power as a buyer (eg a large, and possibly mobile, industrial customer, or a collective of agricultural producers). Regulators will also have a legitimate interest in verifying that any mandated recycled water projects undertaken are efficient in meeting underlying obligations or targets, particularly where the revenue from recycled water users leaves a financial shortfall to be funded by other customers and/or CSO payments.

Light handed regulation appropriate

These considerations, together with the pricing principles suggesting that recycled water prices should fall within the range defined by an efficient pricing band, give support to the continuation of a relatively light-handed approach to the regulation of prices for recycled water. This augurs for an approach where regulators require adherence to specified principles rather than prescribing specific prices or directly intervening in commercial arrangements.

While it is important to have sound general principles in setting prices, regulators should recognise that their application to different recycled water schemes may result in widely varying outcomes.

Regulatory principles

The discussion in this report also suggests a number of other matters that should be reflected in regulatory decision-making with respect to recycled water prices:

6 Towards pricing guidelines and strategies
continued

- If uneconomic recycled water projects are mandated, it would be appropriate that regulators 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;
- Prohibition of price discrimination between recycled water users may undermine efficiency/cost recovery objectives;
- There is a strong case for transparency over the costs of recycled schemes and any associated cross-subsidies, particularly where schemes are implemented because of regulatory mandate, rather than being the most efficient means of meeting the system-wide supply-demand balance.

6.4 Summary of principles and guidelines for pricing recycled water

The discussion in this report leads to a number of principles for the pricing of recycled water:

- Prices for recycled water should be set within a price band, with (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 (ie 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 not locking in artificially low prices for an unnecessarily long time into the future.
- Prices for recycled water should be set as part of a longer term pricing reform strategy encompassing the suite of products provided by the industry (rather than a short-term position based on current charges for potable water and other services).
- In the case of mandated targets, 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.
- While regulators have a legitimate interest in overseeing prices of recycled water and the efficiency of these schemes, such regulation should be light-handed to provide appropriate flexibility in pricing (eg an approach where regulators require adherence to specified principles rather than prescribing specific prices or directly intervening in commercial arrangements), particularly where users have alternative sources of supply or considerable countervailing power as a buyer.
- 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.
- Policies towards recycled water and towards competition and regulatory reform should be developed by governments and regulators in an integrated fashion.

Key elements of a pricing approach

While the particular circumstance of each recycling project will vary, the key elements of determining an approach to pricing will involve:

- Understanding the market and willingness to pay;
- Understanding key elements of the costs and benefits of the recycled supply to the systems and its customers;
- A comparison of incremental cost and willingness to pay; and
- Determining an appropriate structure of charges.

In order to provide guidance on the practical application of these principles and guidelines, the following chapters provide some illustrative examples by way of three hypothetical case studies encompassing different water recycling scenarios.

6 Towards pricing guidelines and strategies *continued*

Understanding the market and willingness to pay

In order to gain a good sense of the likely upper bound of the efficient price band, water authorities will need to clearly understand the willingness to pay of users, by having regard to:

- The value of the product or activity to which the particular class of recycled water is being used as an input;
- Any other costs that the user must incur in order to be able to use the recycled water;
- The price ceiling provided by substitutes;
- The value placed on particular attributes of recycled water (that in some cases may even make it more valuable to users than potable water);
- The surety of users having access to the water over a sufficient period to enable recovery of their investment; and
- Attitudes and perceptions of users.

A schematic representation of some of the key considerations is shown in Figure 9 below.

It also needs to be recognised that willingness to pay is not necessarily a fixed ceiling. The experience of many water authorities to date suggests that education of the potential users, consumers of products produced using recycled water, and the broader community can often significantly increase users' willingness to pay. Assessments of the market also need to incorporate robust risk analysis of forecast demands for recycled water.

Understanding key elements of the costs and benefits of the recycled supply to the systems and its customers

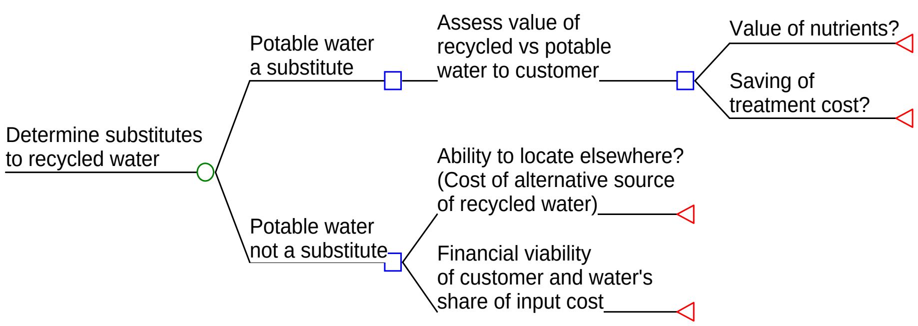
The second broad aspect is to have a sound understanding of key cost elements involved in the recycled water project and the cost of alternatives. In particular, this includes:

- The direct incremental capital and operating costs for the construction and operation of the recycled water infrastructure (generally, the higher the level of treatment, the higher the cost);
- Any system-wide costs or benefits associated with the recycled scheme (eg ability to defer or avoid costs of upgraded wastewater treatment);
- Any external costs or benefits accruing beyond the authority and its customers as customers (eg environmental benefits) and the availability of CSO funding; and
- The costs associated with the alternative scenarios without the recycled water scheme.

Any risks that may ultimately translate into higher costs also need to be factored into the analysis (eg contingent liabilities for claims arising from inappropriate use of recycled water).

Figure 10 (over page) indicates the key steps in assessing the incremental costs of the recycling scheme.

Figure 9 Assessment of willingness to pay



6 Towards pricing guidelines and strategies
continued

Comparison of incremental cost and willingness to pay

Willingness to pay determines the upper bound on the price of recycled water, and the lower bound is assessed by the relevant incremental cost for the particular scheme under consideration, taking into account any system-wide impacts.

Together these determine the band within which prices are able to be set, and whether the price that can be charged will result in a contribution to joint and common costs, at least cover the direct incremental costs, or require a recovery from other customers and/or a CSO or shareholder contribution.

Thus the willingness to pay ceiling from Figure 9 can be compared with the various decision points identified in Figure 10. These diagrams are presented as a simplified characterisation of what in practice will be a more complex decision-making process.

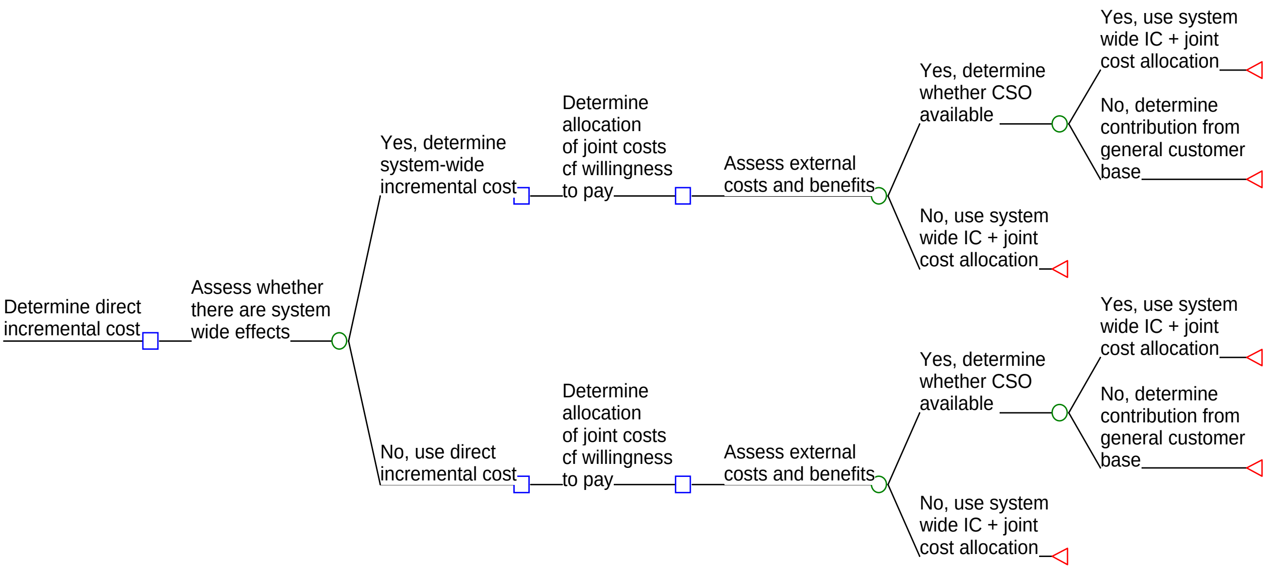
Determine an appropriate structure of charges

Once the broad level of costs to be attributed and subsequently recovered in recycled water charges has been determined, the next question to address is the structure and incidence of recycled water charges.

Key considerations here include:

- Providing appropriate signals as to the cost of providing additional water (ie the long run marginal cost of potable and recycled water);
- Ensuring customers have sufficient control over the level of their bill (which assists with equity considerations);
- Ensuring an appropriate relationship between the volumetric rates for potable and recycled water, to avoid perverse incentives (eg using the recycled water for inappropriate purposes); and
- Appropriate management of risk via the structure of prices and nature of contractual agreement.

Figure 10 Assessment of incremental cost



Practical application of principles and guidelines

In order to provide guidance on the practical application of these principles and guidelines, the following chapters provide some illustrative examples by way of three hypothetical case studies encompassing different water recycling scenarios.

Case Study 1 considers high-quality recycled water provided to industrial customers, where the scheme's viability depends on the customers' willingness to pay for the direct costs of the scheme, and there are few system-wide or external benefits.

Case Study 2 examines the example of recycled water being used to substitute for unsustainable groundwater supplies. In the presence of a strong constraint on willingness to pay, the scheme is justified by the environmental benefits it provides. For it to be financially viable, either a CSO could be provided, or some of the costs could be transferred to the wider customer base on a beneficiary pays principle.

Case Study 3 considers the scenario of a third pipe system in a major new residential development. The recycling approach brings benefits in terms of lower long-term resource augmentation and treatment costs for the system as a whole, as well as providing environmental benefits.

7 Case Study 1: High quality recycled water for industrial processes

The numbers used in this case study are intended to be broadly reflective of the costs of undertaking this type of recycling scheme. However, they have been chosen to illustrate the principles involved, and hence do not represent any scheme in particular.

7.1 Description of scheme

This case study takes the example of a large industrial customer (or group of industrial customers) being supplied with Class AA recycled water suitable for process use. The scheme involves taking secondary treated effluent from an existing wastewater treatment plant that currently discharges to the ocean, transporting it to the industrial site for further treatment and then distributing the recycled product to the customer(s). For the purpose of this example, four customers are assumed, each taking a quarter of the recycled water delivered.

To assess willingness to pay, it is necessary to understand what the "hypothetical" situation would be in the event that the recycling scheme did not proceed. We consider two alternatives. First, assume that the industrial customers would indeed take potable water, although this would impose additional processing costs on them. The alternative hypothetical situation assumes that the customers' industrial processes are such that they require the high quality Class AA water provided by the recycling scheme. Hence in the absence of recycled water, the industrial process would not be undertaken and no potable water would be required in substitution for the recycled volumes.

The initial set-up of the scheme involves investment in a recycled water treatment plant, pipelines, storage, buildings and equipment. The total cost is assumed to be $45m (in 2004 prices). The scheme is assumed to have an initial phase when the amount of recycled water delivered is 10 ML/d, during the first two years. Thereafter the total delivered is assumed to be 20 ML/d[24], with four customers each taking 5 ML/d. The associated operating costs reflect the pattern of water delivered, increasing from an initial $2m pa to $4m pa. The treatment plant and associated infrastructure is assumed to last for 20 years, after which point it is either replaced or abandoned. Table 5 summarises the costs and water delivered. All costs are in 2004 prices.

7.2 Willingness to pay

Willingness to pay forms an upper bound on the price that can be charged for recycled water. As discussed, there are a number of influences on the level of this upper bound, with the price of substitutes one of the key considerations.

7.2.1 Potable water as a substitute for recycled water

In the hypothetical situation where the industrial customers would take potable water in the absence of recycled water, the price of potable water forms the basis of the willingness to pay price ceiling. Suppose that the price of potable water was 75 cents per kl. Allowing for the addition of an annual fixed charge, each of the four customers pay the equivalent of 82.6 cents per kL pa for taking a potable supply of 5ML/d.

However, the price ceiling for recycled water may lie above or below this level, according to the characteristics of the recycled water and its value to the customer. For example, the high quality and/or uniformity of Class AA water may mean that the customers' own processing costs are reduced and/or they need to purchase a lesser volume of water.

For example, if the customer were able to reduce their intake of water by a third compared to potable volumes, the appropriate price comparison becomes 123.3 c/kL. The willingness to pay price ceiling would be even higher if the customers would have had to undertake additional treatment of potable water themselves to obtain the desired quality of water.

Table 5 Scheme costs and recycled water delivered plant

Year	1	2	3	4 to 21
Capital investment $m	45			
Operating expenditure $m		2.0	2.0	4.0
Recycled water delivered ML/d		10.0	10.0	20.0

[24] The treatment of uncertainty in relation to future demand is examined later.

7.2.2 Alternative sources of recycled water

The alternative hypothetical situation considered is where the customer will not take any supply from the water authority in the absence of recycled water. In such circumstances, the customer may examine the feasibility of locating its industrial process elsewhere (for example in another State). Then the limit on willingness to pay will reflect the feasibility of locating elsewhere and the associated price of the recycled water available. If it is not feasible for the customer to locate elsewhere, willingness to pay will depend on the contribution that water costs make to production costs and the financial viability of the customers' products – as this will determine the amount that they can afford to pay for the recycled water.

7.3 Efficient pricing band: stand-alone cost

Willingness to pay needs to be compared with the upper limit on stand-alone cost. In particular, recycled water users cannot be charged above the stand-alone cost (even if the willingness to pay exists), as this would encourage an alternative supplier to build the infrastructure needed to supply the services.

An extreme definition of stand-alone cost might attribute much of the costs of providing potable water and wastewater treatment costs to recycling customers, on the basis that the provision of these services are joint with recycling. Then the stand-alone cost would incorporate some or all of the costs that would need to be incurred to provide recycled water "from scratch" – ie without an existing water supply and sewerage system.

This definition of stand-alone usually lies some way above the willingness to pay ceiling. However, if the resultant price did fall within the willingness to pay ceiling, this method would constitute a valid method of apportioning the costs of the system.

An alternative measure of the upper cost "by-pass" limit would recognize the implications of Part IIIA of the Trade Practices Act for the ability of third party suppliers to access parts of the existing water supply and wastewater system. This is an uncharted area, although there are examples of "sewer mining" and the draft decision of the NCC to declare the transportation and interconnection services of Sydney Water also sets a relevant precedent.

On this basis, the relevant stand-alone price ceiling is likely to be one that involves some allocation of the joint costs involved in service provision (possibly including wastewater treatment and conveyancing costs), together with the direct costs involved with provision of recycled water. This is considered further below, after considering the calculation of direct incremental costs.

7.4 Incremental cost

A lower limit on the price that should be charged for recycled water services is given by incremental cost. Generally, if the incremental costs are not covered, then the service is being cross-subsidised by the customers of other services. Incremental costs (net of benefits) should be assessed broadly, however, to take into account system-wide incremental costs and benefits and possibly also external costs and benefits.

7 Case Study 1: High quality recycled water for industrial processes *continued*

7.4.1 Direct incremental cost

It is relatively straightforward to identify the direct costs involved in the provision of recycled water systems. Comparison of the NPV of the capital and operating costs with the NPV of water delivered would suggest an average cost as follows:

Incremental cost = NPV (capex and opex)/NPV(water delivered)

Assuming a 6% real cost of capital, the NPV of capital expenditure is $42.5m when discounted back to the starting year 0. The NPV of operating costs equals $42.2m, and the NPV of recycled volumes delivered amounts to 211 Ml/d. Thus:

Incremental Cost = (42.5 + 42.2)/211 = 401.1 (expressed in $'000 per Ml/d)

= 110 cents per kL

As well as the costs of the scheme itself, incremental administrative costs – including billing, corporate overheads etc – also need to be added. This might add a further 2 cents/kL.

In the hypothetical situation where the demand for the recycled water came from new customers who were interested only in recycled water and would not otherwise take potable water, then 112 cents/kL would represent the minimum price that should be charged for the recycled water supply. There would be no implications for the costs of the potable water system, and hence no adjustment required to the price of recycled water.

(Here we are making the simplifying assumption that the taking of recycled water does not deliver cost economies to the management of the wastewater stream, so that we are concerned with system-wide costs on the supply side only).

Before determining the final price for recycled water, any external costs/benefits would need to be assessed. This is considered in Section 7.5 below, after considering the system-wide incremental costs.

7.4.2 System-wide incremental costs

System-wide incremental costs need to be considered explicitly under the situation whereby the new customers would otherwise take potable water. In particular, the transfer of future and/or existing demand from potable to recycled water will affect the future costs of providing potable water services. The amount of revenue available from potable customers is also affected.

Most water businesses face demand that is rising gradually but steadily over time. In order to ensure that the supply/demand balance is maintained, the businesses undertake a mixture of capacity augmentation and demand management (where demand management includes the structuring of prices to provide incentives for sustainable demand). Consequently, the reduction in the level of potable demand brought about by the industrial customers' switch to recycled volumes will enable a reduction in future expenditure on potable supply relative to what it would otherwise have been.

There is also a reduction in the amount and cost of the associated wastewater disposal, relative to the situation without recycling, since the recycled water used by industry would otherwise have required disposal. There may also be an absolute reduction in the amount of wastewater disposal, to the extent that any of the recycled water is consumed during the production process and hence is not discharged to the sewer.

When considering the system-wide effects of supplying recycled water, the first issue is whether the incremental cost of supplying additional potable water is greater than, equal to or less than the system incremental cost of meeting that demand via a recycled water supply. This requires taking into account not only the direct cost of the recycling scheme, but also its effect on the system-wide costs of providing other services, and in particular the system-wide costs that are borne by other (ie non-recycling) customers. Also relevant will be any difference between the revenues and costs that would have attached to a substitute potable supply.

7 Case Study 1: High quality recycled water for industrial processes *continued*

One key issue is the relationship between the incremental cost and the existing average cost of supplying potable water. If water supply is a constant cost industry, the cost of supplying the next increment in demand will be the same as supplying existing demand. In these circumstances, existing customers will be unaffected by the presence or absence of the recycling scheme that defers the need for a supply augmentation (provided the direct incremental costs of the recycled scheme can be recovered from recycled water users).

By contrast, costs to potable customers on average will increase as demand increases if the business faces an "increasing cost" potable supply curve – for example if the next resource is more expensive than existing resources. Conversely, there are elements of the supply chain that may exhibit decreasing costs, such as the trunk distribution system. This could result in the LRMC of delivered potable water being lower than the existing average cost of supply.

The case study assumes that the incremental cost of supplying potable water is very close to the existing average cost of supplying potable water of 82.6 cents/kL (assuming that the price for potable water reflects the average cost of providing existing supplies). This encompasses capital expenditure on resource and treatment augmentations equivalent to 50 cents per kL of potable water and future operating costs for the potable supply system of 32 cents/kL Equivalently, these can be seen as the avoidable costs associated with the reduced current and future demand for potable water resulting from a recycled supply.

The fact that long run incremental cost for potable water is similar to the existing average cost suggests that (in this particular example) the transfer of current or future demand from potable to recycled water leaves the costs to be recouped from other potable customers unchanged - provided recycled water customers are willing to pay the full direct incremental costs of the recycled supply. Accordingly, no adjustment to the price of recycled water to reflect potable system effects is needed.

Equally this point can be expressed in terms of a comparison of the marginal revenues and marginal costs involved with the supply of additional potable water (as an alternative to recycled water). The existing price per volume of potable water is $82.6 c/kL, which matches the costs involved with providing additional supply of $82 c/kL. Accordingly, other customers are indifferent to whether the recycled customers choose recycled or potable water – provided the recycled customers cover the direct costs involved with the recycled supply.

Whether the recycled scheme goes ahead, therefore, will depend on the willingness of the potential recycling customers to pay for the direct costs of the recycling scheme. The assumption of the case study is that this is the case, given the benefits to users of the high quality water provided. Hence although providing additional potable water is the lower cost option for the authority, the scheme should proceed because the users place a higher value on the recycled water which is reflected in the higher price that fully recoups the incremental costs of the scheme. This additional value to users is in fact the only rationale for proceeding with a scheme where the incremental cost of recycled water (ie $1.12/kl) is higher than the incremental cost of potable water (82c/kl).

However it is worthwhile considering the implications of the alternative situations (where the marginal cost of additional potable water differs from current average cost and hence current average price). Suppose for a moment that the incremental costs of supplying potable water are greater than the average cost of supplying potable water. If the costs of resource augmentation are particularly high, the incremental costs of potable supply may be higher than the incremental costs of recycled supply (say $1.30/kl). In this case, there are system-wide savings from meeting demand with a recycled supply relative to a standard potable supply option (assuming that there is an obligation to supply). In other words, the total cost of meeting demand is lower with the recycling scheme than if all volumes are supplied through potable water.

However, how (and indeed if) the benefits should be shared between the reuse customer and potable water customers should be considered on a case-by-case basis.

Clearly, if recycled water users are indeed willing to pay $1.12/kl for the recycled supply, in this case existing potable water customers receive a major benefit from the existence of the recycled scheme in that their average costs (and price) of supply remain as they were previously at 82.6c/kl, rather than increasing to (say) 90c/kl to absorb the higher $1.30/kl for the additional volumes required under the potable supply alternative.

7 Case Study 1: High quality recycled water for industrial processes *continued*

Moreover, a reduction in the price of recycled water (below direct incremental cost) may be justified to ensure the scheme goes ahead and the lowest cost means of meeting system-wide demand is adopted. Thus, if recycled water users are not willing to pay the full $1.12/kl to take recycled water, existing potable water customers would still be better off for the recycled scheme to go ahead with a contribution from potable customers, provided that the resultant average costs are no more than what they would have been if the demand was met instead by potable supply (ie 90c/kl).

Again, we can express the comparison in terms of the marginal revenues and costs of the avoided potable supply. By providing recycled instead of potable volumes, the water authority avoids $1.30/kL of additional costs and loses only $82.6/kL of revenue in the first instance. (Although if the additional potable supply went ahead, average costs and hence prices charged to all customers for potable volumes would rise over time).

The alternative situation is one where the marginal cost of potable supply lies below existing average cost and hence average price. For example, suppose that the LRMC of additional potable water supply costs 0.75c/kL, compared to the average cost of 82.6 c/kL. This could reflect the fact that there are economies of scale due to large fixed costs in the distribution system that mean additional volumes lower average costs despite the incremental resource costs.

In this situation, the supply of additional potable volumes to recycled customers instead of undertaking the recycled scheme would serve to reduce the average costs of potable water as a whole. Thus other potable customers would have to bear higher average (potable) costs if the recycling scheme goes ahead relative to a potable supply option, unless the recycled customers make the same contribution to fixed costs as they would have done as potable customers. In terms of marginal revenues and costs, the water authority potentially loses 82.6c/kL in revenue if potable water is not supplied to the recycling customer, and avoids 75.0c/kL of additional costs. (Again we need to recognise that in the absence of the recycled scheme, average costs and hence price for potable supplies would decline to somewhere below 82.6c/kL)[25].

Does this mean that the recycled customer should pay a price which is higher than the direct costs of the recycling scheme, to reflect the adverse impact on other (potable) customers? The answer depends on a number of factors, including how the resultant price for recycled water compares with willingness to pay, how prices for standard potable customers are determined, and the ceiling implied by stand-alone costs.

In setting a price for recycled water, the water business will need to keep in mind the potential for "by-pass", with a third party providing recycled water supplies by sewer mining or by obtaining access to the sewer network. The total costs that would be incurred by the third party, including payments to the water authority for access services or the purchase of sewage, therefore provide a ceiling on the price that can be charged for recycled water. Clearly an issue arises if the ceiling is below the system-wide incremental cost of the recycling scheme, yet above the direct incremental cost. This would enable a competitor (or the water authority) to provide recycled water, even though average costs and hence prices to existing and future potable customer would rise. This indicates the importance of having an appropriate allocation of joint costs when determining access charges for authorities' network systems.

Thus in determining a price for recycled water it is necessary to consider how the benefit of the savings (or losses) in system-wide costs should be attributed between customer groups. Efficiency considerations require that prices be within the Baumol-Willig price bands (as adjusted by the system-wide effects). In addition, where an overall revenue requirement acts as a constraint, charges to customers should be increased in proportion to willingness to pay (ie Ramsey pricing principles). However, equity considerations are also relevant.

[25] It should be noted that this foreshadowed reduction in the price of potable water would impact on the willingness of users to take recycled water where they have an option between the two. In this example, the users will not be willing to pay the incremental cost of $1.12 for recycled water were the price of potable water to fall below 74.6 c/kl.

In the base case considered in this example, direct incremental cost lies within the willingness to pay ceiling and there are no system-wide implications for other customers, so that the efficiency criteria are satisfied by pricing recycled water at direct incremental cost. If system-wide savings did arise from the recycled water scheme, it would be largely an equity question as to whether the price charged for the recycled water should be reduced, bearing in mind that charges to the general customer base would have to rise[26] in order to ensure adequate revenues for the water business overall. Whether this is appropriate or not is largely an equity question, at least under the assumption here that demand is not price sensitive. Were the different pricing possibilities to imply different demand patterns, with cost consequences, then there would be efficiency as well as equity aspects to the precise pricing determination.

If the LRMC for potable water lies below average costs and prices, then the advent of the recycling scheme means that the water authority may lose a contribution to the fixed costs of the system if the recycled customers pay only their direct incremental costs [27]. Average costs and prices to standard potable customers could therefore increase as a result. Again whether this system-wide effect should be recouped from the recycling customers will depend on a mix of efficiency and equity considerations.

7.5 External costs and benefits

The discussion of this case study has so far centered on the costs and benefits to the water supply businesses and its customers. However, as discussed in the report, it is important to also take account of any external costs and benefits imposed by the recycled water scheme.

For example, the re-use of effluent may result in lower waste discharges into environmentally sensitive receiving waters. This may be because the recycled wastes are being discharged into the environment at an alternative location and/or lesser volumes require disposal (relative to the situation without recycling). Similarly the reduction in potable water may enable less raw water extraction with associated environmental benefits. In both cases, it is appropriate to identify the likely scale of the benefit, and to consider the best method of reflecting that benefit in prices.

As discussed, the most transparent method of dealing with external benefits such as this would be for government to make a CSO payment to rectify any shortfall in the finances of the recycling scheme. The amount of such CSO payments would then allow the setting of a lower price for the recycled water, to ensure that the scheme proceeds.

In the absence of a CSO mechanism, the question arises whether the full costs of the recycling project should be borne by the recycled water customers, or whether the wider customer base should contribute in order to reflect the external benefit to the customer base as a whole. (

Efficiency considerations would suggest that such contributions should be levied in the least distorting method – ie according to willingness to pay. If the price of recycled water is below the price of effective substitutes – and within the willingness to pay ceiling – then it may be appropriate for recycled customers to cover all of the costs of the recycled scheme. (The efficient outcome will depend on the relative price sensitivity if different categories of demand. It will also depend on whether there are any other pricing distortions – for example through any external impacts of potable water not currently being priced).

If, however, recycled customers were unable to cover all of the costs involved in the scheme, then it would be appropriate for the wider customer base to make a contribution towards the cost, provided this contribution is less than the external benefits involved. Such an approach is appropriate if the customer base is being taken as an approximation to the taxpaying base. It could also be seen as being consistent with a "polluter pays:" principle, where the potable customers are to be taken as an approximation for the polluters. Note that charging polluters for the costs of cost-justifiable remediation works was recognised by NCC as one of the 'acceptable' approaches to resource management charging in place of a full polluter pays or beneficiary pays approach).

This is an issue which is explored in further detail in Case Study 2. Equity considerations may also support a contribution from the wider community, provided it is done in a non-distorting manner.

[26] Towards the levels that would apply in the absence of the recycling scheme.

[27] Assuming that in the absence of the recycling scheme, the customer takes potable volumes

7 Case Study 1: High quality recycled water for industrial processes
continued

7.6 Fully allocated cost

The discussion above suggests a pricing band which lies above the direct incremental cost (with the base assumption of no system-wide or external costs and benefits) of 112 c/kL and below the willingness to pay ceiling of 123 c/kL. The choice of a particular price within that band will reflect other considerations, including the appropriate allocation of joint costs and commercial considerations such as the allocation of risk.

7.6.1 Treatment of joint costs

As discussed above, recycled water services are provided jointly with water and sewerage services. Accordingly, issues arise as to the appropriate allocation of those costs which are incurred jointly between potable water customers, wastewater customers and recycled water customers. These include the costs of operating the supply/waste network.

Efficiency considerations dictate that joint costs should not be allocated to customers beyond their willingness to pay. Given the relatively low level of the willingness to pay price ceiling, it is likely that relatively few of the costs which are joint with potable supply/wastewater treatment should be allocated to recycled water, although there would be scope for some such costs to be allocated to the recycled water scheme.

7.6.2 Commercial considerations and risk issues

The building of the recycled water plant and associated infrastructure involves a significant element of risk, namely that one or more customers withdraw prematurely. This could result in the assets becoming partly (or wholly) stranded, if no replacement customers can be found.

Such risks can be handled in a number of ways. One such is to institute long-term "take-or-pay" contracts. Another approach would be to adjust the level of demand for recycled water that is built into the pricing calculation, to reflect the "expected value" of demand. Thus if there was a 25% probability that one of the customers would withdraw after two years, this would reduce the expected level of demand to 18.75MLd (from 20 MLd) for year 4 onwards. This would increase the estimated direct incremental cost of the scheme to 117 cents/kL.

An alternative approach might be to adjust the cost of capital/discount rate used to compare the costs and revenue for pricing purposes. However, adding a premium on the cost of capital can distort the assessment of cashflows and is generally not favoured by regulators.

Finally, higher risk can be addressed by altering the structuring of tariffs, to increase the proportion of revenue recovered from up-front or fixed payments.

7.7 Inter-relationship with other services

The appropriate method of handling risk is closely related to the relationship between recycling and other services, and how the prices of the core services of water supply and wastewater disposal are determined. Requiring recycled customers to provide a full return including the commercial risks (eg by using probability adjusted volumes) is appropriate when the outcomes from the recycling project are "ring-fenced" from the other section of the business.

However if the recycled customers are unable to cover the full cost of the scheme including a commercial return, then it may be appropriate for the wider customer base to carry the demand risk and/or bear some of the cost of the scheme. This might be justified if the water supply business is required to meet recycling targets, and the scheme is essential in meeting the targets required of the business. It would also be justified by the presence of external benefits and/or system wide cost savings. There is, however, a strong case for this to be transparently disclosed.

The mechanism by which the deficit can be covered under current price-setting practice is considered in Case Studies 2 and 3 below.

7.8 Summary of pricing considerations

Table 6 summarises the various considerations to be taken into account when pricing the recycled water supplied by the recycled water scheme (in terms of the quantum of revenue). The following section discusses the issues involved in determining the structure of prices for recycled water.

7 Case Study 1: High quality recycled water for industrial processes *continued*

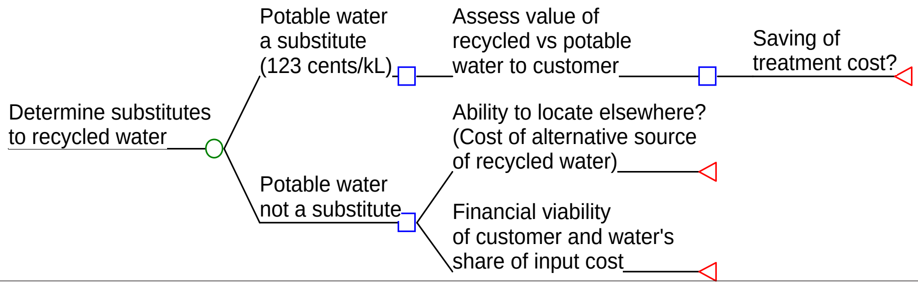
Table 6 Summary of pricing consideration for Case Study 1

	Potable water is a substitute	Potable water not a substitute
Willingness to pay	123.3 c/kL plus further margin if customer has to further treat potable water	Depends on financial viability of customer and/or ability to locate elsewhere
Direct incremental cost	112 c/kL	112 c/kL
Impact on system-wide costs	Assumed zero in this case. If LRMC > existing average cost, allocation of system wide savings would be subject to efficiency and equity considerations	None
External costs and benefits	Assumed zero. Where there are benefits, judgement required as to how value is allocated between potable and recycled customers	Assumed zero. Where there are benefits, judgement required as to how value is allocated between potable and recycled customers
Allocation of joint costs, for fully allocated cost	Some allocation of joint cost could be made, according to willingness to pay	Depends on willingness to pay

The table presents the considerations for the two hypothetical situations considered, namely when potable water is and is not a substitute for the recycled water.

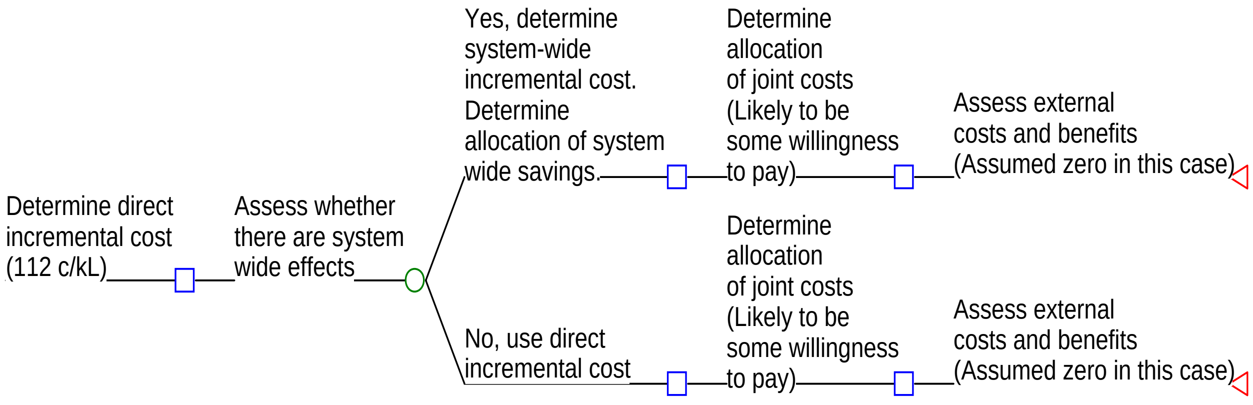
Figure 11 and Figure 12 below set out the assessment process for willingness to pay and incremental cost.

Figure 11 Willingness to pay assessment



7 Case Study 1: High quality recycled water for industrial processes *continued*

Figure 12 Assessment of incremental cost



7.9 Pricing structure

Once the total quantum of revenue to be recovered from prospective recycled water customers has been identified, the remaining issue is how the tariffs should be structured.

Supplies of recycled water to major industrial customers are likely to be covered by some form of contractual agreement. A contract term that extends over the expected life of the assets involved would minimise the risk of stranded assets. On the other hand, long contract terms may reduce flexibility in responding to changes in the price of alternatives, regulatory changes etc.

Where there is uncertainty over the level of demand, there is an argument for sharing the demand risk with customers by increasing the proportion of revenue recovered through fixed charges, relative to equivalent potable contracts. Given the fact that the market for recycled water is in early stages, there is much greater potential for the withdrawal of a single large customer to effectively strand a significant portion of the assets. Increasing the proportion of revenue recovered through fixed charges would partially compensate by providing some limited protection from demand risk. Other options include long-term “take or pay” contracts, and up-front capital contributions.

8 Case Study 2: Supply of recycled water to horticulture

8.1 Description of scheme

Case Study 2 considers the example of a recycled water treatment plant which takes secondary treated water from an existing wastewater plant, treats it to Grade A standard, and then delivers it through a reticulation system to a number of horticultural customers. In this case recycled water is substituting for groundwater extractions by the horticulturalists.

Note that the case study has been designed to illustrate the principles involved, and so the numbers presented do not represent the outcomes expected for any particular scheme.

There are significant environmental benefits that arise from the scheme through a reduction in groundwater extraction, which is currently at unsustainable levels and leading to seawater intrusion. In addition, the disposal of secondary treated effluent is causing damage to seagrass and mangrove ecosystems.

Table 7 summarises the costs and water delivered for the scheme. The capital investment involves the construction of a recycled water treatment plant, together with a pipeline and reticulation system to deliver the recycled water. The amount of recycled water delivered increases gradually (after an initial start-up phase) to 60 ML/d. The level of operating costs reflects the amount of water delivered. The scheme is assumed to operate for 20 years. All costs are expressed in 2004 constant prices.

8.2 Willingness to pay

For Case Study 2, we assume that the current price of potable water is $1.00 per kL, plus a fixed charge which is a minimum of $150 for non-domestic customers. However, in this case the price of potable water does not form the basis of the price ceiling for recycled water. Currently, groundwater provides a much cheaper source of water, at a direct cost of 5 cents per kL[28]. Indeed, the horticulturalists would not be able to afford to use potable water, so that in the absence of groundwater or recycled water, the horticultural activity in the region would cease, with an associated loss of employment and income.

While groundwater remains freely available, it provides a significant constraint on the price that users will be prepared to pay for an alternative such as recycled water. However, in future the groundwater could well become unavailable or significantly more expensive, for example due to the inclusion of externality or resources charges aimed at stopping the over-exploitation of the resource. In these circumstances, the effective willingness to pay price ceiling for recycled water would increase.

The willingness to pay ceiling may also increase in advance of externality or resources charges being imposed, if growers see these as a possibility, and want to obtain a secure source of supply. The prospects for this happening could be increased through announcement of a clear policy – of restricting access to or raising the charges for groundwater – that could be designed to accompany the introduction of the scheme.

Table 7 Scheme costs and water delivered for horticultural recycled water

Year	1	2	3	4	5	6	15	21
Capital investment $m	52							
Operating expenditure $m		2.0	2.0	2.4	2.6	2.6	3.1	3.3
Recycled water delivered ML/d		25.0	25.0	35.0	40.0	41.3	53.8	60.0

[28] And excluding externalities, which are considered below

8 Case Study 2: Supply of recycled water to horticulture *continued*

Willingness to pay would still be heavily constrained, however, by the ability of the horticulturalists to support higher input costs in what is a strongly competitive product market. We assume for the Case Study that the growers would be able to pay up to 20c/kL for recycled water and still maintain a viable horticultural business.

In fact, willingness to pay will depend on many considerations, and is likely to change over time. For example, even if groundwater is available, the growers will be aware that there is a risk that the groundwater will become more expensive, restricted or unavailable. Thus they may be willing to pay a premium over the current price of groundwater (at 5c/kL), in order to gain greater certainty over the price and availability of their future supply.

However it is important to recognise the distributional impact of a rise in the price of groundwater. The 20c/kL need not necessarily represent an 'excess' profit above the levels needed to sustain the activity. Were the price of the water to rise from 5c to 20c, this would almost certainly be reflected in a fall in the value of the land with access to the water. Current horticulturalists may well suffer significant losses, in the form of capital write-downs, and be locked into interest and loan repayments based on the old value – but still be willing to pay the 20c. If they are unable to pay the extra, then the land would probably transfer to new owners, at a price reflective of the new water price, and with the cash resources to finance the new supply.

Two further considerations are also relevant, concerning the value to customers of using recycled water. On the one hand, the nutrients remaining within recycled water are likely to be of some value to users. As against that, there may be some adverse public perception about the use of recycled water in the food chain – with possible commodity demand and price implications. Both will influence that amount that the growers are willing to pay for recycled water. For the purposes of this case study, we assume that the net effect of these considerations is that horticulturalists place a premium of 5c/kl on recycled water (eg reflecting additional security of supply, and savings in fertiliser costs due to the presence of nutrients in the recycled water) relative to the groundwater alternative.

Given that the absolute ceiling on willingness to pay is 20c/kL for recycled water (in the absence of cheaper alternatives), the ceiling for groundwater must be 15c/kL - reflecting the additional value of recycled water to horticulturalists.

8.3 Incremental cost

8.3.1 Direct incremental cost

Comparison of the capital and operating expenditures, with the projected water delivered, gives a direct incremental cost of:

NPV[29](capex and opex)/NPV(water delivered)
= ($49.1m + $31.2m)/471.6 Mld
= 47 cents/kL.

This is considerably less than the unit incremental direct cost of Case Study 1, which involves more expensive plant (to provide higher quality recycled water) and lower volumes.

Even so, this is substantially above the price that the customers would be willing to pay, which we assume to be 10 cents/kL[30] given the continued availability of groundwater, or 20 cents/kL if recycled water is the only available option.

8.3.2 System-wide incremental costs

In this example, the provision of the recycled water is assumed to be largely independent of the potable water supply system and would have no implications for the supply of potable water.

However, we assume that in the absence of the recycled water scheme, a requirement will be imposed on the water business to improve the quality of the effluent discharged in order to protect the seagrass and mangrove ecosystems[31]. The cost of upgrading the treatment plant, and associated operating costs, would fall on the existing customer base, but is avoided if the recycling scheme goes ahead. These costs are assumed to total $15m for capex and $5m for opex, in NPV terms.

The incremental cost, taking account of changes in system-wide costs induced by the recycling scheme, is calculated as:

[NPV(recycling costs) – NPV(cost of effluent upgrade)]/NPV(water delivered)

= ($49.1m + $31.2m - $15.0m - $5.0m)/471.6 Mld

= 35 cents/kL.

While this reduces the gap between estimated cost and willingness to pay, it leaves a gap of between 15 and 25 cents/kL.

[29] Using a real cost of capital of 6%
[30] Equal to the cost of groundwater at 5c/kL premium for the additional nutrients etc.
[31] If no such requirement was imposed, the value of the reduction in damage to the seagrass and mangrove ecosystems would appear as an external benefit, see the following section.

8.3.3 External costs and benefits

Clearly, if the scheme is to be justified the case will rely heavily on the external benefits it provides. In addition to reducing the environmental impacts of effluent discharge, the supply of recycled water is expected to reduce or eliminate the over-abstraction of groundwater in the region, avoiding further damage to the source through seawater incursion.

As the alternative to using groundwater is to cease the horticultural activity, the use of recycled water can also be seen as providing economic development benefits to the region, benefits that are external to the water business.

Such environmental and economic benefits can be very significant. However, the estimation of the magnitude of the benefits can be controversial. It is beyond the scope of this study to assess such benefits here. However, it is straightforward to identify what magnitude of benefits would be needed to make the recycling scheme a viable project in triple-bottom line terms.

Working backwards, the size of the external environmental and regional benefits must be such that:

EB ⩾ System-wide IC – Value to Users

Where EB equals the value of the external benefit and IC is the incremental cost of the recycling scheme.
In terms of the case study, this implies:

EB ⩾ \$49.1m + \$31.2m - \$15m - \$5m – Value to users

In the case where groundwater is not available or is priced beyond the willingness of users to pay, then:

Value to users = NPV of water deliv'd x willingness to pay price

= 471.6 x 0.20 x 1000 x 365 = \$34.4m

So that:

EB ⩾ \$49.1m + \$31.2m - \$15m - \$5m - \$34.3m

⩾ \$25.8m in NPV terms, or \$2.3m per annum

In other words, the external benefits must be at least \$2.3m pa in order to justify the recycling scheme in triple bottom line terms. Given the severe implications of the over-abstraction of groundwater and the damage to aquatic environments from effluent disposal, as well as the importance of horticultural activity for regional employment, it is plausible that the external benefits would justify undertaking the scheme – from an overall community point of view. A final position on this would need to take into account alternative strategies for addressing the externality concerns. (For example whether extractions from the groundwater should be regulated more tightly, or even banned, and whether externality charges might be applied).

Given the continued availability of groundwater at subsidised[32] prices, growers' willingness to pay is capped at the artificially low level of 10 cents/kL – ie the 5c/kL cost of the groundwater plus the 5c/kL premium for recycled water. A first best response would be to reduce the implied subsidisation of groundwater by setting the price of groundwater to more closely reflect the environmental damage associated with its use. Assuming that the environmental impacts are the \$2.3m p.a. discussed above, then a price for groundwater that reflected these broader costs would be 20 cents/kL (equal to 5 c/kL current cost of groundwater plus 15c/kL for the external costs associated with its use). However this lies above the 15 c/kL ceiling price that users are willing to pay for groundwater – implying that the horticultural activity would not be economically viable using this source of water. Thus although the efficient policy prescription is fairly clear, for the reasons alluded to earlier, rapid removal of the implicit subsidy could have substantial distributional consequences, and this may be a consideration in any final decision on changes to the pricing arrangements.

For now, we assume that the recycling scheme offers the only politically feasible response to the issue and will deliver external benefits worth in excess of \$2.3m pa. The question then becomes one of how it should be funded.

If groundwater continues to be available at a price of 5 cents/kL, then the maximum willingness to pay for recycled water will be 10c. At this price, there is a financial deficit to the water business of \$43.1m. If the recycling scheme is to go ahead, therefore, this deficit needs to be covered either by taxpayers (through a CSO) or the broader customer base. Thus the amount of funding needed to enable the recycling scheme to go ahead would be \$43.1m. (If groundwater is available at a price of 20 cents/kL, then the additional funding is \$25.8m as above).

8.3.4 Fully allocated cost

In this Case Study, recycled water customers are unable to cover the system-wide costs of the scheme. It is not therefore possible to allocate any joint costs to the recycling scheme.

[32] ie prices that do not reflect the external costs of using the groundwater

8 Case Study 2: Supply of recycled water to horticulture
continued

8.4 Inter-relationship with other services

This Case Study provides an example whereby it is in the interests of the community as a whole for the recycled scheme to be undertaken, despite the fact that the customers taking recycled water are unable to cover all of the costs involved. One option is for a transparent CSO payment to cover the deficit. Otherwise, prices to the wider customer base have to rise to cover the costs involved. This section examines the mechanism by which the deficit can be covered by the wider customer base, under current regulatory price-setting methods.

As required by COAG, price-setting methodologies are currently being developed by independent regulators for water and sewerage businesses in a number of States. These generally involve the determination of an (average cost) revenue requirement for the business, covering operating costs, depreciation, a return on the regulatory value of assets and tax. Allowable prices are then set so that forecast revenue equals the forecast revenue requirement.

Provided the revenue requirement for recycled water is not identified separately and kept separate, this method of setting prices enables the broader customer base to contribute to the cost of recycled schemes where appropriate. For example, where a government or technical regulator has mandated a recycling target, the entire customer base would contribute if necessary towards the cost of the recycling scheme, as it has effectively become a cost of being in the water supply business.

Under current regulatory practice, the revenue requirement is determined for the business as a whole, and hence includes the cost of planned recycling projects (together with other commercial services such as trade waste and contractual agreements for water supply). The revenue requirement for other water supply and sewerage services is then determined by deducting the revenue received for these commercial services. If the planned revenue received from recycling services is insufficient to provide a return on the implied regulatory asset value of the assets involved, prices for standard water and sewerage services are necessarily higher. Conversely, if willingness to pay for recycled water is relatively great, more joint costs can be allocated to the recycled service, so that prices for standard services are lowered.

This is shown in Table 8, which shows the derivation of a revenue requirement for a typical water supply business. A five-year regulatory review period is shown, starting in year 2 of the recycling scheme project. The top part of the table shows the total revenue requirement, which covers operating costs, depreciation of the "regulatory asset value", and a return on the regulatory asset value[33]. The rolling forward of the regulatory asset value is assumed to include all capital expenditure, including expenditure on the recycling scheme. Likewise operating costs include the costs associated with recycling.

Table 8 Revenue requirement for whole business, $m

Year	2	3	4	5	6
Operating costs	375.0	393.8	413.4	434.1	455.8
Depreciation	160.0	181.8	180.2	178.5	176.9
Return on regulatory asset value	150.0	146.0	142.6	139.2	135.9
Total revenue requirement	685.0	721.6	736.2	751.8	768.7
less recycling revenues					
at system-wide cost (35 cents/kL)	3.2	3.2	4.5	5.1	5.3
at willingness to pay price (20 cents/kL)	1.8	1.8	2.6	2.9	3.0
at willingness to pay price (10 cents/kL)	0.9	0.9	1.3	1.5	1.5
Revenue requirement net of recycling scheme					
Recycling charged at system wide cost (35 c/kL)	681.8	718.4	731.7	746.7	763.4
Recycling charged at willingness to pay (20c/kL)	683.2	719.8	733.6	748.9	765.7
Recycling charged at willingness to pay (10c/kL)	684.1	720.7	734.9	750.4	767.2

[33] For simplicity we have excluded tax from the revenue requirement

8 Case Study 2: Supply of recycled water to horticulture
continued

The second part of the table compares the amount of revenue that would be received if the recycling scheme were priced to cover the system wide incremental cost (ie at 35 cents/kL) with the revenues actually forecast under the willingness to pay prices of 10 cents/kL and 20 cents/kL. By the final year of the regulatory review period, the difference in revenue is expected to be just under $4m pa (comparing the 35 and 10 cents/kL prices). This necessarily translates into a higher revenue requirement for the other parts of business, and hence higher prices to water and sewerage customers.

This is not to say that the prices for recycling services will not be subject to regulatory scrutiny. As discussed in the report, regulators are requesting that businesses explain the principles underpinning their approach to pricing recycled services. As price regulation becomes formalised in the water sector, it will be important for the businesses to ensure not only that their pricing approaches for recycled water services gain regulatory approval, but also that their approach in dealing with any financial deficit – due to the system-wide effects or externalities – are agreed by the regulator. While the example given in Table 8 shows the effect on the revenue requirement to be relatively small, the cumulative effect of several such recycling projects will begin to have a discernable effect on the prices for standard water and sewerage services if there are significant external benefits involved and continuing reliance is made on the general customer base for funding.

It is also important to note that this approach does not negate all risk from such projects. If the expected revenues from the recycling project do not materialise as planned, there is no compensation under a tariff basket for the lower than expected revenues within the review period. When tariffs are re-set for the following regulatory period, the future revenues expected will reflect recent experience, but under a tariff basket there is no retrospective adjustment for the current review period. A revenue cap (or hybrid) price control approach would incorporate an element of automatic compensation for revenue under-achieved in the previous review period. However, the tariff basket price control is more commonly used in the water sector in Australia.

8.5 Summary

Table 9 summarises the considerations for determining the appropriate quantum of revenue to be recovered from recycled water horticultural customers. In this Case Study, potable water is not a substitute for the recycled water. However, we identify two different willingness to pay ceilings, based on whether or not groundwater is available as a low-priced substitute for the recycled water. In practice, blended prices between these two bounds could be expected if pricing of the groundwater remains unchanged, but increasing resource degradation results in reduced availability.

Table 9 Summary of pricing consideration for Case Study 2

	Groundwater available	Groundwater not available
Willingness to pay	10 c/kL, to reflect the risk attaching to future groundwater supplies and value of nutrients	20 c/kL
Direct incremental cost	47 c/kL	47 c/kL
System wide incremental costs	35 c/kL	35 c/kL
External costs and benefits	External benefits of $2.3m pa justify the scheme. Funding of $3.75m pa required to cover the costs of the scheme if groundwater remains available.	External benefits greater than $2.3m pa would justify the scheme. Funding of $2.3m required to support the scheme.
Allocation of joint costs, for fully allocated cost	None	None

In order to demonstrate the nature of the pricing decision process, the following two diagrams present the logical structure of assessment of willingness to pay and incremental cost. After determining the willingness to pay (as per Figure 13), the alternative incremental cost bases can be examined. Thus the willingness to pay ceiling from Figure 13 can be compared with the various decision points identified in Figure 14.

8 Case Study 2: Supply of recycled water to horticulture
continued

Figure 13 Assessment of willingness to pay

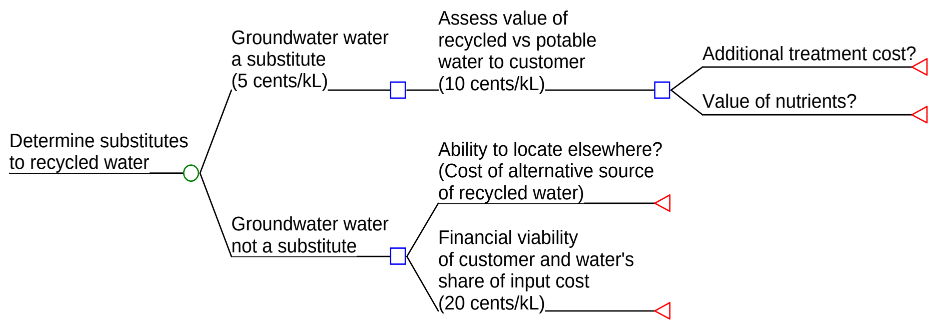
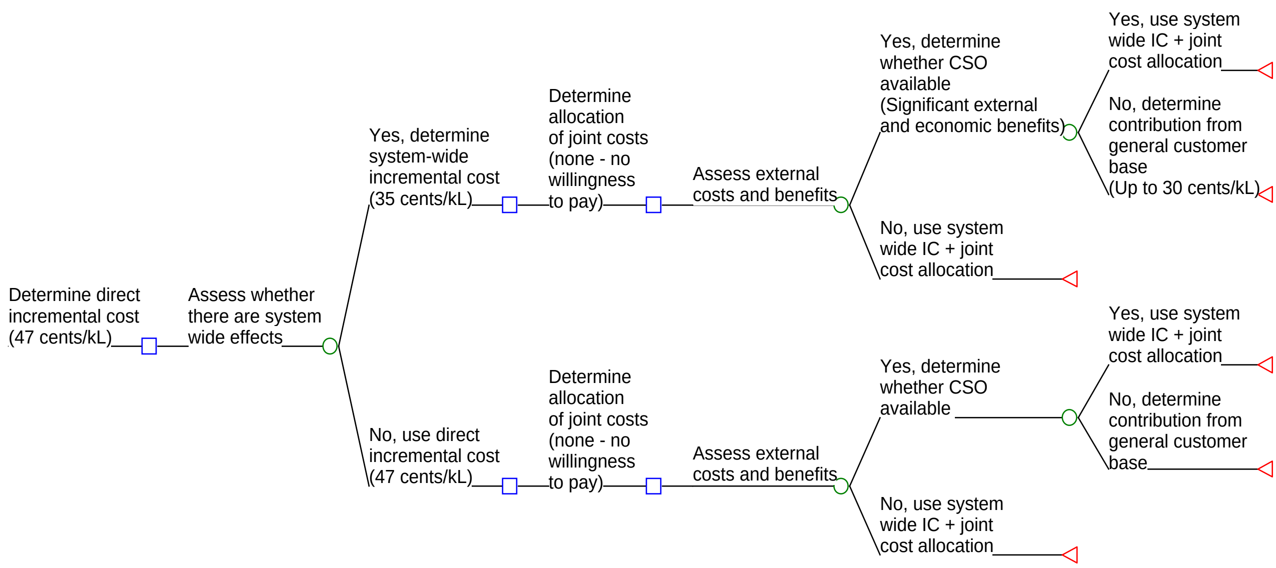


Figure 14 Assessment of incremental cost



8.6 Pricing structure

If low-cost groundwater is freely available, the price that is able to be charged for a unit of recycled water may be significantly below the marginal cost of supplying the recycled water – both short-term and long-term marginal costs.

Indeed, there may be a 'second best' argument for pricing recycled water below its marginal cost if groundwater is being charged at less than its true marginal social cost, in order to redress the distorted incentives for users to use groundwater rather than recycled water.

If groundwater is not available, or is priced to better reflect the environmental costs associated with its continued extraction, the price ceiling for recycled water will be correspondingly higher. This would then permit charging a volumetric price for recycled water more reflective of its marginal cost.

To the extent that there is a reasonable expectation that the unsustainable extraction of groundwater will not be permitted to continue indefinitely, this suggests that making recycled water available at less than its marginal cost should only be seen as a short term response. Locking in low prices for long contract terms may introduce a further long-term distortion.

9 Case Study 3: Recycled water for new housing developments

9.1 Description of scheme

This case study takes the example of:

- providing a major greenfield housing development (Boomtown) with Class A recycled water (for certain uses such as garden watering, toilet flushing etc) alongside potable supplies, and
- using rainwater tanks and water sensitive urban design to reduce demand for potable water and improve the management of storm water.

As with the previous case studies, the numbers used in this case study are intended to be broadly reflective of the costs of undertaking this type of recycling scheme. However, the numbers have been chosen to illustrate the principles involved, and hence do not represent any scheme in particular.

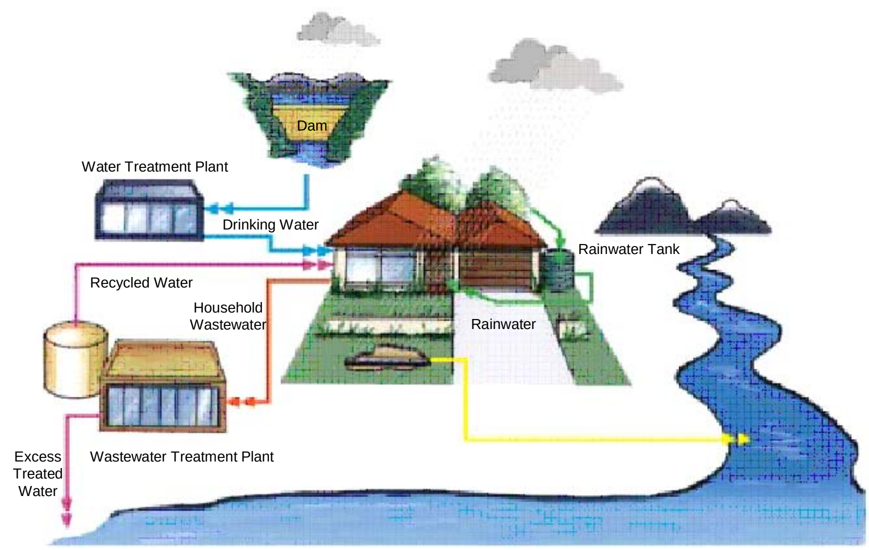
Figure 15 provides a diagrammatic representation of the scheme.

The benefits of the scheme include very substantial reductions in potable water demand and in effluent discharges into the environment, compared to the standard potable supply system.

The scheme is to be developed in an area in which rapid population growth is forecast, approximately 150,000 people over 50 years. The existing infrastructure in the area is insufficient for the expected growth. As the region as a whole is experiencing water shortages, the projected increase in demand for water will place considerable strain on available supplies if it is to be met solely from potable sources.

The expenditures required to meet the forecast growth in demand will be undertaken by a combination of the water business, the local council and developers. It is the comparison of total costs to the community as a whole that is relevant when determining whether it is appropriate to employ the recycled approach rather than the traditional approach. However, it is the costs borne by the water business that need to be recovered in prices, although an understanding of the costs borne directly by other parties is necessary to determine willingness to pay. Therefore Section 9.1.1 examines the total costs involved with meeting future demand, and Section 9.1.2 examines the costs that are specific to the water business and hence need to be recovered in the pricing of recycled water.

Figure 15 Recycled water schematic



9 Case Study 3: Recycled water for new housing developments
continued

9.1.1 Comparison of recycling versus traditional approach to meeting demand

Volumes delivered

Figure 16 shows the trend in volumes of water delivered to the development, comparing the volume and composition of water delivered under the recycling approach versus the standard potable approach. The left hand side of the figure shows the trend in delivered recycled water, potable water and the amount of rainwater utilised through the rainwater tanks. The right hand side shows the amount of potable water delivered under the standard approach.

The figure shows that the total volume of water delivered (from all sources) is somewhat less under the recycling approach, compared to the standard potable approach, with the amount of potable water delivered being significantly lower.

Note that Annex A provides further details of the volumes and expenditures that underpin each of the figures in this section of the paper.

Total capital expenditures

Figure 17 shows the capital expenditure involved in supplying services to Boomtown, comparing the recycled water approach with the standard potable approach. For each approach, the figure shows the level of investment required in infrastructure to supply recycled water, potable water, sewerage and stormwater services. In total, capital expenditure is $837m (in NPV terms) under the recycling approach, and $732m under the standard potable approach.

Figure 16 Volumes of water delivered

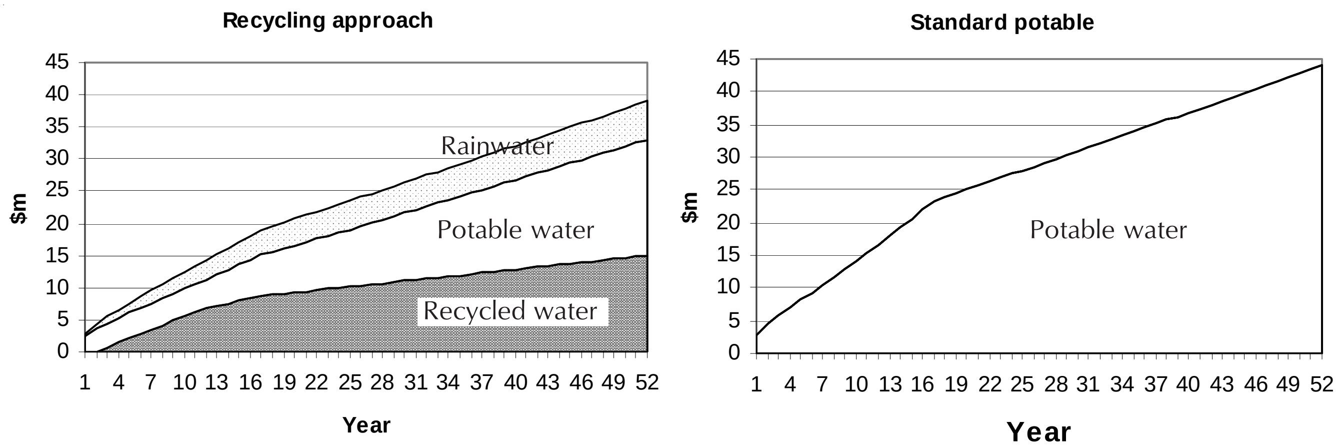
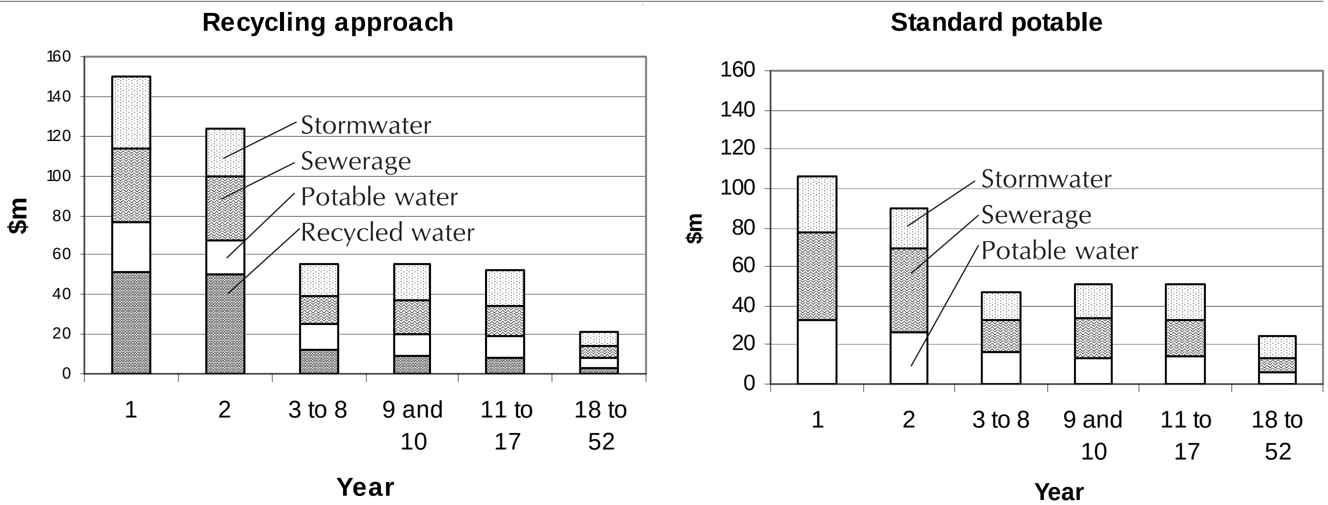


Figure 17 Total capital expenditure



9 Case Study 3: Recycled water for new housing developments
continued

Using the recycled water approach, investment on recycling assets includes construction of a recycled water treatment plant, development of aquifer storage, the distribution system including storage reservoirs, the reticulation system and internal household plumbing works (including household tanks and pumps).

Total investment in the potable water system includes expenditure on the distribution system (pipelines and pumping stations), service reservoirs, reticulation pipeline systems and household plumbing works. The expenditures on potable assets are much lower than for the standard potable approach, as these are a relatively smaller element of the recycled scheme. Note that the expenditures do not include "headworks category 1" costs, which relate to infrastructure planned on the basis of demand in the region as a whole. While demand in Boomtown will influence the timing, and possibly the scale, of expenditures on water reservoirs, treatment plant and trunk distribution, these expenditures are not incurred solely on behalf of the development. Hence they are considered in the section on system wide costs below.

Investment in sewerage includes trunk sewers, rising mains and household sewers. We have excluded expenditure on sewage treatment and discharge, again on the basis that these are planned on a system-wide basis. These costs are considered below in the section on system wide costs.

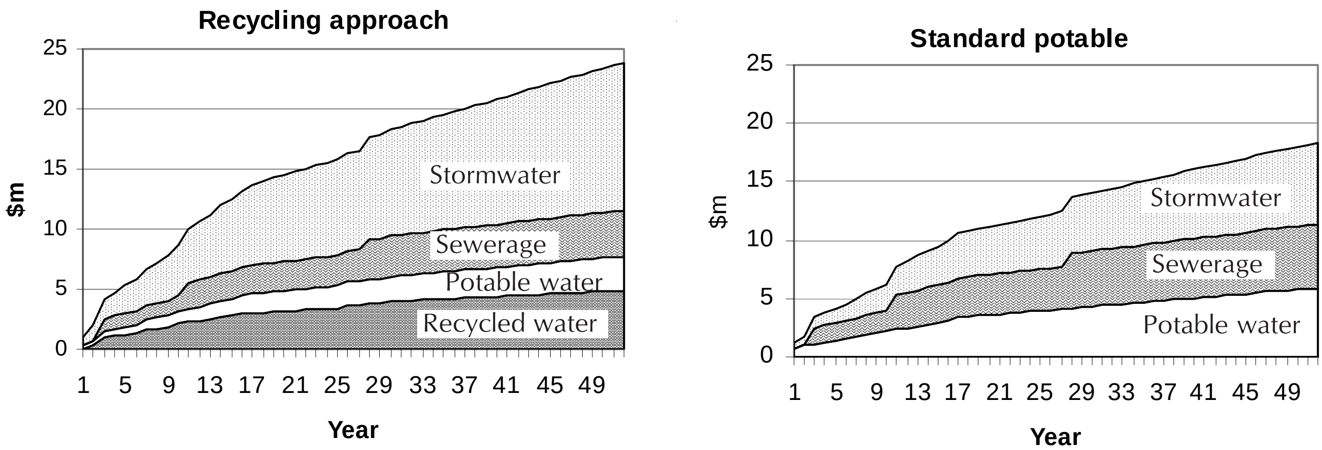
Investment in stormwater services involves the provision of stormwater drainage, and in the case of the recycling approach, rainwater tanks.

Figure 17 indicates that the total level of direct capital expenditure is higher under the recycling approach. This is because the savings in direct capital expenditure on potable water and sewerage services is more than outweighed by the additional expenditure on recycling assets. The savings in indirect or system-wide costs, which can be expected to offset the higher direct costs incurred under the recycling approach, are considered further below.

Total operating expenditures

Figure 18 compares the expected level of operating costs incurred under the two approaches. Under the recycling approach, the savings in potable water and sewerage operating costs are slightly greater than the additional recycled water operating costs. However, there are substantial additional operating costs involved with the rainwater tanks (which are part of the stormwater costs). In total, operating expenditure is $167m (in NPV terms) under the recycling approach, and $129m under the standard potable approach

Figure 18 Total operating costs



9 Case Study 3: Recycled water for new housing developments *continued*

Comparison of recycled and traditional potable approaches

Table 10 summarises the total direct costs involved in the two approaches, in NPV terms (assuming a 6% cost of capital). This shows that the direct cost of using the recycling approach is $1,005m compared to $861m under the standard potable approach (which amounts to a difference of 16.7%).

Table 10 Comparison of total costs

	Total costs $m	
	Recycling approach	Standard potable
PV of capital recycling	196	0
PV of capital potable	170	220
PV of capital sewerage	224	269
PV of capital stormwater	246	244
PV of opex - recycling	37	0
PV of opex - potable	20	42
PV of opex - sewerage	30	41
PV of opex – stormwater	81	46
Grand Total	1,005	861
PV of volumes delivered ML/d	245	284
Cost $ per kL	11.23	8.31

These costs can be converted into a cost per kL by dividing the absolute cost by the present value of the quantity of water delivered. (For the recycled case, we take the total of all water delivered – ie recycled, potable and rainwater). However the comparison of price per volume is somewhat misleading, because the emphasis on conservation with the recycling approach results in a reduction in total water delivered. Hence the cost per kL for water delivered under the recycling scheme appears significantly higher at (35%), while the costs of meeting demand under the two approaches differs by just 16.7%.

Moreover, we need to consider the implication of system-wide savings before making comparisons between the recycling and potable approaches.

System wide implications

We assume that under the recycling approach the very significant reduction in potable volumes enables delays in the planned augmentation of major resource and treatment capacity required to serve the potable customer base, relative to what would be required if Boomtown was to be served by a standard potable system. Similarly, we assume that planned augmentations to sewerage treatment plant can be delayed by instituting the use of smart sewers rather than traditional construction methods.

Under the standard potable approach, we assume that meeting region-wide demand requires a major resource expansion, costing $100m, to begin in year 4 along with an extension to treatment capacity costing $50m. Given continued growth in demand, a desalination plant is planned for year 20, costing $90m. (All expenditures are expressed in 2004 prices). In total, the NPV of these costs amounts to $147m.

A substantial amount of the growth in demand is contributed by Boomtown. If the recycling approach goes ahead, therefore, we assume that the resource expansion can be delayed until year 20, the treatment expansion can be delayed until year 10 and the desalination plant can be avoided altogether. Given these deferrals (and avoidance of de-salination), the NPV of these headworks costs is reduced to $59m.

We assume that similar deferrals on the sewerage treatment and disposal side amount to $10m in NPV terms, with treatment and disposal capital expenditures reduced from $40m to $30m in NPV terms.

Taking into account these system-wide savings from deferrals, the comparison between the recycled and potable approaches is shown in Table 11. (The table does not include the direct costs of supplying customers in other parts of the water authority's supply area, but these are assumed to be the same for the recycling and potable approaches).

9 Case Study 3: Recycled water for new housing developments *continued*

Table 11 Comparison of total costs under recycling and potable approaches

	Recycling approach	Standard Potable	Difference
Direct cost Boomtown	1,005	861	144
Headworks 1 costs - water	59	147	- 88
Headworks 1 costs - sew	30	40	- 10
Total	1064	1007	46

Relative to a standard potable water supply system, the recycling approach involves higher direct costs of $144m in NPV terms. However, the recycling approach enables savings on headworks costs of $98m for potable water and sewerage services. Overall, the recycled approach involves an additional $46m in NPV terms compared to the standard potable approach.

Option value

We note that the installation of dual reticulation capabilities may have value extending beyond the specific recycling scheme. Houses fitted in this manner can be expected to offer access to the retrofitting of a variety of alternative supply capabilities at substantially lower cost than would be the case with the single supply system of a traditional supply. This extra value, which could be viewed as flowing from the *options* created by the greater system flexibility, is unlikely on its own to be sufficient to justify dual reticulation, but might be enough in some cases to tilt the balance.

External benefits

Table 12 recaps the volume of potable water supplied under the two different approaches, along with the associated quantity of wastewater collected. This shows a very large decrease (65%) in potable volumes required. There is a smaller (22%) reduction in wastewater collected from the households, since wastewater is collected from both potable and recycled water used in the development. However a lower overall return factor is achieved through greater use of technology and customer education. In addition, there is a significant reduction in the amount of stormwater inflow and groundwater infiltration into the waste system.

Table 12 Comparison of volumes delivered and collected

	Standard potable approach	Recycling approach	% Reduction
Potable water (PV of ML/d)	283.7	100.4	65%
Sewage collected (PV of ML/d)	209.0	162.3	22%

On the basis of these reductions in volumes, it is very likely that the recycling approach will bring with it significant environmental benefits. These will include the external benefits that result from reduced potable extraction, and reduced effluent discharges. For example, annual external benefits of $2.9m pa or more would be sufficient to offset the above $46m present value differential and to justify the recycling approach.

The above considerations suggest that the scheme, viewed from the perspective of the whole system and factoring in the external impacts, may well offer a net benefit. The question then arises as to whether pricing arrangements can be developed to share the costs in a way that makes the scheme feasible.

9.1.2 Costs to the water business

When pricing recycled services, only the costs incurred by the water business should be recovered through charges. However knowledge of the costs incurred by other parties, such as developers, will be important in determining willingness to pay.

Direct costs

Table 13 summarises the direct costs incurred by the water business under each of the recycling and traditional potable approaches. It also sets out the costs incurred by third parties. The table shows that in fact many of the costs involved in servicing a new development are incurred by other parties including developers, local council and householders. Such costs include reticulation systems, household plumbing, household sewers and stormwater costs (which includes the provision of rainwater tanks)[34].

[34] While these costs are relevant to an overall assessment of the viability of the recycled approach, they have been excluded from the costs to be recovered by the authority itself. If the authority were also responsible for stormwater and/or provision of rainwater tanks, these costs would also need to be incorporated into the analysis here.

9 Case Study 3: Recycled water for new housing developments *continued*

Table 13 Comparison of direct costs to the water business

	Direct costs to the water business $m	
	Recycling approach	Standard potable
<u>Direct costs to water business</u>		
PV of capital recycling	128	0
PV of capital potable	65	91
PV of capital sewerage	77	100
PV of capital stormwater	0	0
PV of opex - recycling	22	0
PV of opex - potable	5	25
PV of opex - sewerage	7	14
PV of opex – stormwater	0	0
Total direct cost to the water business	303	230
Direct costs to other parties	701	631
Total direct costs per Table 10	1005	861

System wide costs

Table 14 summarises the difference in the costs incurred by the water authority between the recycling and potable approaches. In contrast to total costs incurred by all parties, the costs to the water authority are lower using a recycling approach than the standard potable approach. This is because much of the higher direct costs under the recycling scheme are borne by third parties. Although the direct costs of the recycling approach are still higher than under the potable approach, these higher costs are more than outweighed by the savings made through deferring system-wide expenditures on headworks for water and sewerage.

Table 14 Comparison of water authority costs under recycling and potable approaches

	Recycling approach $m NPV	Standard Potable $m NPV	Difference $m NPV
Direct cost Boomtown	303	230	73
Headworks 1 costs - water	59	147	- 88
Headworks 1 costs - sew	30	40	- 10
Total	393	417	-24

9.2 Willingness to pay

The willingness of the householder to pay is complex to assess in this case. There are a range of considerations that are likely to influence the householders' decision and willingness to pay.

We assume that householders in Boomtown would not be offered a choice between a recycled supply and an alternative (potable) supply. Rather it is assumed that it will be mandatory for each house to be connected to the recycled supply for uses such as garden watering, toilet flushing etc. While a household can choose to use more or less potable and recycled water, the key decision point for them is whether or not to purchase a house in the development.

Ultimately, the costs of installing water and sewerage infrastructure will be borne by householders, and/or the existing owners of the land (which may become more or less valuable depending on the costs of development versus the value of the housing provided).

Importantly, the "greenfield" nature of the site means that the utility's supply of services (potable, recycled and sewerage) will be paid for by a combination of developer charges and annual water and sewerage charges. In addition, developers will bear a significant portion of the third party costs identified in Table 13 above. Therefore the householders' willingness to pay will need to account for annual charges and the implication of developers' costs[35] on the price of housing in Boomtown.

The willingness of developers to pay will be relevant, assuming that any individual developer has the choice of building in Boomtown or elsewhere. Thus there will be a point at which the overall cost of building in Boomtown may induce a developer to not proceed if the price at which they can sell to homeowners renders the project commercially unattractive relative to other opportunities.

From the point of view of householder, the willingness to pay for developers' costs will in turn reflect the willingness of homebuyers to pay for house/land packages. Expectations of future annual water and sewerage charges for the development will also impact on what people are willing to pay for the property.

[35] Where developers' costs comprise both the costs incurred directly by developers and developer charges.

Householders will compare the level of charges they pay under the recycled scheme with the standard tariffs for water and sewerage (which are typically regionally averaged tariffs). It is expected that there will be some acceptance that tariffs may need to rise to reflect rising costs for supplying water supply, particularly when there are concerns about water scarcity. However, householders may be concerned if the charges become too high compared with the regional-average tariffs. For this purpose, it is the amount of the average bill that is likely to be relevant, possibly adjusted for any change in the acquisition price of the property, rather than the volumetric and service charges levied *per se*.

Customers may also be willing to pay a premium for environmentally friendly or "green" water and sewerage services and the associated community environment, and possibly also for a reduction in the likely level of future usage constraints – effectively greater reliability of supply. This premium may be in the amount of developer costs and/or annual charges.

9.2.1 Annual prices to existing customers

By way of comparison, the current volumetric charge to existing potable customers is assumed to be $1.00 per kL, which is combined with a fixed charge of $150 per property. For sewerage we assume there is a single fixed charge of $420 per property. Assuming an average household consumption of 300 kL per property, Table 15 sets out the charges to the average existing household. These are expressed on a per kL of total water delivered basis and as an average bill per household.

Table 15 Tariffs to existing customers

	Average charge per kL of water delivered	Ave bill per household
Water	1.50	450.00
Sewerage	1.40	420.00
Total	2.90	870.00

9.3 Incremental cost

9.3.1 Direct incremental cost of recycling scheme

For pricing purposes, we are interested in the direct incremental cost of the scheme, taking into account only the costs that are incurred by the water business.

Table 16 details the calculation of direct incremental cost for each of the services provided, as:

Incremental cost = NPV(capex and opex)/NPV(water delivered)

As before, we calculate total incremental cost based on the total water delivered (whether recycled, potable or rainwater). We also calculate a cost per household.

Table 16 Direct incremental cost to the water authority under recycling scheme

	PV capex	PV opex	PV water used	Incremental cost	Ave incremental cost per house-hold
	$m	$m	Ml/d	$/kL	$/hh
Recycled water	128.1	22.4	245.0	1.68	468
Potable water	64.7	5.1	245.0	0.78	217
Sewerage	76.6	6.7	245.0	0.93	259
Total	269.3	34.1		3.39	944

9 Case Study 3: Recycled water for new housing developments *continued*

The total direct incremental costs to the authority of the recycled scheme are $303 million. The incremental costs (expressed in $/kL) are higher than the existing level of charges. This is due in part to the anticipated water conservation savings, which reduce the denominator (the PV of water delivered). The average direct incremental cost per household (calculated on the basis of equivalent tenements) is also shown in Table 16.

A further reason that the direct costs appear high is that they include some costs which are usually recouped through developer charges (ie headworks category 2[36] and local distribution costs). Hence some of these costs would be charged to developers, rather than through annual water and sewerage bills. (Note, however, these incremental costs do not include any allocation of headworks category 1 costs- ie the system wide costs – which are considered further below).

9.3.2 Direct incremental cost of traditional potable supplies

Table 17 calculates an equivalent direct incremental cost of providing potable water and sewerage services under the traditional approach, based on the water business' own costs. The direct incremental cost of undertaking the standard potable approach amounts to $230m in NPV terms.

Comparison of Table 16 with Table 17 shows that the recycled water supply system involves higher direct costs than the standard potable water system: namely $944 less $715 = $229 per household per annum, or $303m less $230m = $73m in terms of NPV of direct costs. However, this comparison does not take into account the savings in headworks 1 costs that result from using a recycled approach, or the external benefits, which are considered in the next sections.

9.3.3 System-wide incremental cost

Section 9.1.1 identified the amount of savings to the water business expected from the recycling approach in terms of the deferral of resource and treatment expenditures required for the region as a whole (relative to a standard potable approach). These savings amounted to $88m for water and $10m for sewerage in NPV terms.

Efficiency requires that the savings be allocated to recycled customers to the extent it is required to ensure that prices fall within the Baumol-Willig efficient price band. Once this is achieved, equity may suggest that any residual benefits of reduced costs be shared between the recycled and standard customers.

Note, however, that if the potable approach of meeting future demand were to be followed, the costs involved would be spread over the combination of new and existing customers. Thus we need to identify the savings that accrue to standard (or non-Boomtown customers), as distinct from the customer base as a whole. The total amount of these savings then represent the maximum amount that standard potable customers would be willing to contribute towards the cost of recycling scheme.

Table 17 Direct incremental cost to authority under standard potable approach

	PV capex	PV opex	PV water used/sewage collected	Incremental cost	Ave cost per house-hold
	$m	$m	Ml/d	$/kL	$/hh
Potable water	91.4	24.7	283.7	1.12	361
Sewerage	99.5	14.3	283.7	1.10	354
Total	190.9	39.0		2.22	715

36 Costs included within the Headworks 2 category include items such as trunk mains the reticulation System, Pump stations, elevated reservoirs and non-centralised ground level reservoirs.

9 Case Study 3: Recycled water for new housing developments *continued*

Table 18 Allocation of shared headworks costs

	Potable approach	Recycling approach	Difference	System wide incremental cost	Difference between std potable & recycled after reallocation
Boomtown					
Direct Incremental cost	230	303	73		
Share of Headworks	53	25	28		
Total	283	329	46	= 329 - 70 = 259	-24
Non-Boomtown					
Direct cost	Y	Y			
Share of Headworks	133	63	70		
Total	133+Y	63+Y	-70	=63 + Y + 70 =133+Y	0

Reallocating potable savings to Recycling approach

Table 18 makes a simple assumption about the allocation of headworks costs between Boomtown and other standard potable customers, namely that $70m of the $98m savings in headworks 1 costs accrue to standard potable customers[37]. This provides a basis for allocating the headworks costs between Boomtown and other customers as per the second and fifth lines of the table. Thus the headworks costs are shared between other customers and Boomtown in the ratio 70:28 (ie 133:53 under the potable approach and 63: 25 under the recycling approach).

The fourth column of the table shows that, consistent with our assumption, the savings in headworks costs that result from undertaking the recycling approach are assumed to be made up of $28m savings to recycling customers and $70m of savings to standard potable customers.

For this example, we assume that it is appropriate to transfer all of the headworks savings that accrue to potable customers to the recycled scheme, in order to ensure that the scheme goes ahead[38]. Thus the system-wide incremental cost is assumed to be $259m in total NPV terms, or $806 per household.

By transferring all of the savings on headworks expenditures that standard potable customers would have enjoyed as a result of the recycling scheme, we ensure that all of the savings that arise from undertaking the recycling scheme are attributed to recycling customers. This can be seen from the final column of the table, which shows that the difference between column 1 and column 4 ($24m) equals the total savings in direct costs to the water authority (as per Table 14).

Note that we have made a simplifying assumption that the direct incremental costs of supplying Boomtown should be recovered directly from Boomtown customers. If, however, the costs of servicing new areas are not completely covered by the customers in those areas, so that some of the additional costs are rolled into the overall customer base, then the amount that existing (non-Boomtown) customers would be willing to pay for the recycled scheme may be higher than the $70m assumed in Table 18.

If the system-wide savings are attributed to recycling customers, as per Table 18, then there is a choice as to whether these savings are used to reduce the annual charges to householders, or other charges such as developers charges. Given that the costs incurred by developers are higher under the recycling approach than under a traditional supply approach, making the savings available to developers may be an appropriate course.

[37] See Annex B for the derivation of this assumption, which relates to the relationship between incremental costs and existing average costs.

[38] Another option would be to allocate just sufficient savings to the recycling project to ensure that it goes ahead. By contrast, the option used in this example is to allocate all of the savings accruing to standard customers to offset the higher direct cost of the recycling scheme. In this case, charges to standard customers would be increased to the level they would have reached in the absence of the recycling scheme. Standard potable customers are no worse off, but there is a value judgment needed as to whether this would be equitable. In practice, the appropriate outcome is likely to lie somewhere between these two extremes.

9 Case Study 3: Recycled water for new housing developments
continued

9.3.4 External costs and benefits

In Case Study 2, external benefits justified pricing the recycling scheme below the incremental system wide cost to the water business, in order to ensure that the scheme proceeded. Section 9.1.1 above showed that an external benefit of $2.9m p.a. would justify the recycling approach in this case study. However, much of the additional costs of recycling are borne by third parties. Thus it is an open question as to whose costs should be mitigated/compensated in recognition of the external benefits of the scheme.

If some compensation is to be given to third parties, such as developers, this could be done independently of the water business. Alternatively it could be done by lowering the level of developer charges for Boomtown, and recovering the revenue loss from the entire customer base.

9.3.5 Fully allocated costs

As discussed above, the incremental costs above do not include any allocation for recycled customers' share in joint and common costs. For example, there is no element included for their share of the cost of providing water resources and treatment capacity – which is undertaken jointly for the region as a whole. Likewise there is no allowance for corporate overheads, or jointly provided sewerage treatment costs.

Given that total costs are lower under the recycling approach, there may be some ability to allocate such joint costs to the recycled water customers. However, care is required, given that much of the costs of the scheme are borne by third parties. Thus the water business will need to be careful that the total costs borne by households (through the cost of purchasing the house as well as annual water and sewerage charges) are not too high to breach the willingness to pay ceiling.

9.4 Charging structure

9.4.1 Developer versus annual charges

Once the quantum of costs to be recovered from the recycling customers and the remaining customer base has been determined (ie the savings in system wide costs have been allocated between the two groups), it is necessary to determine how these costs are to be recovered.

As suggested above, developer charges need to be determined jointly with future annual charges, and in the knowledge of the costs incurred by different parties. If the recycling approach is justified on triple bottom line grounds, then it is important to ensure that the incidence of costs and prices fall within the Baumol-Willig by-pass ceiling.

If the decisions of house purchasers (and hence developers) are relatively insensitive to the level of development costs, if for example these form a small part of the total cost of the house, some increase in the total quantum of costs incurred by developers could be managed. If however, the increased costs incurred by developers affect their willingness to develop properties in Boomtown, then the level of developers charges may need to be adjusted in order to ensure that the recycling approach can go ahead.

9.4.2 Structure of annual charges

It is also necessary to set the structure of the annual charges.

One option might be to consider setting the charge in terms of an annual bill (so that separate prices are not identified for recycled water, potable water and sewerage services). Such an approach might be warranted if the costs of providing the services are largely invariant to the volumes taken.

However, in practice it is likely that the long run costs will vary according to the volumes demanded, so that the lack of a volumetric element for recycled water charges may encourage inappropriately high consumption (as occurred in the Sydney Rouse Hill recycling scheme). Given that the LRMC of additional resources is high, it is likely to be preferable to set volumetric prices for each service.

In that case, the balance of fixed and variable charges will need to ensure that appropriate pricing signals are given by the volumetric price and that customers have an appropriate degree of control over the level of their bill. In addition fixed charges provide a degree of revenue stability, and therefore lessen the degree of revenue risk.

9.5 Inter-relationship with rest of the business

The implications of the recycling scheme for the charges to other customers will depend on a number of factors. These include:

- The extent to which joint costs are allocated to the recycled scheme. To the extent that a share of joint costs are not allocated to recycled users, charges to the remaining customer base will be higher;
- The extent to which costs are recovered through developer charges versus annual charges, and hence the comparison between the annual charges to recycled customers and the general customer base. If annual charges breach the willingness to pay ceiling, then it may be necessary to roll some of the costs into the general charging base in order to ensure that the recycling scheme goes ahead; and
- The extent to which subsidies are required to address the higher costs incurred by third parties, and the source

9 Case Study 3: Recycled water for new housing developments *continued*

of such subsidies. If it is the "responsibility" of the water business to ensure that the recycling scheme goes ahead, again some of the costs involved may need to be carried over onto the wider customer base.

9.6 Summary

The various pricing considerations are summarised in Table 19.

In this case, the level of annual charges to existing customers provides only a very approximate guide to the willingness to pay for recycled scheme. Several other considerations will also be important, including willingness to pay for the house/land package, and willingness to pay for a "green" water approach.

The direct incremental cost of the recycling scheme is $944 per household. If account is taken of the savings that arise for standard potable customers (in terms of delayed augmentation requirements), the price charged to recycled customers could be lower to $728 per household and still leave the standard potable customers no worse off than they would have been under a standard potable approach.

Whether it is appropriate to allocate any joint or shared costs to Boomtown customers will depend on a number of factors. Key issues include the willingness to pay for higher development costs, the incidence of costs on other parties, and the extent to which the wider customer base contributes towards the higher costs of recycling.

Table 19 Summary of pricing consideration for Case Study 3

	Considerations
Willingness to pay	Average potable bill to existing customers = $870 pa. Need to take account of the effect of developers' costs on the cost of properties. Customers willing to pay more for green water.
Direct incremental cost per hh	$944
System wide incremental costs per hh	$806
External costs and benefits	Likely to be significant
Allocation of shared costs	Depends on willingness to pay and contribution of wider customer base.

The figures below set out the assessment process for willingness to pay and incremental cost.

Figure 19 Assessment of willingness to pay

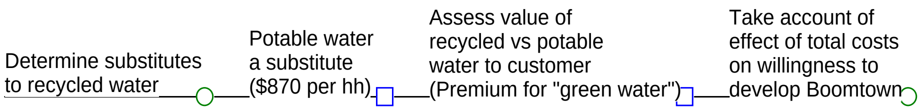
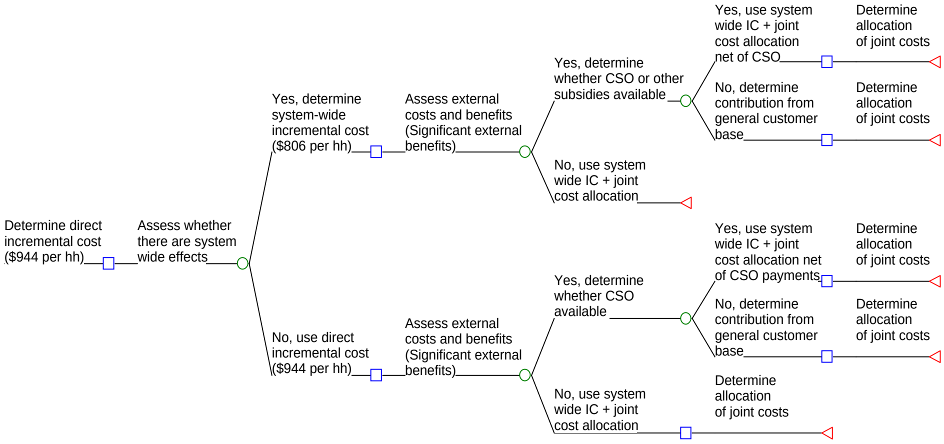


Figure 20 Assessment of incremental cost



Annex A to Case Study 3: Expenditure Data

All expenditures are expressed in 2004 dollars.

Total costs under the recycling approach

Table 20 details the total capital expenditure involved in supplying services to Boomtown under the recycled water approach. Thus they cover all expenditures, whether incurred by the water business, the local council or the developers.

Table 20 Capital expenditure under recycling scheme

Year	1	2	3 to 8	9 and 10	11 to 17	18 to 52
Recycled water capex $m	51.6	50.0	11.8	9.0	7.8	3.1
Potable water capex $m	25.0	17.0	13.2	11.1	11.1	4.6
Sewerage capex $m	37.0	32.6	13.8	16.7	15.0	6.2
Stormwater capex $m	36.0	23.8	16.7	18.0	18.0	7.7
Total capex $m	149.6	123.4	55.6	54.8	52.0	21.5

NB: columns may not add to totals due to rounding.

Table 21 details the total estimated operating costs and the quantity of potable and recycled water delivered under the recycling approach, including the quantity of wastewater discharged.

Table 21 Operating expenditure and services delivered under recycling scheme

Year	1	2	3	9	19	29	39	49
Operating costs $m								
Recycled water	0.07	0.30	1.01	1.84	3.11	3.79	4.35	4.79
Potable water	0.28	0.40	0.49	0.94	1.67	2.05	2.40	2.76
Sewerage	0.00	0.00	1.08	1.30	2.44	3.40	3.57	3.73
Stormwater	0.74	1.23	1.57	3.70	7.04	8.64	10.24	11.85
Total	1.08	1.94	4.16	7.78	14.25	17.88	20.56	23.12
Water delivered/sewage disposed of Ml/d								
Recycled water	0.0	0.0	0.7	4.8	9.1	10.9	12.7	14.5
Potable water	2.4	3.7	3.8	4.3	7.0	10.3	13.6	17.0
Rainwater	0.3	0.7	1.0	2.4	4.1	4.7	5.3	5.8
Sewerage	0.0	2.5	3.2	7.5	14.3	17.5	20.8	24.0

NB: columns may not add to totals due to rounding.

Annex A to Case Study 3: Expenditure Data
continued

Total costs under the standard potable approach

Table 22 and Table 23 show the equivalent information for a traditional potable approach. These tables show only the direct (ie non-system wide) costs. Total costs are given - ie those that would be incurred by the water business, local council or other parties such as developers.

Table 22 Capital expenditure under standard potable system

Year	1	2	3 to 8	9 and 10	11 to 17	18 to 52
Recycled water capex $m	0.0	0.0	0.0	0.0	0.0	0.0
Potable water capex $m	32.4	26.8	16.3	13.7	14.8	5.8
Sewerage capex $m	45.4	43.0	16.0	20.3	18.1	7.2
Stormwater capex $m	28.6	19.7	14.9	16.8	17.6	11.6
Total capex $m	106.4	89.5	47.2	50.7	50.5	24.6

NB: columns may not add to totals due to rounding

Table 23 Operating expenditure and services - standard potable system

Year	1	2	3	7	9	29	39	49
Operating costs $m								
Potable water	0.7	0.9	1.1	2.0	3.5	4.2	5.0	5.7
Sewerage	0.0	0.0	1.4	1.7	3.4	4.7	5.1	5.4
Stormwater	0.4	0.7	0.9	2.1	4.0	4.9	5.8	6.7
Total	1.2	1.6	3.4	5.8	10.9	13.9	15.8	17.8
Water delivered/sewage disposed of Ml/d								
Potable water	2.7	4.5	5.7	13.0	24.5	30.4	36.3	42.2
Sewage	0.0	3.2	4.1	7.7	9.7	22.6	26.8	30.9

NB: columns may not add to totals due to rounding

Annex B to Case Study 3: Derivation of savings to standard potable customers

Table 24 sets out the information needed to identify the savings that would accrue to standard potable customers as a result of the recycling scheme. The first line indicates an assumed annual cost[39] for existing water and sewerage capacity with respect to headworks 1 category assets. The cost associated with existing assets is assumed to be the same whether a recycling or standard potable approach is adopted.

The NPV of additional expenditure on headworks assets (from Table 14) is added to derive a total cost, in line three of the table, again in NPV terms. The volume of potable water supplied is also greater under the standard potable approach. However, the increase in costs is proportionately greater than the increase in volumes, reflecting the fact that water resources tend to be subject to an increasing cost supply curve.

The amount of the benefit that accrues to standard potable customers under the recycling approach depends crucially on the relationship between the average cost of the existing resource and treatment services and the incremental cost of providing additional services. If the incremental cost is very much greater than the existing average cost, then potable customers gain significantly by delaying the need for future expenditures.

Dividing volumes into costs provides a comparison of the average cost of providing bulk resource capacity to customers under each approach. As would be expected in an increasing cost industry, average cost is lower under the recycling scheme since the total quantity of potable water supplied is lower.

The penultimate line in the table identifies a quantum of savings that accrue to potable customers as a result of the recycling scheme being undertaken. This is calculated by multiplying the average saving per volume, equal to 0.16 – 0.14 (in units of $m per ML/d), by the NPV of potable water supplied under the recycling approach. This represents the amount that would be saved by all potable water users as a result of undertaking the recycling approach. The final line adjusts for the fact that some of these savings accrue to the potable volumes taken by Boomtown customers (and hence are not properly regarded as savings that accrue to standard potable customers).

Table 24 Savings accruing to standard potable customers

	NPV of costs and volumes under recycling approach	NPV of costs and volumes under standard potable
Cost of existing resources $m	440	440
Additional headworks 1 costs $m	89	187
Total cost of resources $m	529	627
Potable demand (NPV ML/d)	3,683	3,866
Average cost per volume ($m/ML/d)	0.14	0.16
Implied savings to all potable customers, $m	71	
Implied savings to standard potable customers, $m	70	

[39] For example, the NPV of annual depreciation charges plus allowed profit.

Survey of Recycled Water Schemes

Background

As part of this consultancy, ACIL Tasman undertook a survey of WSAA member's pricing practices. The survey sought information on the key drivers, uses of water, number and nature of users, pricing methodology, the level and structure of prices, the process for review of prices and length of supply contracts for *existing* recycled water schemes. Responses from WSAA members provided information on 142 schemes. The water from these schemes is used in households, industry, sporting fields, and agriculture.

The survey results indicated that in a significant proportion (44%) of schemes, users are not charged for recycled water. In respect of the zero charging schemes, many water authorities indicated a desire to charge for water in the future. There was a significant positive relationship between the use of water in agriculture and non-zero pricing. Only a small proportion of schemes charge more than 50 cents per kilolitre.

Key driver for establishment of scheme

The most common key driver for establishment of recycled water schemes was 'environmental'[40]. Over fifty percent of schemes indicated the reduction of impacts in receiving water was one of the key drivers of establishment (Table 25), while the reduction of extraction of surface water was also repeatedly indicated as an important driver.

Table 25 Key drivers for establishment of scheme:

Substitute for potable water use	Treatment/ disposal of waste	Economic development	Reducing impacts on receiving waters
25%	32%	13%	56%

Note: Respondents were able to indicate multiple drivers

Other notable key drivers indicated were 'public good' (35 percent), 'opportunistic', and 'ministerial conditions'.

There is some statistically significant correlation between the driver being treatment/disposal of waste and zero charge for recycled water. This indicates authorities are less likely to charge for recycled water when the motivation for establishing the scheme is the treatment/disposal of waste. The correlation between other drivers for establishment and non-zero pricing is not statistically significant.

Table 26 Correlation between establishment driver and non-zero charge for water

	Substitute for potable water use	Treatment/ disposal of waste	Economic development	Reducing impacts on receiving waters
Correlation coefficient	- 0.042	- 0.301	0.037	0.141
p-value	0.621	0.000	0.665	0.094

Uses of Water

The majority of schemes included in the survey results produce recycled water for public parks and sporting fields and agriculture (Table 27). Of the schemes that produced recycled water for more than one use, the majority produced the water for both agriculture and public parks.

Only three schemes produced water for household use. All of these schemes also produced recycled water for other purposes. The combined production of the schemes represents over 20 percent of the total volume of recycled water produced by the schemes included in the survey. The recycled water produced for household use is Class A for all schemes.

Eight schemes produce water for industrial purposes; of these schemes six were producing the water purely for an individual industrial user. These six schemes produce approximately 7 percent of the total recycled water produced by the schemes included in the survey. The class of water produced for industrial purposes varies between schemes.

Table 27 Uses of recycled water

Households (toilets and home gardens)	Industrial	Public parks and sporting fields	Agriculture	Environmental Flow
2%	6%	56%	43%	1%

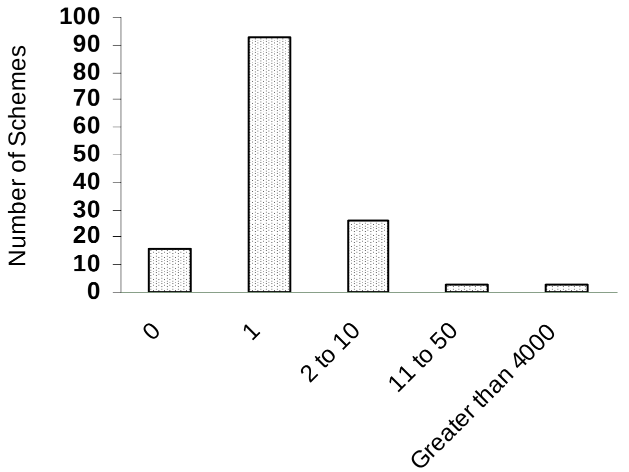
[40] The options for key drivers offered in the survey were 'substitute for potable use', 'treatment/disposal of water', 'economic development', 'reducing impacts on receiving waters' and 'other'.

Survey of Recycled Water Schemes
continued

Number of users/customers

There is some relationship between the number of clients and the use of the water. While the majority of schemes only have one customer, the three schemes that supply to households have the greater number of clients. One with approximately 4000; another estimates 8500 properties when the estate will be fully developed; and another scheme is starting at approximately 5000 customers, moving to approximately 150,000 by the year 2056. The six schemes that only supply water for industrial purpose have only one user per scheme and the majority of schemes producing water for agriculture have less than 10 users.

Figure 21 Number of users per scheme



Note: Zero users refers to authority using the water itself

Pricing Methodology

The survey responses indicated that a range of methodologies is currently used to establish prices for recycled water (see Table 28). Some 45 percent of schemes cited both 'assessment of willingness to pay' and 'cost analysis' as the basis of pricing methodology. The consideration of the environmental benefits in determining the price level of recycled water was also noted.

Table 28 Basis of Pricing Methodology

Assessment of willingness to pay	Specified percentage of potable water price (specify percentage)	Cost analysis	Competing product (e.g. irrigation supply)
57%	4%	58%	19%

The survey indicated a relationship between the assessment of willingness to pay and a zero charge – that is if the basis for pricing was 'assessment of willingness to pay', it was more likely that the scheme would charge for water. There is also a positive relationship between methodology being based on competing product and non-zero pricing. Of the 26 schemes for which the price of a competing product was indicated as a basis of pricing methodology, only one charged at a zero rate.

Price of recycled water

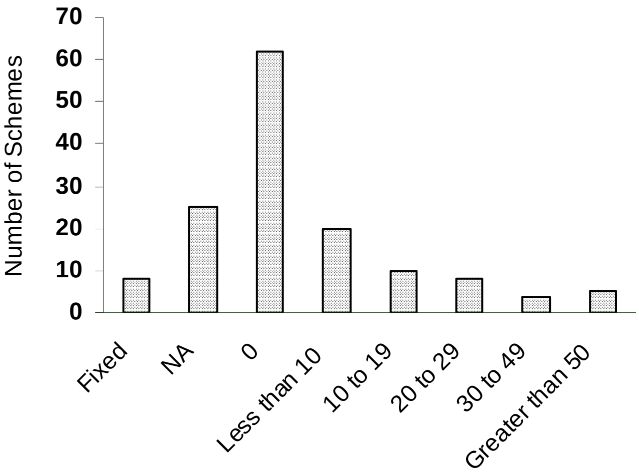
The survey results indicated that a significant proportion of recycled water schemes are not charging for recycled water. Some 44 percent of schemes have a zero charge for water. In respect of the zero charging schemes, many authorities indicated an intention to charge for water in the future. There was a significant positive relationship between the use of water in agriculture and non-zero pricing. Some schemes also included a "take or pay" clause in the contract.

Table 29 Correlation between pricing methodology and non-zero charge for water

	Assessment of willingness to pay	Specified percentage of potable water price (specify percentage)	Cost analysis	Competing product (e.g. irrigation supply)
Correlation	- 0.396	0.168	-0.200	0.380
p-value	0.00	0.045	0.017	0.00

Survey of Recycled Water Schemes
continued

Figure 22 Distribution of Price of Recycled water (cents per KL)



Note: 25 schemes did not provide a price, eight were fixed and could not be converted into cents per KL

Only a small proportion of schemes charge greater than 50 cents per kilolitre (Figure 22). The water produced from these schemes is used in households, industries, sporting fields, and agriculture.

Pricing Structure

The most common pricing structure of schemes reported in the survey is pure-volumetric (55% of schemes), while nearly a quarter of the schemes have a fixed annual charge. Only 4% of schemes utilised seasonal charges. The survey indicated no relationship between structure of pricing and use of recycled water.

Table 30 Pricing structure of recycled water (exclude zero charge data)

Two part tariff	Pure volumetric	Seasonal	Fixed annual charge
13%	55%	4%	24%

Note: percentages are based on respondents who indicated pricing structure. Zero charge data and undisclosed information is not included.

Process for review

Of the 142 schemes, information on the process of reviews for pricing was provided for 82 schemes. Of these, over 50 percent have an automatic adjustment for CPI. Also, a number of schemes have predetermined price paths set into the contract.

Table 31 Process for price review as percentage of responses

None – fixed for contract term	Automatic adjustment, eg. CPI	Provision for renegotiation
7%	51%	44%

Length of supply contracts

The most common length of contract was 10 years (Table 32), while 38 schemes had either an ongoing or standing contract. A number of contacts had an option for extension at the end of the period.

Table 32 Contract Length

	Standing/ongoing	5	10	15+
Number of schemes	38	21	37	17

Note: the remainder of schemes did not provide details of contact length

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continued

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Glossary

Effluent	Treated or untreated liquid waste flowing from agricultural and industrial proc esses, or from sewage treatment plants.
Environmental flow	The release of water from storage to a stream to maintain the healthy state of that stream.
Greywater	A combination of wastewater from the laundry, bathroom and kitchen.
Groundwater	Subsurface water from which wells, springs, or bores are fed.
Indirect potable recycling	The withdrawal, treatment and distribution of potable (drinking) water from a surface water or groundwater that contains some proportion of recycled water.
Industrial effluent	Liquid waste produced by industry and its processes.
Influent	Liquid waste flowing into a treatment facility.
Irrigation	The watering of crops, pasture, golf courses, parks, gardens and open spaces, which may involve using different applications (e.g. drip, trickle, spray and flood).
Integrated water cycle management	The integration management of water supply, wastewater (including recycled water) and stormwater systems to achieve sustainable outcomes.
Non-potable purposes	The use of water for purposes other than drinking, cooking and bathing: for example, irrigation of gardens, lawns and toilet flushing.
Potable water	Water of a quality suitable for drinking, cooking and bathing.
Rainwater tanks	Tanks used to collect and store rainfall from household roofs for beneficial use.
Raw water	Water that forms the source supply for potable water, before it has been treated.
Recycled water	Appropriately treated wastewater effluent
Sewage	The used water of community or industry, containing dissolved and suspended matter (also known as wastewater).
Sewerage	The sewerage system comprises the pipes and plant needed to treat sewage.
Sewer mining known as "water mining").	Diversion and treatment of sewage for on-site purposes such as irrigation (also
Stormwater	All surface water runoff from rainfall, predominantly in urban catchments.
Treated effluent	Aqueous waste flowing from agriculture and industry processes, or sewage treatment plants, that has been subjected to screening, sedimentation, biologi cal and chemical processes to improve its quality.
Wastewater	The used water of domestic, communicator industrial origin, containing dis solved and suspended matter.
Water quality	The chemical, physical and biological condition of water.
Water recycling eficial purposes.	Use of appropriately treated wastewater and urban stormwater for further ben-
Water resource	The sources of supply of ground and surface water in a given area.
Water Sensitive Urban Design (WSUD)	The integration of urban planning and development with the management pro tection and conservation of water within a whole water cycle context.

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