Oakley Greenwood

Cost drivers for wholesale sewerage services and cost impacts of recycled water plants

prepared for:

Independent Pricing and Regulatory Tribunal

MWH now part of Stantec

Melbourne +613 9016 2550 **Sydney** +612 8091 3650 **Adelaide** +618 8331 1358 **Brisbane** +617 3263 7612

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Report prepared by	Tim Ryan; Principal Consultant Jim Snow; Executive Director Chiew Wong; Principal Engineer (Stantec)
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1. Introduction

The Independent Pricing and Regulatory Tribunal (IPART) is currently undertaking a review of wholesale water and sewerage prices for Sydney Water and Hunter Water. Oakley Greenwood was engaged to provide advice on the cost drivers associated with wholesale sewerage services and the potential water and/or sewerage cost savings created by recycled water schemes.

As part of the engagement, Oakley Greenwood was required to:

- Identify the:
  - Cost drivers of wholesale sewerage services[1];
  - Sewerage and water costs to Sydney Water and Hunter Water that are likely to differ because a wholesale customer operates a recycled water plant; and
  - Possible sewerage and water costs or cost savings (i.e. avoided costs) to Sydney Water and Hunter Water from recycled water plants.
- Assess whether the above cost drivers or cost savings would be similar enough for different recycled water schemes that an average cost saving for a 'typical' scheme could be developed to be included in a system-wide price determination (either as a single price, a schedule of prices or a pricing methodology/formula).
  - If so, the time and information that would be required to develop robust 'average' or 'typical' values;
  - If not, set out the reasons that 'average' or 'typical' estimates would be materially inaccurate.
- Depending on the outcomes of the advice, develop quantitative estimates of the cost savings to be included in a system-wide determination of prices.

Oakley Greenwood's report (entitled "*Cost drivers for wholesale sewerage services and cost impacts of recycled water plants*") was published by IPART along with its Supplementary Draft Report on 27 March 2017.

IPART sought comments from stakeholders on its Supplementary Draft Report (including the Oakley Greenwood report).

IPART engaged Oakley Greenwood to:

- Review and advise on stakeholder submissions to the Supplementary Draft Report that relate to the Oakley Greenwood report; and
- Where required, update the Oakley Greenwood report to reflect stakeholder submissions.

1.1. Summary of submissions to IPART review

The following is a summary of the submissions to the wholesale pricing review that have led to the development, and refinement, of this report.

1 A wholesale sewerage service could comprise the transportation, treatment and/or disposal of waste from a wholesale customer to a Sydney Water / Hunter Water sewerage network.

1.1.1. Submissions to Draft Report

In response to IPART's November 2016 Draft Report and Draft Determinations, some stakeholders commented on:

- Whether the costs imposed by wholesale schemes on an incumbent's sewerage network differ between wholesale scheme with and without recycled water plants
  - That is, whether the waste discharged from a recycled water plant is significantly different to waste discharged directly from end-use sewerage customers, such that it changes the costs to the wholesale service provider (i.e., by changing the wholesale sewerage service that is provided)
- The propensity for wholesale customers' recycled water plants to create other cost savings (or avoided costs) for Sydney Water or Hunter Water
  - For example, a recycled water plant may avoid or defer the need for Sydney Water or Hunter Water to augment its water supply system.

Among the submissions to IPART's Draft Report, the following submissions made mention of the impact of recycled water plants on the costs of delivering water and sewerage services:

- City of Sydney;
- Flow Systems;
- Hunter Water;
- Lendlease Living Utilities (Lendlease);
- Sydney Water; and
- Water Services Association of Australia (WSAA).

Each of the submissions generally agreed that there is the potential for cost savings for Sydney Water and Hunter Water as a result of the operation of recycled water plants. However, there were different views as to how these would be calculated; the likely magnitude of them; and whether the potential savings are treated consistently across participants.

City of Sydney, Lendlease and Flow Systems sought to highlight the public benefits associated with recycled water, such as increased water security, enhanced liveability and conservation of drinking water supplies.

Flow Systems and Lendlease also highlighted the potential lengthy and costly process of adopting a scheme-specific approach to estimating the potential avoidable costs associated with recycled water plants.

Each of Hunter Water, Sydney Water and WSAA were of the view that there were inconsistencies in the treatment of recycled water schemes (and their associated benefits through cost avoidance) between incumbents (wholesale service providers) and new entrants (wholesale customers).

Both Hunter Water and Sydney Water also considered approaches for estimating upfront facilitation savings – either through a schedule or notional amount - to capture the operational benefits of introducing a recycled water plant.

Hunter Water stated that it accepted that a wholesale customer may create deferral benefits or result in avoided costs, however more work needed to be undertaken to calculate such benefits and demonstrate the ongoing nature of such savings.

1.1.2. Submissions to the Supplementary Draft Report

In response to IPART's Supplementary Draft Report, stakeholders provided submissions that considered the issues raised in the Oakley Greenwood report. Most submissions were supportive of the analysis within the report, with some highlighting examples of issues where further consideration may be required.

Hunter Water raised a number of issues in response to the report:[2]

- *The report is based on the assumption that the upstream potable water and downstream wastewater flow are reduced by the quantity of recycled water produced. This assumption will be valid in situations where all of the recycled water produced is used, however there are several examples of WIC licensed schemes where there is (or is expected to be) an excess.*
- *The report assumes that Hunter Water's LRMC is zero. This disregards the context provided by Hunter Water in its last retail price review.*
- *The bulk water supply and water treatment plant cost estimates should be compared with the public water utility's SRMC estimates (contained in each retail price submission). These may vary on a geographic basis (e.g., depending on whether the catchments are open/closed, or surface water or groundwater source).*
- *It is not clear whether the consultants have considered the impact a new recycled water plant may have on reliable peak potable water capacity at a water treatment plant and in the water supply system.*
- *The report considers the differences in wastewater network operational costs in situations where the public water utility has a gravity sewerage system but does not appear to consider pressure sewerage systems.*
- *The assumptions underpinning the water treatment plant operational cost impacts have not been provided and therefore the calculation cannot be checked.*

The Institute of Sustainable Futures' submission also put forward an approach for adopting specific average cost saving components based on the Oakley Greenwood report.

Sydney Water's submission stated that network and treatment operational savings for the water network should not be included as a minus, as these are already reflected in the reduced volumetric charges.

1.2. Context of the report

Our report is focused on identifying the potential cost impacts, for both the upstream and downstream networks of the wholesale service provider (i.e., Sydney Water or Hunter Water) resulting from the operation of a recycled water plant. We note IPART's wholesale pricing framework provides for a retail-minus pricing approach and consideration of facilitation costs. The purpose of this report is to advise on how these potential cost impacts are to be calculated not how they are reflected in the wholesale price methodology.

2 *Hunter Water's Response to Supplementary Draft Report*, May 2017, p.2-3.

In considering these cost impacts, our focus is on the direct, financial cost impacts for the upstream and/or downstream networks of the wholesale service provider (i.e., Sydney Water or Hunter Water). In undertaking this work, we have based our analysis of the impacts of recycled water plants on the wastewater treatment plants that are currently operating in Sydney Water's or Hunter Water's areas of operation, or likely to be operating in the near future.

We note that there are likely to be broader, public benefits (as identified in submissions from City of Sydney, Lendlease and Flow Systems) as a result of the introduction of recycled water plants. These broader public benefits include factors such as enhanced greening, urban cooling and liveability for communities – currently, these are all quite difficult to quantify. However, this is outside the scope of this project as these impacts do not affect Sydney Water's and Hunter Water's costs, rather they impact on the broader society.

1.3. Structure of the report

The structure of this report is as follows:

- Section 2 discusses the potential impacts for wholesale service providers through the introduction of a recycled water plant (RWP) by a wholesale customer;
- Section 3 considers whether it is feasible that these potential impacts can be estimated on a system-wide basis; and
- Section 4 derives system-wide estimates for those service elements where system-wide cost impacts were considered feasible.

1.4. Summary of findings for the report

Based on the findings of our review, we consider that system-wide cost impacts can be derived for some elements, however there are potentially significant cost impacts that, at this stage, would require scheme-specific estimates.

1.4.1. Cost drivers for wholesale services

The introduction of a RWP through a wholesale customer is likely to have cost impacts for the provision of both upstream (water) and downstream (wastewater) services. The magnitude (and direction) of these impacts is dependent on several factors – some within the wholesale customer's operational control of the RWP and others that are outside their control (operational costs of downstream wastewater treatment plants (WWTPs) or capacity in wholesale service provider's network).

Overview of impact of RWP on typical urban water cycle

When a RWP is introduced in a specific catchment, the upstream water demand and downstream wastewater flow change as a result. To a large degree, the impacts of the RWP depends on the type of RWP. We have considered recycled water plants operated by WICA licensees currently in the Sydney Water and Hunter Water catchment. Based on these schemes, the following recycled water schemes could be identified:

- Rainwater / stormwater / groundwater harvesting to produce recycled water, and return treatment plant waste to Sydney Water or Hunter Water's sewerage system
- Sewer mining at upstream of the development to produce recycled water, that either return or do not return treatment plant waste to Sydney Water or Hunter Water's sewerage system
- Treating all or part of the "new town" sewage to produce recycled water, that either return or do not return treatment plant waste to Sydney Water or Hunter Water's sewerage system

It is noted that the latter two schemes are collectively referred to as “sewage harvesting scheme”. The key distinctions for the purposes of assessing the impacts of recycled water plants on Sydney Water and Hunter Water costs include:

- Source water for recycling, e.g. stormwater, sewage upstream of the development served by the RWP, or sewage from the development served by the RWP;
- Whether the wholesale customer disposes of the treatment plant waste to a wholesale service provider’s sewerage network, or handles the waste itself; and
- Type of treatment technologies employed at the RWP. For example, whether reverse osmosis (RO) is employed to produce higher grade recycled water.

In summary, the following observations could be made:

- Stormwater / groundwater / rainwater harvesting scheme:
  - The upstream potable water is reduced by the quantity of recycled water consumed in the scheme.[3]
  - There is no reduction to the downstream wastewater flow as an additional new source of water is being added to the system.
  - The amount of downstream wastewater loads (mostly suspended solids) will increase by a small fraction due to removal of impurities from the source water.
- Sewage harvesting scheme:
  - The upstream potable water is reduced by the quantity of recycled water consumed in the scheme.
  - The downstream wastewater flow is reduced by the quantity of recycled water consumed in the scheme.
  - The amount of downstream wastewater organic / ammonia loads reduced cannot be related directly to the recycled water produced or consumed.
  - The amount of downstream wastewater phosphorous load reduced relates to the amount of recycled water being irrigated, and is generally scheme specific.

These permutations and considerations have implications to the magnitude of cost impacts achieved by the RWP, as explained further below.

1.4.2. Potential cost impacts to Sydney Water and Hunter Water from the introduction of a RWP

In considering the potential cost impacts for either Sydney Water or Hunter Water from the introduction of a RWP, we have considered the impacts under the following categories:

- Bulk water supply costs;
- Water supply network (i.e. distribution network) costs;
- WTP operational costs;
- WWTP operational costs;
- Wastewater network augmentation; and

3 Note that in using the quantity of recycled water consumed, we have not considered potential changes in consumption behaviour through the use of recycled water rather than potable water (discussed further below).

- WWTP (or disposal) augmentation.

The size of the RWP that is introduced will have an impact on the potential upstream cost savings – i.e., the larger the RWP, the larger the reduction in demand for potable water and therefore the larger the reduction in upstream costs. Given the integrated nature of the bulk water supply network, the location of the RWP is unlikely to have any material impact on the potential cost savings (so long as it is connected to the network). This is influenced by elements such as reservoirs and current capacity within the network.

Any operational cost impacts (both upstream and downstream) are likely to be relatively minor in the scheme of the overall costs. This is primarily due to the variable operating costs of both upstream and downstream services being quite low. The following factors are also important when considering the potential cost impact:

- The operational cost impacts for WWTPs are likely to be impacted by the type of downstream WWTP in operation; and
- Given the likely sizes of both the wholesale customer's RWP and the downstream WWTP, different types of RWP (which can impact on changes to the outflow, such as higher concentration of brine stream) are unlikely to have any effect on the operational cost impacts.

The potential cost impacts for wastewater network augmentation and WWTP augmentation are primarily driven by changes in flow and load requirements and the individual circumstances of the assets and catchments. These individual circumstances relate to factors such as location of the RWP (and the current spare capacity within the catchment) and whether different operating statuses of the RWP can be accommodated by the downstream WWTP. These factors can vary significantly from one catchment to the next and therefore have a considerable impact on any potential cost savings from the introduction of a RWP.

1.4.3. Feasibility of calculating system-wide cost impacts

The development of system-wide cost estimates requires two key factors:

- An understanding of whether individual circumstances (i.e. scheme-specific factors) have a material impact on costs; and
- Whether ex-ante values are available for the cost impact.

In assessing the feasibility of developing cost impacts for a system-wide basis, we considered whether these factors were present. Based on this assessment we concluded that there were two elements that system-wide estimates could be developed for:

- Upstream operational cost impacts for WTPs; and
- Bulk water supply.

We note that operational cost savings would generally be calculated on an actual basis, however, in order to develop ex-ante system-wide cost impacts, a number of assumptions were required with regard to aspects such as, distances for transfer/connection, electricity prices, pump and motor efficiency. Based on these assumptions, the estimated system-wide operational cost impacts for WTPs are:

- Pumping costs: changes in energy cost is estimated to be a cost reduction of approximately $0.04/kL of recycled water consumed.
- Treatment costs: changes in chemical costs is estimated to be a cost reduction of approximately $0.02/kL of recycled water consumed.
- Residual handling: changes in residual handling cost is estimated to be a cost reduction of approximately $0.005/kL to $0.01/kL of recycled water consumed.

It is noted that only variable operating cost component has been considered here. This is because of the relatively small size of all wholesale customers' RWPs at present, as compared to the sizes of existing WTPs. It is noted that the variable operating cost is generally a smaller component of the overall operating cost, as compared to some of the fixed cost items such as asset replacement.

To estimate the cost impacts of bulk water supply from a wholesale customer operating a RWP, we recommend that an LRMC estimate is used as a proxy for the potential upstream augmentation savings. The LRMC is an estimate of the additional cost of a unit of demand based on information on future capital augmentation requirements and expected potable water supply requirements. Given this, we consider that it is a reasonable proxy to determine the estimated cost savings from a sustainable reduction in a unit of demand. In order to value the bulk water supply cost savings, the estimated LRMC is to be applied to the volume of potable water that is displaced by the operation of the RWP.

In its review of Sydney Water's retail prices, IPART devised its own 'best estimate' range of the LRMC for bulk water augmentation based on its preferred approach to estimating the LRMC (a combination of both AIC and the perturbation approach) of $1.11/kL to $1.30/kL.[4] We recommend that IPART's best estimate range for the LRMC for Sydney Water be used as an estimate of the system-wide cost impacts for the upstream bulk water supply costs that could be avoided.[5] This recommendation is based on the fact that the supply of bulk water is highly integrated, the estimate of the LRMC reflects the additional cost of an additional unit of demand and there is a publicly available estimate that has been determined by the economic regulator.

In our previous report, we recommended using an LRMC estimate of zero for Hunter Water until an estimate was developed given that there was no publicly available estimate and no forecast supply augmentations. In response to the report, Hunter Water noted that while there was no publicly available LRMC estimate for Hunter Water, the use of a zero estimate was not appropriate. Given this, we have revised our recommendation and based our recommendation on the following hierarchy of estimation options:

1) Publicly available LRMC estimate for Hunter Water;
2) Develop an LRMC estimate for Hunter Water based on the best available information for Hunter Water at the time;
    a. This would essentially require information on future demand and supply augmentations based on various scenarios
3) Develop a proxy LRMC estimate for Hunter Water that is based on another LRMC estimate for a similar service provider.

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4 Independent Pricing and Regulatory Tribunal, *Review of prices for Sydney Water Corporation - Final Report*, June 2016, p.288

5 The choice of cost estimate within the range will be dependent on the assumptions underpinning the best estimate range and the prevailing supply and demand conditions facing the industry at the time of the introduction of the recycled water plant. As we are not aware of those scenarios that represent the higher-end of the range and those that represent the low-end of the range, we cannot provide explicit recommendations regarding the most appropriate estimate to use within the range. Our recommendation is to adopt an estimate at the high-end of the range when the prevailing conditions most reflect those scenarios that resulted in the high-end of the range; and to adopt an estimate at the low-end of the range when the prevailing conditions most reflect those scenarios that resulted in the low-end of the range.

Given the current circumstances and lack of available information, we recommend that the third option be adopted until such time that sufficient information is available to develop a Hunter Water LRMC estimate. Further details regarding this recommendation can be found in section 3.1.1.

When considering the use of LRMC to estimate bulk water supply cost savings, there are some factors that need to be considered, such as:

- Sustainable reduction in potable water
  - This ensures that it is a true reduction in future bulk supply augmentation requirements
- Capital planning information is robust
  - This is a key input for the estimation of LRMC, it is therefore important to ensure its accuracy and robustness
- Estimate of the LRMC is current
  - Estimates of LRMC change over time depending on the expected future demand and augmentation requirements, therefore a current estimate will provide a more economically efficient price signal to wholesale customers. The benefits of having a current LRMC estimate will need to be balanced with the increased administration cost of regularly updating the estimate.

Based on our analysis, there were some elements of the upstream and downstream services whereby a system-wide approach to estimating the cost impacts was not currently considered feasible:

- Water supply network augmentation;
- WWTP operational costs;
- Wastewater network augmentation; and
- WWTP augmentation.

In considering the appropriateness of system-wide cost saving estimates for these elements, we consider that the LRMC (and SRMC for operational costs) can be used as an appropriate proxy. However, we note that any use of the LRMC should seek to account for the factors that can influence the cost impacts for each of these elements – e.g., location/catchment, type of WWTP, etc. These factors are discussed in more detail in sections 2.2.1 and 2.3.1.

Those services that have considerable variation based on individual characteristics (such as the wastewater networks) may require catchment-based LRMC calculations in order to be appropriate. This would ensure that the individual characteristics of each of the catchments is not lost through the averaging process of the LRMC, thereby resulting in a more accurate estimate for the catchment (and ultimately a more accurate pricing signal).

Therefore, if Sydney Water and/or Hunter Water were to develop LRMC estimates for these services, we consider that they would be appropriate to use where wholesale pricing is seeking to provide ex-ante pricing signals through the use of system-wide cost saving estimates as part of its wholesale pricing.[6]

6 This is assuming that the LRMC estimates have been developed in an appropriate way that account for potential individual characteristics (see sections 2.2.1 and 2.3.1).

Application of estimated unit costs

The estimation of both the bulk water supply cost savings (using the LRMC estimate) and the WTP operational cost savings requires a calculation of the sustainable reduction in potable water demand. As a general rule of thumb, we would expect that the volume of water consumed by customers of the RWP would be a reasonable approximation of the displaced potable water. However, we note that there are factors that can influence the volume of displaced potable water, such as:

- Consumer behaviour changes; and
- Leakage within the recycled water network.

The focus of the report is on the calculation of potential cost savings as a result of a recycled water plant, however we have also identified a number of issues that will need to be considered when using this information for wholesale pricing, such as pricing signals and economic efficiency. This discussion can be found at Appendix B.

1.4.4. Changes from previous report

We have made two changes to our previous recommendations:

- Calculation of the cost savings to the upstream water supply system should be based on the recycled water consumed rather than produced, and
- Given the lack of a publicly available LRMC estimate for Hunter Water, the Sydney Water LRMC estimate should be used as the basis of a proxy until such time there is sufficient information to develop a Hunter Water LRMC estimate.

Further clarification of issues has been provided throughout the revised report in response to comments in submissions to IPART's Supplementary Draft Report.

2. Potential impacts of recycled water plants

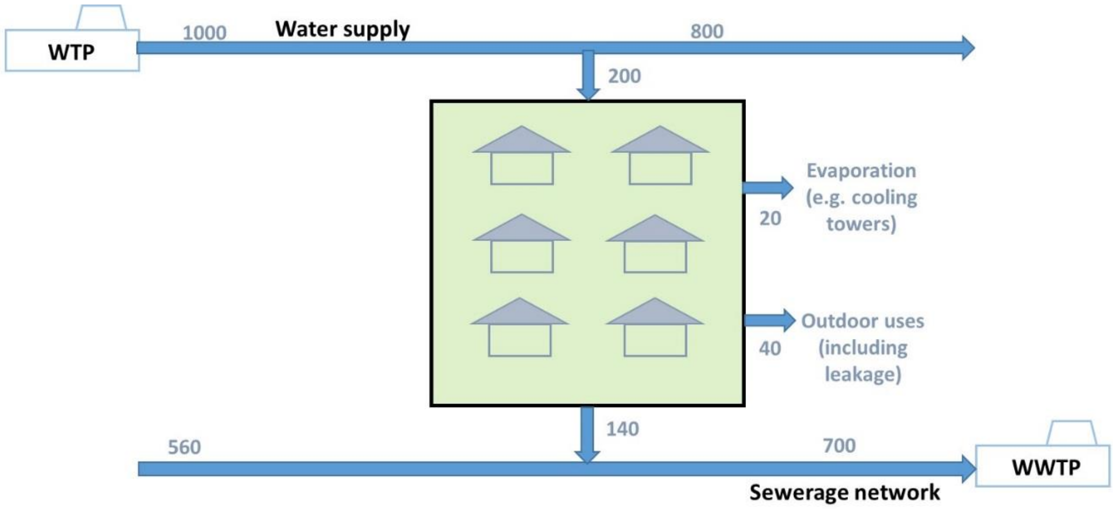
The introduction of a RWP through a wholesale customer is likely to have cost impacts for the provision of both upstream (water) and downstream (wastewater) services. The magnitude (and direction) of these impacts is dependent on a number of factors - some within the wholesale customer's operational control of the RWP and others that are outside their control (operational costs of downstream WWTPs or capacity in wholesale service provider's network). This section provides an overview of the potential upstream and downstream cost impacts from the introduction of a RWP and what factors may influence these impacts.

2.1. Overview of the impact of RWP on typical urban water cycle

Figure 1 provides a description of typical water supply cycle in Sydney Water and Hunter Water catchments. Water is supplied from Water Treatment Plant(s) (WTP) to both residential and commercial customers, while wastewater (or sewage) is returned to a local Wastewater Treatment Plant (WWTP), prior to discharge to the local water body (e.g. ocean, river).

It is noted that on a typical non-rainy day, not all of the water supplied is collected and subsequently treated in a WWTP. A small percentage of water is "lost" as a result of pipe leakage (typically 2% to 4%), while a further 20% to 30% is released to the environment with the end uses. For example, water irrigated onto parks or gardens is absorbed by soils, while water used in cooling towers is evaporated.

Figure 1: Typical "engineered" water cycle in an urban setting



When a RWP is introduced in a specific catchment, the upstream water demand and downstream wastewater flow change as a result. To a large degree, the impacts of the RWP depends on the type of RWP. We have considered recycled water plants operated by WICA licensees currently in the Sydney Water and Hunter Water catchment. Based on these schemes, the following recycled water schemes could be identified:

- Rainwater / stormwater / groundwater harvesting to produce recycled water, and return treatment plant waste to Sydney Water or Hunter Water's sewerage system
- Sewer mining at upstream of the development to produce recycled water, that either return or do not return treatment plant waste to Sydney Water or Hunter Water's sewerage system
- Treating all or part of the "new town" sewage to produce recycled water, that either return or do not return treatment plant waste to Sydney Water or Hunter Water's sewerage system

It is noted that the latter two schemes are collectively referred to as "sewage harvesting scheme". The key distinctions for the purposes of assessing the impacts of recycled water plants on Sydney Water and Hunter Water costs include:

- Source water for recycling, e.g. stormwater, sewage upstream of the development served by the RWP, or sewage from the development served by the RWP;
- Whether the wholesale customer disposes of the treatment plant waste to a wholesale service provider's sewerage network, or handles the waste itself; and
- Type of treatment technologies employed at the RWP. For example, whether reverse osmosis (RO) is employed to produce higher grade recycled water.

The following sections provide a conceptual discussion on the impacts of the different types of recycled water schemes on the upstream and downstream systems. In undertaking this analysis, it is assumed that introduction of a recycled water scheme will not affect customer behaviour regarding water consumption. This assumption is made as there is no conclusive evidence that a recycled water scheme affects customer behaviour on water consumption.

2.1.1. Rainwater / stormwater / groundwater harvesting scheme

In a rainwater / stormwater / groundwater harvesting scheme, the source of water is rainwater harvested and treated locally. The amount of recycled water consumed will lead to a reduction in the potable water required to be supplied.

However, there is no corresponding reduction to the downstream wastewater flow and load. In fact, there could be a minor increase to the wastewater flow and load (compared to if there was no recycled water plant) if the waste is discharged to the wholesale service provider's sewerage network. This is associated with the removal of impurities from the source water, e.g. low levels of suspended solids. Obviously if the wholesale customer decides to handle the waste itself, there is no impact to the wholesale service provider's sewerage network and downstream WWTP.

2.1.2. Sewage harvesting scheme

The majority of the recycled water schemes operated by wholesale customers treating sewage to produce recycled water to their customers. The major distinctions between the different schemes include:

- Source of sewage: Some projects harvest sewage from a large trunk main (often upstream of the development it serves), while other projects harvest sewage from the same development where the recycled water is supplied to. In the latter case, excess sewage could be disposed to the wholesale service provider's sewerage system.
- Disposal of waste: Whether the wholesale customer disposes of the recycled water plant waste to a wholesale service provider's sewerage network, or handles the waste itself (or employs a third-party provider to do so).

It is noted that if the wholesale customers do not dispose any of the excess sewage or treatment plant waste to the wholesale service provider's sewerage network there is no wholesale sewerage service provided.

To understand the impacts of the sewage harvesting scheme on the upstream water supply system and downstream sewerage network, a number of scenarios were examined. These are illustrated in Figure 2.

Figure 2: Effect of a sewage harvesting Recycled Water Plant in a typical urban water cycle

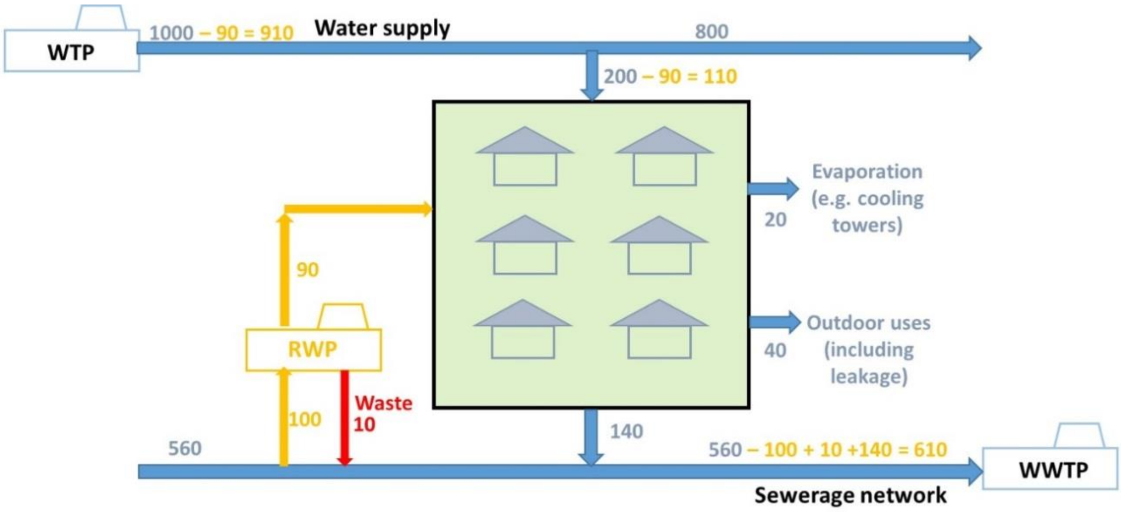


Figure 2 depicts a sewer mining scheme where recycled water is produced from an upstream trunk sewer.

Change in water and wastewater flows as a result of RWP

The water supplied by the RWP generally provides a direct reduction in the potable water supplied by the upstream WTP(s). At the same time, the amount of sewage released to the downstream sewage is reduced by the same amount, which is the quantity of the recycled water consumed.

Change in wastewater loads as a result of RWP

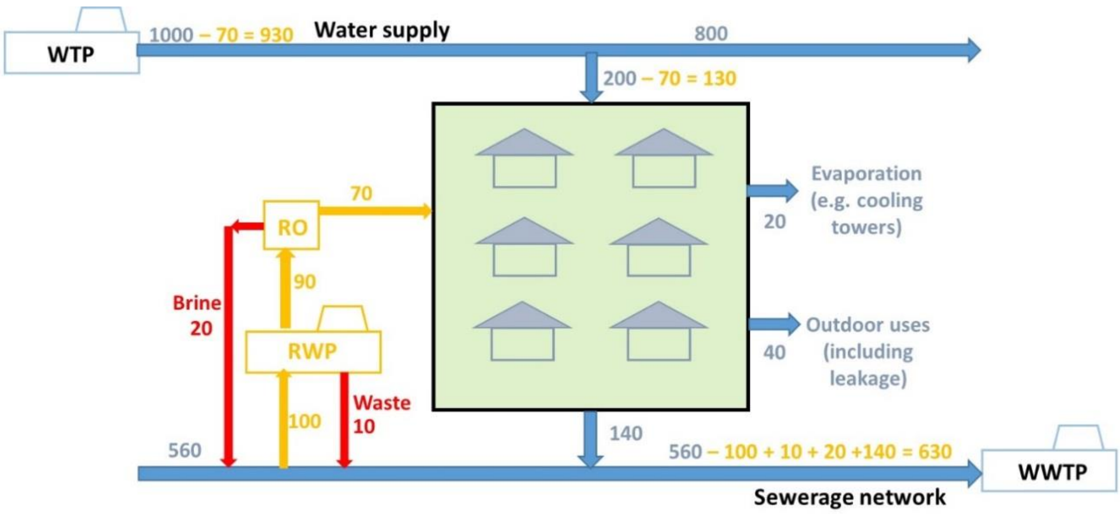
Wastewater consists of a number of compounds that may need to be removed by the downstream WWTP. This includes solids, organics, nitrogenous compounds (existing mostly in the form of ammonia) and phosphorous. It is noted that the requirement for downstream treatment depends on the local requirements and could vary significantly. This point will be discussed in latter sections.

When a RWP is implemented to produce recycled water from sewage, the following observations could be made with regard to the fate of the wastewater constituents, and thus the impacts of the RWP:

- Generally, in order to produce the recycled water, practically all biodegradable organic compounds, as well as ammonia, are oxidised as part of the treatment process. This is often required to ensure the efficiency of the downstream disinfection process.
  - Most of the organics are converted to gaseous carbon dioxide, and released to the environment. Some of the organics are utilised for growth, leading to the creation of biosolids as a by-product.
  - Essentially all nitrogen compounds in the wastewater is oxidised. Most of the oxidised nitrogen is then converted to gaseous nitrogen and released to the environment. A small fraction (generally less than 20%) remains in the oxidised state, e.g. as nitrate.
  - The **net impact** is that there is a reduction in the wastewater organic and nitrogen loads to be treated by the downstream WWTP.

- Phosphorous compounds:
  - A small percentage of phosphorous compounds are absorbed into the biomass to facilitate growth. If the biomass is subsequently wasted and disposed of into the downstream sewerage network, the amount of phosphorous reduced by the RWP is considered negligible.
  - Some reduction in phosphorous is achieved if phosphorous-rich recycled water is irrigated onto land. The quantity of phosphorous reduced is thus scheme specific, depending on the amount of recycled water being applied to land (if any).
  - The **net impact** is that there is only a reduction in the wastewater phosphorous loads if the recycled water is irrigated onto land.
- A number of residuals are produced from the RWP. These include screenings, grits, and biosolids as part of the by-products from the production of recycled water.
  - If the screenings and grits are returned to the downstream sewerage network, there is no reduction in the quantity of residuals to be treated at the downstream WWTP.
  - If the biosolids are returned to the downstream sewerage network, any reduction to the downstream WWTP biosolids can be considered minimal.
  - The **net impact** is that there is minimal reduction in the residuals as well as biosolids to be handled by the downstream WWTP.
  - If residuals such as screenings, grit and biosolids are disposed of independently by the wholesale customer, the **net impact** is a reduction to the downstream WWTP residuals. However, if there is no connection to the wholesale service provider's there is no wholesale sewerage service provided.
  - It is noted that the amount of organics and ammonia load reduced does not necessarily relate to the recycled water produced or consumed, but rather the wastewater flow treated by the RWP. This point is important when comparing a RWP without a RO process, with another RWP that consists of an RO process, as illustrated in Figure 2 and Figure 3. In both cases, the wastewater loads reduced are the same, however the RWP with a RO process will produce less recycled water, with some additional brine being produced.

Figure 3: Effect of a sewage harvesting Recycled Water Plant (with desalination process)



2.1.3. Summary of observations

In summary, the following observations could be made:

- Stormwater / groundwater / rainwater harvesting scheme:
  - The upstream potable water is reduced by the quantity of recycled water consumed in the scheme.
  - There is no reduction to the downstream wastewater flow as an additional new source of water is introduced to the system.
  - The amount of downstream wastewater loads (mostly suspended solids) will increase by a small fraction due to removal of impurities from the source water.
- Sewage harvesting scheme:
  - The upstream potable water is reduced by the quantity of recycled water consumed in the scheme.
  - The downstream wastewater flow is reduced by the quantity of recycled water consumed in the scheme.
  - The amount of downstream wastewater organic / ammonia loads reduced cannot be related directly to the recycled water produced or consumed.
  - The amount of downstream wastewater phosphorous load reduced relates to the amount of recycled water being irrigated, and is generally scheme specific.

These permutations and considerations have implications to the magnitude of cost impacts achieved by the RWP, as explained in the latter sections.

It is noted that Hunter Water queried whether the cost impacts should be associated with the recycled water produced or alternatively recycled water consumed. In our view:

- From an upstream potable water perspective, we agree that the cost impacts should be associated with the recycled water consumed;
- In terms of downstream impacts to the wastewater system, the wastewater flow is reduced by the recycled water consumed; and
- In terms of wastewater load reduction, we still consider the most appropriate approach is to base it on wastewater treated / recycled water produced (instead of recycled water consumed).
  - We note however, that the load-based costs are immaterial in this report as there is not a definitive relationship between cost impacts and load reduction.

2.2. Cost impacts to upstream water network

There are expected to be cost impacts to the upstream water network through the introduction of a RWP – generally through changes in potable water consumption (i.e., that recycled water is used instead of potable water). These cost impacts can generally be categorised in the following:

- Bulk water supply costs;
- Water supply network (i.e. distribution network) costs; and
- WTP operational costs.

The introduction of a RWP will result in a direct reduction in the demand for potable water, thereby enhancing water security for the region. This is the case regardless of whether it is a sewage harvesting scheme (in its different variants), or a stormwater harvesting scheme, on the basis that the consumer behaviour does not change as a result of a recycled water scheme. Assuming that this reduction in consumption of potable water is a sustainable reduction, this can result in reduced requirements for bulk water supply augmentation. This may arise through the deferral, or avoidance, of future bulk water supply augmentations. This situation is likely to provide the highest potential upstream cost savings to the wholesale service provider through the introduction of the RWP. However, as mentioned above, this cost saving is dependent on the extent to which recycled water use reduces potable water use.

Reductions to the required potable water supply can potentially have cost reductions to the water supply network through deferment of capital expenditure due to an increase in spare capacity (e.g. in handling peak demand)[7] or a potential reduction in the size of future capital requirements. The magnitude of any cost saving to the augmentation of the water supply network is dependent on a number of factors (as outlined below).

For a typical WTP, the operating costs consist of both fixed and variable costs. The reduction in demand for potable water will not impact on the operational fixed costs of an existing WTP as these are not expected to vary with the volume of water treated. This is the case considering the relative capacities of the existing WTPs and the current wholesale customers that operate RWPs whereby the introduction of a small-sized RWP is unlikely to have any potential impact on the fixed costs of the much larger WTPs upstream. The fixed cost items will only be affected if the capacity of the new RWP is more than 10-20 per cent of the capacity of the WTP. Typical fixed costs include compliance and reporting costs; labour; fixed operating costs such as ventilation; and facility maintenance and renewal costs. Operating costs that are volume dependent, and could be reduced from the introduction of a RWP include:

- Energy cost
  - For a WTP and related supply network, the energy cost is dominated by pumping cost for transfer, filter backwashing, etc. This relates directly to the flow that is being transferred (or pumped).
- Chemical cost
  - For a WTP, chemical is generally dosed in a flow paced manner, e.g. to achieve a residual chlorine set point. As a result, the quantity of chemical used can be considered to have a direct relationship to flow.
- Residual disposal cost
  - For a WTP, residuals such as sludge are produced from removal of raw water suspended solids. The quantity of residuals is generally a function of the raw water flow treated.

7 Recycled water plants could be considered as decentralised water supply systems. As part of most recycled water projects, local storages are typically provided. This provides a buffering effect to the water supply network, meaning that the required peak capacity is reduced. Therefore, RWPs could potentially lead to deferment of a required upgrade to the water supply infrastructure sized to handle peak capacity. However, it will be difficult to quantify the potential savings as it will be scheme specific. Furthermore, given the sizes of the current RWPs (and likely future RWPs), it is not expected that any of the RWPs will make the incumbent's infrastructure redundant.

Given the sizes of the current RWPs operated by wholesale customers are relatively small when compared to the upstream WTPs, the potential cost reduction on the wholesale service provider's WTP is generally confined to the variable operating cost items (instead of the fixed operating cost items), which are likely to be relatively low in comparison to the overall costs of the recycled water scheme of the wholesale customer. It is noted that the variable operating cost is generally a smaller component of the overall operating cost, as compared to some of the fixed cost items such as compliance and reporting costs and labour costs.

2.2.1. Factors that can influence these cost impacts

The following considers some of the factors that may influence the impact that the introduction of a RWP may have on the water network.

Location of RWP

In the Sydney, Illawarra and Hunter regions, the bulk water supply is generally considered to be quite integrated – thereby any source of bulk water supply can generally be transported to most parts of the network. This means that the issues regarding location (catchment area) of the recycled water plant do not necessarily impact the potential cost savings. Essentially, so long as the recycled water plant is displacing potable water from within the integrated supply network, it will have the same reduction in bulk water supply costs wherever it is located.

Potential cost impacts for the augmentation of the water supply network is not as simple as the bulk water supply as there are likely to be different impacts based on the different locations. While the network is generally connected, there are different degrees of capacity within the network (such as through the use of reservoirs to manage supply) which can impact whether there are any cost savings to the water supply network from the introduction of an RWP.

Size of recycled water scheme

The magnitude of the potable water that is displaced by recycled water will have a direct impact on the size of the cost savings to the bulk water supply. The larger the displacement of potable water, the larger the potential cost saving. It should be noted however, that the potential value of these cost savings will be impacted by factors such as the level of water security and future augmentation requirements (this is discussed further in section 3.1.1).

In general, the impact on operational costs for WTP can be considered linear for the flow reduction achieved by RWP is some small percentage of the WTP capacity, e.g. 10% or lower.[8] This linear effect is the nature of variable operating cost items, which is flow dependent. When the flow reduction is significantly higher, e.g. at 20% or more of the WTP capacity, fixed operation cost items were also affected, e.g., asset renewal and maintenance. This can lead to additional cost impacts such as deferral, or avoidance, of capital augmentations.

Turning the Sydney Desalination Plant on

Some of the submissions to IPART's November 2016 Draft Report raised the prospect of avoiding the costs of the Sydney Desalination Plant and the impact of scarcity costs:

8 Linear in this context means that an increase in the flow reduction achieved by an RWP results in a proportionate decrease in the operational costs for the WTP (e.g. there is no diminishing return of cost savings from an increase in flow reduction).

- City of Sydney was of the view that recycled water schemes increase water security for all customers and should receive similar financial contributions covered by the broader customer base e.g., for an amount of up to $0.12/kL (the amount set by IPART is its 2016 review of Sydney Water retail prices that is applicable when Sydney Desalination Plant is switched on) to avoid switching on the Sydney Desalination Plant.[9]
- Flow Systems pointed out that the standing costs of the Sydney Desalination Plan are recovered through Sydney Water charges and therefore integrated water cycle management (IWCM) schemes that increase water security and avoid water scarcity costs should be incorporated into usage charges.[10]
- Lendlease put forward that a wholesale customer who promotes IWCM should be excluded from any increases in costs if the Sydney Desalination Plant is turned on.[11]

As identified above, we consider that the introduction of a RWP by a wholesale customer will result in an increase in water security for the region through reduced requirements of potable water. The consideration of whether this increased security results in an avoidance of desalination costs is a separate issue however (and can be quite theoretical), as there are many different potential scenarios that would impact the valuation of these potential cost savings. We have considered this issue further in section 4.2.

2.3. Cost impacts to downstream wastewater network

The potential wastewater cost impacts through the introduction of a RWP are heavily dependent on the type of treatment technology employed by the downstream WWTP. Sydney Water and Hunter Water operate approximately 50 WWTPs across the catchments.[12] [13] It is noted that there are significant differences in operating expenditures depending on the different types of treatment technologies employed at the WWTPs. This is especially the case for Sydney Water, where approximately 75% of the wastewater is treated at three large ocean discharge WWTPs. These WWTPs provide only primary treatment, and hence their operating cost (on a per kL basis) is significantly lower than other WWTPs that provide secondary and/or tertiary treatment.

We note that the size of the current RWPs are relatively small when compared to the downstream WWTPs. Hence the cost impact to the downstream WWTP is generally confined to the variable cost items of energy cost and chemical consumption cost, instead of fixed cost items. This is generally true for a mature catchment, where percentage of in-fill is relatively low as compared to the existing population. The impact of RWP on the downstream wastewater network is expected to be larger for large-scale greenfield development,[14] if a wholesale service provider would otherwise need to spend significant funds to either significantly expand the capacity of an existing WWTP, or construct a new WWTP.

9 City of Sydney Submission, pp.5-6.

10 Flow System Submission, p.8.

11 Lendlease Living Utilities Submission, p.16.

12 https://www.sydneywater.com.au/SW/water-the-environment/how-we-manage-sydney-s-water/wastewater-network/wastewater-treatment-plants/index.htm and http://www.sydneywater.com.au/SW/water-the-environment/how-we-manage-sydney-s-water/recycled-water-network/index.htm (Accessed on 3rd March 2017)

13 https://www.hunterwater.com.au/Water-and-Sewer/Wastewater-Systems/Wastewater-Treatment-Works/Wastewater-Treatment-Works.aspx?Page=0& (Accessed on 3rd March 2017)

14 A greenfield development is a new development where there are currently no services available.

The cost impacts to the downstream wastewater network can generally be categorised in the following:

- WWTP operational costs;
- Wastewater network augmentation; and
- WWTP (or disposal) augmentation.

The WWTP operational costs are impacted by the wastewater flows and loads that it receives. For a typical WWTP, the operating costs consist of both fixed and variable costs. Fixed costs are not expected to vary with the volume of wastewater volume treated. This is the case considering the relative capacities of the existing WWTPs and the current wholesale customers that operate RWPs. Typical fixed costs include compliance and reporting costs; labour; fixed operating costs such as ventilation; and facility maintenance and renewal costs.[15] The following are the potential variable costs which may be impacted through the introduction of a RWP:

- Energy cost (pumping, aeration – if employed at the WWTP)
  - For a WWTP conducting primary treatment only, the energy cost is dominated by pumping cost. This relates directly to the flow that is being pumped.
  - For a WWTP conducting secondary and/or tertiary treatment, the energy cost is dominated by aeration cost as well as pumping cost:
    - The pumping cost relates directly to the flow that is being transferred (or pumped);
    - The aeration cost is a function of the organic and ammonia loads that are oxidised in the secondary process.
- Chemical consumption cost
  - For a WWTP, chemical is generally dosed in a flow-paced manner, e.g. to achieve a target level of effluent phosphorous, or to achieve a level of residual chlorine for disinfection.
    - For chemicals that relate to the removal of phosphorous, the quantity of chemical used can be considered to have a direct relationship to phosphorous load in the wastewater.
    - For chemicals that relate to disinfection, the quantity of chemicals used can be considered to have a direct relationship to flow.
- Residuals management cost
  - While residuals management is a variable cost, the effect of a RWP on this variable cost item can be considered negligible under the following scenarios.
    - For a sewage harvesting recycled water scheme where the residuals from the RWP are returned to the wholesale service provider's sewerage network.

15 It is noted that the facility maintenance and renewal cost will only be reduced if a RWP results in deferment of infrastructure of the downstream WWTP. Generally, for this to happen, the capacity of the RWP must be at least 20% the capacity of the downstream WWTP.

- For a stormwater harvest/groundwater scheme, the impact on downstream WWTPs residual management cost is a function of the level of residuals in the raw water extracted. Generally, the suspended solids level in these raw waters is relatively low as compared to the suspended solids level in the wastewater.

The potential cost impacts for wastewater network augmentation and WWTP augmentation are primarily driven by changes in flow and load requirements and the individual circumstances of the assets and catchments (see discussion below).

2.3.1. Factors that can influence these impacts

The following considers some of the factors that may influence the impact that the introduction of a RWP may have on the wastewater network.

Location of RWP

Wastewater networks are generally disaggregated networks, therefore the sewerage catchment that the wholesale customer's RWP is located in will have a potentially significant impact on cost impacts relating to wastewater network or WWTP augmentations. This is due to the fact that the cost impacts for these two elements are highly dependent on the spare capacity within the catchment and the likelihood of the RWP to defer, or avoid, this expenditure:

- If a catchment has little spare capacity (based on existing assets):
  - The introduction of a RWP has the potential to have an impact on the timing of that upgrade which may result in cost savings to the wholesale service provider (this is dependent on the size of the development and the capacity of the WWTP)
- If there is no explicit catchment as the development is not directly serviced through existing assets (e.g., some greenfield developments):
  - The introduction of a RWP has the potential for deferral, or avoidance, of capital expenditure which may result in material cost savings to the wholesale service provider (this is dependent whether the wholesale service provider would have serviced the development, the size of the development and the potential costs to the wholesale service provider of servicing the development). We note, however, that if there is no connection to the wholesale service provider's network, there is no wholesale sewerage service.
- If a catchment has significant spare capacity:
  - The introduction of a RWP is likely to have minimal, if any, cost savings to the wholesale service provider in relation to the downstream network.

Type of downstream WWTP

The potential cost impacts are related to the treatment technology of the downstream WWTP. This is especially the case in Sydney where approximately 75% of the wastewater flows is treated at three ocean discharge WWTPs practising primary treatment only.

For a WWTP providing primary treatment only, the energy cost is dominated by the pumping cost to lift the sewage from underground to the above ground facility. However, for a WWTP providing secondary and/or tertiary treatment, the energy cost is dominated by the cost of aeration to oxidise ammonia as well as organics, in addition to the pumping cost. On the other hand, the chemical cost is dominated by the use of ferric and/or alum to remove phosphorus, and sodium hypochlorite and sodium meta bisulphite for disinfection.

It is noted that in some WWTPs, UV light disinfection is employed instead of chlorination and dechlorination. While this results in a reduction in the unit chemical cost, there will be a corresponding increase in the energy cost.

Type of RWP (de-salting or non-desalting)

Some RWPs desalinate the source water for end uses such as cooling tower make-up water. The by-product of such RWP is a concentrated brine stream, which has a salinity approximately 4 times the salinity of the source water.

Given the relative size of the existing RWP and downstream WWTP, the brine stream is not expected to result in any significant impact on the downstream WWTP. Locally, however, it may affect the pipework. In the case of a sewage harvesting scheme, if a significant portion of the local sewage is mined to produce high grade water, the local sewerage network may witness a significantly higher residence time (with the extraction of sewage) leading to higher chance of anaerobic conditions in the sewer. Couple this with a higher concentration of sulphate as a result of the discharge of the brine stream, septicity of the sewage is expected to increase, potentially leading to production of higher level of compounds such as hydrogen sulphide that could cause corrosion to the pipework. This is a theoretical observation, however, and would need to be assessed on a case-by-case basis.

As discussed earlier in this section, the type of technology employed at the RWP will also affect the calculation of load reduction to the downstream WWTP.

Operating status of RWP, including bypass

The cost impact is expected to relate proportionally to the flow and load reduction to the downstream WWTP.

It is noted that some utilities argue that the WWTP needs to be sized to cater for worst case event, e.g. when the upstream RWP(s) are undergoing maintenance and operate in a "bypass" mode. This argument is only valid if the RWP(s) are recycling more than 20%-30% of the total wastewater flow. The rationale behind this are that:

- From a hydraulic perspective, almost all WWTPs are sized to handle peak wet weather flow in excess of 3 times average dry weather flow. Therefore, as long as the "bypass" event can be co-ordinated and planned to not coincide with a significant wet weather event, the hydraulic impact of an upstream RWP operating in "bypass" mode is expected to be negligible.
- From a load perspective, the biological process has a "buffer" capacity to handle small variation in load on a short-term basis (e.g. several days to a week). In addition, most environmental discharge licenses operate on a statistical compliance basis, thus providing some leeway in variation in treatment plant performance.

Type of sewers

In Hunter Water's submission, an issue was raised regarding the type of sewers (especially pressure sewers) and whether this would have any effect on the estimated cost impacts.

Generally, most developments are served by gravity sewers, where sewage gravitates prior to being lifted in a sewage pumping instances. In some (generally rarer) cases, pressure sewers are employed which include a "pot" being located at a household, which collects and pumps sewage to a downstream sewer (generally a gravity sewer). In general terms, the key performance difference between the two types of sewers are that there is lower level of infiltration with the pressure sewers. This means that less groundwater (especially during wet-weather events) is collected by the pressure sewers. This could perhaps lead to a small reduction to the peak flow to the downstream WWTP. However, as most pressure sewers are used in combination with gravity sewer, sewer infiltration still exists.

Through our assessment we considered both the new entrant and incumbent types of sewer networks:

- In terms of upstream benefit (or cost), the type of sewer is not considered to have any impact.
- In terms of downstream benefit (or cost), we made the following observations:
  - In a brownfield sewer mining scheme, the cost of sewerage network (whether it is gravity or pressure sewers) is existing, and not provided by the wholesale customer.
  - In a new greenfield development, if the developer / wholesale customer chooses to provide pressure sewers, it will not lead to a material difference to the downstream benefit especially given the relative size of RWP to existing WWTP.

Overall, we do not consider the type of sewers to be a material factor in the cost impact to the downstream WWTP.

3. Feasibility of system-wide estimates

Following the identification of the cost impacts that RWPs can have on both upstream and downstream services, this section assesses whether those cost impacts would be similar enough that an average cost impact for a 'typical' scheme could be developed (i.e. a common, system-wide value of the impact).

The ideal approach to calculating these cost impacts would be to base them on the actual costs of the wholesale service provider. However, we note that in order to provide an ex-ante system-wide approach, a number of assumptions are required.

The remainder of this section considers each of the different elements of the upstream and downstream services (in the categories identified in section 2) and whether the cost impact for these elements could be used to estimate system-wide cost impacts or whether a scheme-specific approach would be required.

3.1. Water service cost impacts

3.1.1. Bulk water supply costs

The highly-integrated nature of the bulk water supply network means that it is not as exposed to the locational-based issues (such as catchments) that are inherent in other networks with lower levels of integration (such as wastewater). In addition, the WTPs employ very similar treatment technology and have a similar range of operating costs. As outlined in section 2.2.1, so long as the RWP is displacing potable water from within the integrated bulk supply network, it will have the same impact on the bulk water supply costs wherever it is located.

Given this, the ability to use a system-wide approach to estimate potential cost impacts is dependent on:

- Information on future capital augmentation requirements; and
- Changes to potable water supply requirements.

One approach that can be used to estimate the cost savings is the estimate of long-run marginal cost (LRMC). The LRMC is an estimate of the additional cost of a unit of demand based on information on future capital augmentation requirements and expected potable water supply requirements. Given this, we consider that it is a reasonable proxy to determine the estimated cost savings from a sustainable reduction in a unit of potable water demand. The following considers the different estimates of LRMC for both Sydney Water and Hunter Water and their feasibilities to be applied.

LRMC estimate for Sydney Water

As part of Sydney Water's 2016 Pricing Determination from IPART, it submitted an estimated LRMC based on an average incremental cost (AIC) approach. In its review, IPART devised its own 'best estimate' range of the LRMC based on its preferred approach to estimating the LRMC (a combination of both AIC and the perturbation approach).

IPART's LRMC estimate for Sydney Water is based on costs associated with:

- Augmenting current capacity to meet future growth
  - These relate to the capacity costs of increasing the bulk water yield in response to demand growth – it was not possible to make similar estimates for the other stages of the water supply chain.
  - The inputs will ideally align with the Metropolitan Water Plan if possible.

- Servicing current growth demand within the existing available capacity
  - These relate to drought response costs, such as the operation of Shoalhaven Pumping and the Sydney Desalination Plant
  - Additionally, the impact of changes to demand from implementing water restrictions was incorporated (note the costs of complying with restrictions, for both Sydney Water or its customers, was not included due to a lack of robust estimates).

In addition to the different approaches, IPART also used multiple periods for the modelling of the LRMC – 20, 30, 40 or 50 years. To trigger the drought measures, IPART simulated variable inflows to determine the level of storage at the end of 50 years. IPART repeated this calculation 5,000 times to estimate the LRMC. These multiple scenarios resulted in IPART deriving its best estimate range.

Given the robustness of the approach to estimating the LRMC, it would appear that this estimate would be feasible to use for a system-wide cost estimate.

Hunter Water LRMC estimate

Hunter Water did not provide IPART with an estimate of the LRMC as part of its 2015 Price Submission.[16] Hunter Water stated that as the analysis in the Lower Hunter Water Plan concluded that the Lower Hunter's supply is secure for approximately the next 20 years, there was no imperative to identify the next source augmentation. This would indicate that the LRMC will be quite small (depending on the planning horizon used for the estimate). Given this, Hunter Water stated that it does not have any formal suite of demand management and supply augmentation measures on which to re-calculate the LRMC.

In the 2016 review of Hunter Water's prices, IPART acknowledged that:

- The Lower Hunter Water Plan does not specify the next water supply augmentation; and
- Any estimate of the LRMC would be highly uncertain.

IPART therefore decided to maintain the water usage charge in real terms for the period 1 July 2016 to 30 June 2020.

It has been indicated by Department of Primary Industries (DPI) Water that the next water supply augmentation will be considered in the next review of the Lower Hunter Water Plan, IPART stated this would enable a LRMC estimate to be available for the next review of Hunter Water's retail prices.[17]

In our previous report, we recommended using an LRMC estimate of zero for Hunter Water until an estimate was developed given that there was no publicly available estimate and no forecast supply augmentations. In response to the report, Hunter Water noted that while there was no publicly available LRMC estimate for Hunter Water, the use of a zero estimate was not appropriate. Given this, we have revised our recommendation and based our recommendation on the following hierarchy of estimation options:

1) Publicly available LRMC estimate for Hunter Water;
2) Develop an LRMC estimate for Hunter Water based on the best available information for Hunter Water at the time;

16 Hunter Water, *Submission to IPART on prices to apply from 1 July 2016*, June 2015.

17 Independent Pricing and Regulatory Tribunal, *Review of prices for Hunter Water Corporation - Final Report,* June 2016, p.101.

   a. This would essentially require information on future demand and supply augmentations based on various scenarios

3) Develop a proxy LRMC estimate for Hunter Water that is based on another LRMC estimate for a similar service provider.

The best option would be to use a publicly available LRMC estimate for Hunter Water that has been approved by IPART. Given this was not developed during the recent review of Hunter Water's prices, this option is not currently available.

The second option would be to develop an LRMC estimate based on the best available information. However, given that no supply augmentations were forecast within the Lower Hunter Water Plan, it is unlikely that there will be sufficient information available.

The final option would be to utilise an existing LRMC estimate for a similar service provider (e.g., Sydney Water) to derive an estimate for Hunter Water. As noted above, there is currently an LRMC estimate for Sydney Water that has been approved by IPART. Given this, an LRMC estimate for Hunter Water could be developed in reference to the Sydney Water estimate. Some of the factors that would need to be considered in terms of adjusting the estimate to better reflect Hunter Water's characteristics include:

- The level of spare capacity within the Hunter Water catchment compared to the Sydney Water catchment;
- Forecast growth in demand within Hunter Water compared to Sydney Water; and
- High-level expectations of future augmentations (noting that detailed information is not available).

We note that, even after considering these factors, it may be that the best proxy for Hunter Water is equal to the Sydney Water LRMC estimate. This will depend on whether there is sufficient information on these factors above to justify a change to the estimate that would result in a more accurate proxy for Hunter Water.

Given the current circumstances, we recommend that the third option should be adopted until such time that sufficient information is available to develop a Hunter Water LRMC estimate. Further discussion on the factors that are to be considered when adopting an LRMC estimate is provided in Appendix B.

3.1.2. Water supply network augmentation costs

While there is a high degree of integration throughout the water supply network, there are localised factors that can influence the potential cost impacts to the wholesale service provider. This results in a variety of potential outcomes:

- May result in a 'bring-forward' of network augmentation capital expenditure (as the wholesale customer is developing an area earlier than anticipated) thereby increasing the costs to the wholesale service provider;
- May result in deferral of network augmentation due to the reduced potable water requirements and limited capacity within the network, thereby decreasing the costs to the wholesale service provider; or
- It may result in no change to the costs of the wholesale service provider – this can be based on the size of the RWP that is installed or a high-level of spare capacity within the network.

The significantly variable nature of the potential impact does not lend itself to a system-wide approach to estimating the cost impacts to the wholesale service provider in relation to network augmentation through the introduction of RWPs by wholesale customers.

3.1.3. WTP operational costs

In Sydney, 80% of potable water is supplied by the Warragamba Dam and Prospect Water Filtration Plant. This is supplemented by a number of other smaller reservoirs and eight other smaller WTPs (or Water Filtration Plants). In general, the WTPs employ similar treatment technologies (namely media filtration followed by chlorination). In addition, the system is flexible in the sense that raw water could be transferred between reservoirs to manage supply. As a result, it is hypothesized that a system-wide cost impact can be calculated for the effect of a RWP to the upstream operations of a WTP.

Hunter Water sources its water from six major sources and treats its water at six WTPs. While the water treatment process may vary slightly at different locations, the basic principles are largely the same. The majority of the network is integrated; however, it is not as integrated as the Sydney Water network as there are some water sources that are isolated from the remainder of the network.

The estimation of system-wide cost impacts on WTP operational costs is considered in section 4.1.1.

3.2. Wastewater service cost impacts

3.2.1. WWTP operational costs

As identified in section 2.3.1 there are a number of factors that can influence the size of any operational cost impact to WWTPs. The first key factor is scheme type:

- Stormwater harvest or groundwater scheme does not yield any saving to the downstream WWTP. In fact, if a residual stream is disposed to the sewerage network, it may result in a small increase in the operating cost of the downstream WWTP. This residual stream is a result of the removal of impurities in the source water.
- For sewage harvesting scheme, savings to the downstream WWTPs relate to reduction in both wastewater flow and loads:
  - Wastewater flow: reduced by the amount of recycled water consumed.
  - Wastewater loads: While there are reductions in wastewater loads, the quantity of different wastewater loads reduced are scheme specific. As explained in Section 2, the following factors impact the load reduction:
    - Amount of phosphorous reduced is a function of the amount of irrigation water used
    - Whether a desalting process is part of the RWP treatment process

In addition, the potential cost saving is strongly influenced by the treatment process employed at the downstream WWTP, namely:

- Secondary/Tertiary treatment; or
- Primary treatment.

Given this, we have concluded that it is currently not feasible to provide an estimation of system-wide cost impacts for the downstream WWTPs.

3.2.2. Wastewater network augmentation

Wastewater networks are generally closed networks that have different characteristics across each catchment. These characteristics can be related to factors such as:

- Current level of spare capacity within the catchment network;
- Age and condition profile of the network infrastructure;
- Expectations of future growth in demand; and
- Forward-looking capital requirements for the catchment.

These differences in the characteristics of individual catchment networks makes it difficult to establish system-wide estimates of cost impacts to wholesale service providers based on currently available information. As discussed further in section 4.3, estimates of catchment-wide cost impacts may be able to be undertaken in the future, however this will depend on the availability of robust information.

Given this, we consider a scheme-specific approach is more feasible than a system-wide approach to estimating the cost impacts to wastewater network augmentations.

3.2.3. WWTP (or disposal) augmentation

As outlined in section 2.3, there are a number of factors that can have a significant impact on the quantum of the cost impacts for specific schemes. The combination of these factors (and the size of their impact) make it difficult to derive a system-wide approach. The following is a consideration of some of these factors and the reason they can have such an impact on the estimate.

Size and structure of the recycled water scheme

The size of the wholesale customer's RWP will have a considerable impact on the likelihood of augmentation requirements for the wholesale service provider as it will determine the size of any changes to downstream flow and load.

This is especially the case if a RWP is treating a significant component of the overall load in the wholesale service provider's sewerage network. Question arises in terms of level of back-up to be provided by the downstream WWTP in case the RWP needs to shut down for a period of time. If the back-up is required from the wholesale service provider, the key factors to consider are the duration of the required back-up, whether it will be planned or unplanned and the percentage of flow. Generally, if the RWP is relatively small, and the back-up event is short and can be planned, the cost impacts downstream to the WWTP can be negligible.

Location of the scheme

The sewerage catchment area that the wholesale customer's recycled water scheme is located in will also have a significant impact on the potential impacts to the wholesale service provider's WWTP augmentation requirements. Each catchment area is unique, as an example, two different wholesale customers could develop identical RWPs, however, given that they are located in different catchment areas, the potential impacts to the wholesale service provider's WWTP augmentation requirements can be quite different. This difference will be driven by the spare capacity of the WWTP servicing the catchment and the timing of the next augmentation requirement.

The significantly variable nature of the potential impact does not lend itself to a system-wide approach to estimating the cost impacts to the wholesale service provider through the introduction of RWPs by wholesale customers.

Environmental discharge licences of the existing WWTP

Another factor that can influence the estimation of the cost impacts is the environmental discharge licences. These licences can have a material impact on whether a capital upgrade is required, as those WWTP with lower environmental discharge requirements are less likely to require upgrades due to incremental growth.

While the variable nature of this impact is limited to the number of different types of environmental discharge licences, it is another variable that makes it difficult to determine system-wide cost impacts.

The combination of these variables means that a scheme-specific approach is more feasible than a system-wide approach to estimating the cost impacts to WWTP augmentations from the introduction of RWPs by wholesale customers.

3.3. LRMC and SRMC as system-wide estimates

In its submission to the Supplementary Draft Report, Hunter Water stated that the proposed operational cost savings should be compared with its SRMC estimates. It went on to state that these may vary on a geographic basis (e.g., depending on whether the catchments are open or closed, or surface water or groundwater source).

In considering the appropriateness of system-wide cost saving estimates, we consider that the LRMC (and SRMC for operational costs) can be used as an appropriate proxy. However, we note that it must be used in an appropriate way that accounts for the individual characteristics that can influence the services.

Those services that have considerable variation based on individual characteristics (such as the wastewater networks) may require catchment-based LRMC calculations in order to be appropriate. This would ensure that the individual characteristics of each of the catchments is not lost through the averaging process of the LRMC, thereby resulting in a more accurate estimate for the catchment (and ultimately a more accurate pricing signal).

Therefore, if Sydney Water and/or Hunter Water were to develop LRMC estimates for these other services that currently do not have LRMC estimates (water supply network augmentation, wastewater network augmentation and WWTP augmentation), we consider that they would be appropriate to use where IPART is seeking to provide ex-ante pricing signals through the use of system-wide cost saving estimates as part of its wholesale pricing.[18]

Similarly, we consider that SRMC estimates, where appropriately developed and applied, could be used to provide system-wide cost saving estimates for operating costs (both upstream and downstream). The issue for the WWTP operational costs, as outlined above, is that there is considerable variation and therefore SRMC per treatment plant may be required.

We note that SRMC estimates have been provided to IPART as part of the urban price reviews, however these are not publicly available. Given that there is no detailed publicly available information, we have sought to undertake a bottom-up approach to estimating system-wide operational cost savings for the upstream WTP (the service that we consider system-wide cost savings could be estimated for). We consider that further development of SRMC estimates could be incorporated into the development of system-wide cost estimates (for operating cost savings).

Further discussion on the appropriateness of LRMC for estimating system-wide cost savings and the issues that may need to be considered within the wholesale pricing framework are contained in section 4.2.1 and Appendix B.

18 This is assuming that the LRMC estimates have been developed in an appropriate way that account for potential variations.

4. Quantitative estimates of cost impacts

Based on the discussion in section 3, we consider that system-wide cost impacts to wholesale service providers can be estimated for:

- Upstream operational cost impacts for WTPs; and
- Bulk water supply.

The following provides our estimates on these service elements and what would be required to estimate system-wide cost impacts for the other elements.

4.1. Operational cost impacts

4.1.1. WTP operational cost impacts

As outlined in section 3.1.3, the variable WTP operating costs that may be impacted through the introduction of a RWP include:

- Energy cost
- Chemical cost
- Residual disposal cost

In estimating a system-wide cost impact, the following assumptions are made:

- Energy cost is based on an average tariff of $0.14/kWh[19]
- An average of 20 m water head to lift the raw water from the water reservoir to the head of the WTP
- An average of 40 m water head to maintain a minimum network pressure of 20 m at the customer tap
- Pump efficiency of 70%
- Motor efficiency of 90%

For the purpose of this report, pumping cost is estimated with the following equation:

$$\textit{Pumping cost} \propto \textit{Tariff}\ \frac{Q.\rho.g.H}{\textit{Eff}_{Pump}.\textit{Eff}_{Motor}}$$

Where:

Q = Flow pumped

ρ = Density of water

g = Acceleration due to gravity

19 Jacobs, *Hunter Water Expenditure Review for IPART - Final Report*, February 2016, p.69.

This estimate is based on the forecast average variable electricity price for the whole of Hunter Water as part of Jacob's expenditure review for IPART's review of Hunter Water's water and sewerage charges to apply from 1 July 2016. In order to estimate an ex-ante system-wide cost impact, an ex-ante electricity price assumption is required. The use of the average electricity price determined for Hunter Water is a reasonable, publicly available proxy. In terms of the sensitivity of this assumption, there is a direct relationship between the increase in electricity prices and the increase in the estimated reduction in pumping costs. If, for example, there was a 50 per cent increase in the marginal electricity price ($0.21/kWh) results in a 50 per cent increase in the estimated reduction in pumping costs ($0.06/kL).

Tariff = Energy tariff

H = Head of water pumped

Eff_{Pump} = Pump efficiency

Eff_{Motor} = Motor efficiency

Pumping cost impacts

Based on the above assumptions, the system-wide cost impact for wholesale service providers based on changes in energy cost is estimated to be a reduction of approximately $0.04/kL of recycled water consumed.

Treatment cost impacts

Based on the above assumptions, the average avoided chemical cost is estimated to be a reduction of approximately $0.02/kL of recycled water consumed. In addition, the average avoided residual handling cost is estimated to be a reduction of approximately $0.005/kL to $0.01/kL of recycled water consumed.

Overall the variable cost impact for upstream water costs of a RWP is estimated to be approximately $0.07/kL (or $70/ML) or recycled water consumed[20].

4.1.2. WWTP operational cost impacts

As outlined in section 3.2.1, the WWTP operational cost impacts as a result of the implementation of a RWP relates to a multitude of factors, with most of the factors being scheme specific. As a result, it is generally not possible to provide estimates on system-wide cost impacts for the downstream WWTPs.

Appendix A provides some analyses on the indicative cost saving for the different types of schemes. This is included for information only, to illustrate that a system wide average is very difficult to calculate.

4.2. Bulk water supply

As identified in section 3.1.1, we consider that the highly-integrated nature of the bulk water supply allows for the estimation of system-wide cost impacts to the wholesale service provider from the introduction of an RWP by a wholesale customer. The LRMC is an estimate of the additional cost of a unit of demand based on information on future capital augmentation requirements and expected potable water supply requirements. Given this, we consider that it is a reasonable proxy to determine the estimated cost savings from a sustainable reduction in a unit of demand.

20 The variable operating cost estimates were estimated based on consultants' experience from operation of WTP's. As a comparison, the estimated cost is compared with the operating cost data from "2012-2013 Water Supply and Sewerage Benchmarking Report" published by NSW DPI Office of Water in 2014. The report outlines the range of costs reported by regional councils. Specifically, we considered the total operational cost that serves >10,000 properties (see Table 13 in the report), which is reported to be in the range $82/ML to $443/ML once reticulation-only systems are excluded from the analysis. It is noted that in the DPI Water Report, the reported operational cost includes both fixed and variable costs and the two cost items cannot be segregated. An estimate of $70/ML for variable cost component only is considered appropriate considering the economies of scale of the WTP's operated by Sydney Water and Hunter Water.

In its review of Sydney Water, IPART devised its own 'best estimate' range of the LRMC for bulk water augmentation based on its preferred approach to estimating the LRMC (a combination of both AIC and the perturbation approach) of $1.11/kL to $1.30/kL. We recommend that a point estimate within IPART's best estimate range for the LRMC for Sydney Water be used as an estimate of the system-wide cost impacts for the upstream water supply network that could be avoided. [21] This recommendation is based on the fact that the supply of bulk water is highly integrated, the estimate of the LRMC reflects the additional cost of an additional unit of demand and there is a publicly available estimate that has been determined by the economic regulator.

Recycled water could be considered an efficient water source if it can be produced at a cost below the LRMC. This would result in an efficient outcome as the potable water that is being displaced annually by recycled water is being done so at, or less than, the long-run marginal cost of providing the additional demand for potable water.[22]

However, we note the uncertainty associated with LRMC estimates and the challenge of accurately estimating an LRMC value.

Use of LRMC and price signals

Based on our proposed approach of using the LRMC to estimate the cost savings, the LRMC price signal effectively serves two purposes:

- It impacts on the up-front investment in the recycled water plant; and
- It impacts on the on-going operation of the scheme.

In establishing wholesale prices, IPART needs to ensure that it is driving efficient behaviours under both situations.

The use of a dynamic LRMC (i.e., one that adjusts over time to reflect the forecast supply/demand balance) should in theory do this, as it should:

- Incentivise efficient up-front investments, as investments should be made where the average cost of the new investment over its useful life is **less than** the opportunity cost of supply (represented by the LRMC of the alternative, being the centralised supply); and
- Incentivise efficient on-going operation of those existing schemes, such that their continued operation only occurs if the marginal cost is **less than** the marginal cost of the alternative (being a centralised supply).
    - In this case, if the security of supply balance of the central case improves significantly, the opportunity cost (being the LRMC of the centralised supply) reduces, this should be signalled to the existing schemes so that they only provide services if their marginal cost continues to be **less than** the opportunity cost of supply (being supply from the wholesale system at the new LRMC).

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21 The choice of cost estimate within the range will be dependent on the assumptions underpinning the best estimate range and the prevailing supply and demand conditions facing the industry at the time of the introduction of the recycled water plant. As we are not aware of those scenarios that represented the higher-end of the range and those that represented the low-end of the range, we cannot provide explicit recommendations regarding the most appropriate estimate to use within the range. Our recommendation is to adopt an estimate at the high-end of the range when the prevailing conditions most reflect those scenarios that resulted in the high-end of the range; and to adopt an estimate at the low-end of the range when the prevailing conditions most reflect those scenarios that resulted in the low-end of the range.

22 This is disregarding any downstream cost impacts that may also assist in offsetting the wholesale price and the retail and reticulation costs which are being considered separately by IPART.

4.2.1. Estimation of the cost savings

The estimated cost impacts for the water supply network would equate to the volume of potable water that is displaced by recycled water multiplied by the LRMC of water supply for that region. As a general rule of thumb, a reasonable approach to estimating the reduction in potable water demand is equal to the volume of recycled water consumed. We note however, that there are factors, such as consumer behaviour changes and leakage within the recycled water network, which can influence this calculation.

The calculation for the bulk water supply cost savings is shown as:

$$\text{Reductions in Costs (Bulk Supply)} = \text{LRMC (\$/kL)} \times \text{Potable water displaced by recycled water (kL)}$$

We note that this approach differs to the previous guidance provided by IPART in relation to calculating capital deferrals and avoided costs, this is because the previous guidance was based on the calculation of capital deferrals and avoided costs for an individual scheme, whereas this approach is designed to calculate system-wide cost impacts for wholesale customers.[23]

When considering the use of LRMC to estimate bulk water supply cost impacts, there are some factors that need to be considered, such as:

- Sustainable reduction in potable water
  - This ensures that it is a true reduction in future bulk supply augmentation requirements
- Capital planning information is robust
  - This is a key input for the estimation of LRMC, it is therefore important to ensure its accuracy and robustness
- Estimate of LRMC is current
  - Estimates of LRMC change over time depending on the expected future demand and augmentation requirements (this is discussed further below)

Alternative applications of the LRMC

In recommending how the LRMC could be used to estimate the cost savings, we considered alternative approaches to its application. The primary alternative was an approach that considered the use of two LRMC estimates – with and without the recycled water plant – and calculating the difference between the two estimates.

In considering this alternative, we note that the LRMC is already a marginal cost estimate and therefore represents the marginal cost savings in a unit-based form (per kL in this case). Thereby using the difference of the two LRMC estimates represents the marginal difference in the marginal cost from the introduction of the recycled water plant, not the actual marginal cost itself, i.e. it would only estimate cost savings where the introduction of the recycled water plant actually changed the marginal cost estimate for the network. This change in the LRMC and treatment of the subsequent efficiency benefits to the industry relates to the broader wholesale pricing framework rather than cost savings and is discussed in more in B.2.

23 Independent Pricing and Regulatory Tribunal, *Pricing arrangements for recycled water and sewer mining - Final Report*, September 2006.

Impact of Sydney Desalination Plant

As noted earlier, some submissions raised the issue of potentially avoiding the costs of the Sydney Desalination Plant and the scarcity value of water. Assuming that the LRMC approach is used for estimating the potential cost impacts for bulk water supply, we consider that these issues raised by these stakeholders will be addressed if:

- The LRMC calculation uses operating costs for the desalination plant;
  - Based on the information provided by IPART in its review of Sydney Water's retail prices the potential for future operating costs of the desalination plant were incorporated in developing the range of LRMC estimates. [24]
- The calculation of the LRMC is undertaken periodically.
  - Assuming that the calculation, and use, of the LRMC occurs periodically, then we would expect that the estimation of the cost impacts would fluctuate (discussed further below). This means that the value that the RWP operators are providing (through reducing the reliance on potable water) increases as the possibility of future augmentations to the water supply network increase. Similarly, the value decreases as the possibility of future augmentations decreases.

If these two elements are correct, then the value of the RWP operator providing additional security to the water supply network will flow back to that owner and/or customer (depending on tariffs).

Dynamic nature of augmentation cost savings

It is important to acknowledge that the estimation of augmentation cost impacts (and therefore the impact on any wholesale pricing) is dynamic. That is, it can change significantly from one period to the next. The following two scenarios demonstrate this dynamic impact:

- The wholesale service provider is planning on undertaking a significant upgrade of its network due to growth forecasts in the region; and
- The wholesale service provider has recently undertaken a significant upgrade of its network due to growth in the region.

Under the first scenario, there is the potential for significant cost savings if a wholesale customer constructs a scheme that leads to the deferral (or suspension) of the significant upgrade.[25] Alternatively, there are very little (if any) potential cost savings under the second scenario as the significant upgrade has already been undertaken.

This means that as growth increases in catchment areas, leading to a required infrastructure upgrade, you would expect to see the potential cost impacts increase. These potential cost impacts would increase until the time that the upgrade is undertaken, with the potential for cost impacts being significantly reduced (or completely removed) after the upgrade. This is illustrated in Figure 4 below.

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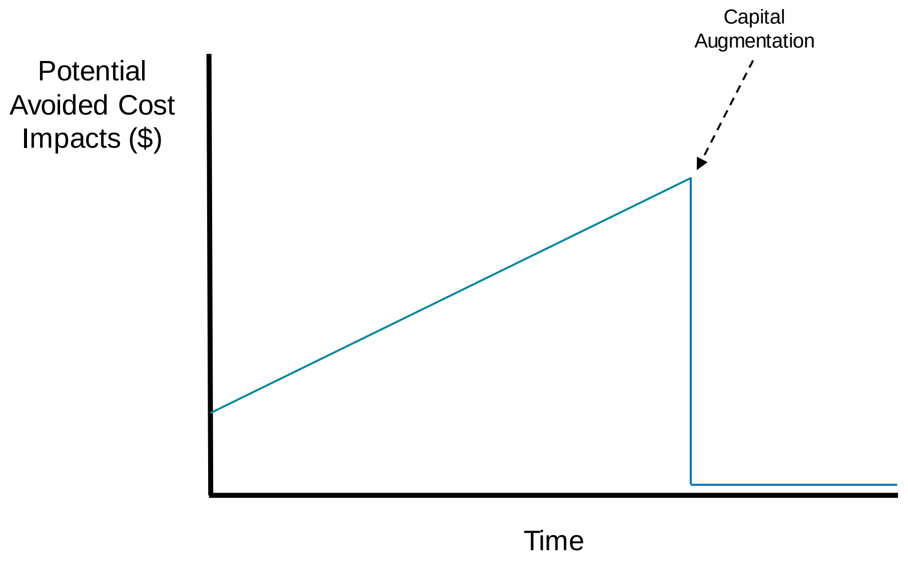
24 Independent Pricing and Regulatory Tribunal, *Review of prices for Sydney Water Corporation - Final Report*, June 2016, p.294.

25 This generally assumes that the wholesale customer is proposing to service customers that were factored into the demand forecasts resulting in that upgrade (if not, the upgrade may not have been forecast and therefore not in the capital planning).

Figure 4: Illustration of impact of capital augmentation on potential cost impacts



This increase in the likelihood of augmentation also applies to an increase in the likelihood of other sources (such as the Sydney Desalination Plant) being turned on. The greater the likelihood of the Sydney Desalination Plant being turned on, the higher the estimated LRMC and therefore the greater the cost savings attributable to the recycled water scheme.

While there is this dynamic nature of the estimation of potential avoided cost impacts, a trade-off is required between:

- The accuracy associated with more frequent updates of the estimates; and
- The administration costs associated with having more accurate estimates through frequent updates.

The decision on this trade-off may need to be informed by the level of activity in terms of RWP and wholesale customers to determine the demand for a more up-to-date estimate.

4.3. Information required to develop additional system-wide estimates

Section 3 identified that there were some elements of the upstream and downstream services whereby a system-wide approach to estimating the cost impacts was not considered feasible:

- Water supply network augmentation;
- WWTP operational costs;
- Wastewater network augmentation; and
- WWTP augmentation.

The key reason for the inability to estimate system-wide cost impacts for these elements is the significant variations that can arise.[26] The primary driver for these variations is the location of the wholesale customer's RWP. Given this, one potential option in the future is to develop catchment-wide estimates of the cost impacts from the introduction of RWPs. In order to develop these estimates, it would require detailed augmentation requirements and forecast demand based on location.

Once LRMC (or SRMC) estimates are developed for the service, this estimated cost per unit could be used to estimate the potential cost savings by using the sustainable reduction in the unit of measure from the introduction of the RWP. By using the term, 'unit of measure', we note that an LRMC for a wastewater service may be based on specific elements of the load (or per customer) rather than a standard unit of water (kL) that is used for the bulk water supply estimate. The calculation of the cost saving would then be consistent with the approach outlined for bulk water supply in section 4.2.1.

26 We note that the water supply network augmentation could potentially be based on one, system-wide LRMC estimate, however no estimate is publicly available at present.

Appendix A: Indicative cost savings to downstream WWTP operational costs resulting from the introduction of RWP

As identified in section 4.1.2, the different factors that can influence the potential operational cost savings to a WWTP makes it difficult to estimate a system-wide cost impact for the introduction of a RWP. This means that scheme-specific factors will need to be taken into account. These factors include, but are not limited to the following:

- Scheme type
- Treatment technology employed at the downstream WWTP
- Treatment technology employed at the RWP

The following table provides a summary of indicative cost savings due to the different factors. This is to illustrate the difficulty to estimate a system wide average saving, e.g., multiple factors influencing the operating costs, the variations in the assumptions made, etc.

Table 1: Indicative saving to downstream WWTP operational cost as a result of RWP

Type of downstream WWTP	Type of RWP	Indicative Change in WWTP Opex
Primary treatment	Stormwater harvesting	• Pumping: Generally negligible increase as a result of the extra residual flow • Residuals handling: Generally negligible increase as a result of the extra residual flow
	Sewage harvesting	• Pumping: Reduced by approximately $0.04/kL to $0.06/kL of recycled water consumed • Aeration: Nil • Residuals handling: Scheme specific, but generally considered negligible
Secondary treatment	Stormwater harvesting	• Pumping: Generally negligible increase as a result of the extra residual flow • Residuals handling: Generally negligible increase as a result of the extra residual flow
	Sewage harvesting	• Pumping: Reduced by approximately $0.01/kL to $0.03/kL of recycled water consumed • Aeration: Reduced by $0.10/kL to $0.15/kL of wastewater treated by the RWP • Residuals handling: Scheme specific • Chemicals (for phosphorous removal): Saving is a function of the recycled water irrigated onto land, and is scheme specific

Type of downstream WWTP	Type of RWP	Indicative Change in WWTP Opex
Additional saving towards tertiary treatment (e.g. filtration, disinfection)	Stormwater harvesting	• Pumping: Generally negligible increase as a result of the extra residual flow • Chemicals: Generally negligible increase as a result of the extra residual flow
	Sewage harvesting	• Pumping: Reduced by approximately $0.01/kL of recycled water consumed • Chemicals (for disinfection): Reduced by approximately $0.01/kL to $0.03/kL of recycled water consumed
Notes/Assumptions 1. Operating costs were estimated based on review of the operating costs for a number of WWTP's with a plant capacity of 5 to 20 ML/d 2. Energy cost is based on an average tariff of $0.14/kWh 3. An average of 70m water head is required to transfer sewage from the network to a WWTP providing the Sydney Water WWTP's primary treatment only 4. An average of 30m water head is required to transfer sewage from the network to a WWTP providing secondary / tertiary treatment 5. An average of 10m water head to facilitate pumping through tertiary filtration 6. Pump efficiency of 70% 7. Motor efficiency of 90%		

It is noted that the submission from ISF suggests the use of a saving figure of $0.17 - $0.28/kL by summing up the "estimated numbers" provided in this Appendix of the previous report. This is based on the pretext that the three Sydney Water ocean discharge WWTPs *should* treat effluent up to tertiary standards (see last bullet on page 5 of the ISF submission). We consider this argument does not reflect that Sydney Water is not required to meet such standards. This is therefore based on a hypothetical scenario and does not reflect the actual structure (and costs) of the industry. Whether the ocean discharge WWTPs should treat effluent up to a tertiary standard is outside the scope of this work.

Appendix B: Issues to consider when utilising LRMC as a pricing signal for wholesale prices

The report recommends the use of LRMC to value the cost savings for upstream bulk water supply from the introduction of a recycled water plant.

In applying the LRMC in an ex-ante approach to estimating cost savings (and therefore providing a pricing signal to potential new entrants), there are some further issues that require consideration. This section provides further discussion regarding these issues.

B.1 Application of LRMC during operation of SDP cost pass-through mechanism

In terms of how the LRMC would be applied to the wholesale price during times in which the SDP is operating (and therefore the retail prices have increased to account for the pass-through mechanism), in our view there would be no change to the calculation of the wholesale price. The retail price within any calculation of the wholesale price during this time would be the retail price that includes the SDP cost pass-through of $0.12/kL. Essentially the wholesale price would go up by $0.12/kL to reflect the operational costs of the SDP which are to be passed through.

Given that the new entrant has received a benefit through the LRMC during times of non-operation (based on the probability of the SDP being operated in the future and this being incorporated into the LRMC estimate – see section 0), it would not be appropriate to also provide the operating costs of the SDP through as a saving to the new entrant once the pass-through mechanism is enacted. The process essentially results in a timing issue, as theoretically, the costs should even out in the long-term if the probabilities underpinning the LRMC estimate come to fruition. This timing issue means that:

- If the LRMC estimate factored in the SDP operating for 5 years of a 50-year forecast; and
- The SDP is in operation for 5 years of that same 50-year timeframe

Then the difference is the recovery of those 5 year costs over a 50-year period through smaller allowances (i.e. the LRMC approach) against the recovery of those 5 years of operating costs within that 5-year period through which the pass-through mechanism is in operation.[27]

B.2 Change in value of LRMC and impact on pricing

The LRMC essentially breaks down the expected future augmentation requirements to meet demand expectations into a small unit of value (kL). Therefore, by using the LRMC to value a sustainable reduction in potable water demand, it removes the need for the scheme-specific approach of identifying actual deferrals within the supply augmentation profile. This is because it essentially already values those deferrals through the unit value.

27 This assumes that the forecast operating costs factored into the LRMC estimate are the same as the actual operating costs that eventuate within the period.

This valuation of the LRMC essentially represents a security of supply value for the catchment as it is based on the future costs required to ensure sufficient water to meet future demand. Where a new entrant (or the incumbent for that matter) undertakes significant investment that either reduces future augmentation requirements or reduces potable water demand, this changes the value of security of supply going forward (just like any other market/industry). The estimate of the LRMC should therefore be updated to update the pricing signal to future new entrants to reflect this change in value. Similarly, were a significant drought to occur, this would impact on water supply and potentially result in an increase in the value of security of supply and the estimate of the LRMC should be adjusted to reflect this.

LRMC in a scheme-specific approach

This report has focused on the consideration of system-wide estimates of cost savings from the introduction of RWPs. We note that LRMC can potentially be used in combination with a scheme-specific approach to estimating cost impacts. The key factor in whether it can be adopted is to ensure that there would be no double-counting of cost savings when combining system-wide and scheme-specific approaches. In this case, there is only bulk water supply LRMC estimates available and based on our understanding of how they have been developed, there would be no risk of double-counting if an LRMC estimate is used to estimate the bulk water supply cost savings and a scheme-specific approach is used for other cost components.

An equivalent of the LRMC is used in determining new connection charges for the electricity industry. Section 5.2.5 of the *Connection charge guidelines for electricity retail customers*, [28] the Australian Energy Regulator (AER) sets out the calculation for the incremental cost shared network (ICSN)[29] as:

$$\text{ICSN} = \text{Unit Rate} \times \text{Demand Estimate}$$

The unit rate in this calculation refers to the average cost of adding a unit of capacity to the shared network (i.e., augmentation) which is analogous to the LRMC.

This approach has been adopted by the AER instead of a scheme-specific approach in order to avoid double-counting of costs, to reduce administrative costs and to avoid potential issues within scheme-specific approaches whereby:

- A small new entrant may enter the market and use up any available spare capacity within the network and therefore not incur any significant connection costs; and
- A subsequent (similar-sized) new entrant incurs a considerable connection costs due to their being no available spare capacity within the network.

By adopting this approach, it ensures that these new entrants are treated in a similar fashion and removes the winners and losers that can eventuate by taking a scheme-specific approach.

28 Australian Energy Regulator, *Connection charge guidelines for electricity retail customers - Version 1.0*, June 2012, p.17.

29 The ICSN represents a capital contribution towards the cost of an augmentation.

These issues are similar to the wholesale price review, whereby a number of smaller new entrants invest in RWPs, each not large enough to impact on upstream augmentations in their own right. However, the combined effect of these new entrants results in a reduction in the future supply augmentations and a reduction in the LRMC estimate. Under a scheme-specific approach, only the final investment that results in a change in future augmentation requirements would receive a benefit from the actual deferral.[30] By using the LRMC to estimate the cost savings, this would ensure that each of those new entrants (that would receive no benefit under a scheme-specific approach) receives the benefit of the subsequent deferral (estimated by the LRMC) based on their change in demand on the wholesale service provider's network.[31] This is demonstrated in the following example:

A new entrant may reduce the potable demand requirements by 1ML per annum however it is insufficient to trigger a deferral in future augmentations:

- *Under a scheme-specific approach, the new entrant would receive no benefit from the reduction in potable demand requirements.*
- *Under the LRMC approach, the new entrant would receive a benefit equal to the reduction in potable demand (1ML) multiplied by the LRMC estimate.*

Thereby, under the LRMC approach, all new entrants would receive the benefit of reducing potable demand requirements, regardless of the sequencing issues that can occur through the scheme-specific approach.

As noted above, the LRMC approach to estimating cost savings can be used within a broader scheme-specific approach (for example, the LRMC approach is used to estimate bulk water cost savings), ensuring no double-counting of costs is occurring between the estimates.

Case study of changes in LRMC estimate

In considering how the application of the LRMC in the derivation of wholesale prices, one of the potential scenarios that we have considered is when a new entrant makes a significant investment in a recycled water plant that subsequently reduces the LRMC estimate (and therefore reducing the benefit received by the new entrant from their investment).

This scenario is demonstrated in Figure 5 below whereby a new entrant (RWP_1) invests in a new RWP based on $LRMC_1$ which subsequently impacts on the LRMC estimate. The size of RWP_1 results in a shift in the cost curve and a subsequent reduction in the LRMC estimate (down to $LRMC_2$).

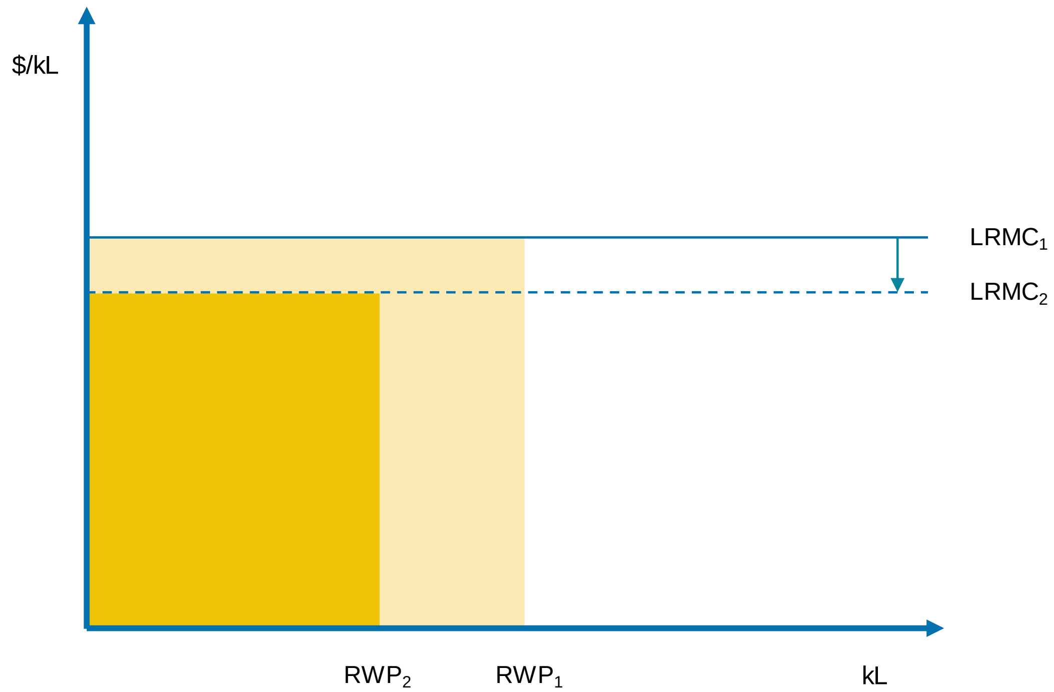
30 Unless a sharing mechanism has been established in combination with the scheme-specific approach.

31 We note that actual deferrals to future augmentation requirements (this could be driven by multiple new sources, or one potential large source) will result in a change to the LRMC estimate when it is re-estimated. This will change the value of the benefit that is attributable to the new entrant going forward. The new entrants will continue to receive the benefit, but the value will be lower, this reflects the change in value of security of supply for the network due to increased alternative sources.

This change in the cost curve and new LRMC estimate ($LRMC_2$) results in a change to the pricing signal for the up-front investment for subsequent new entrants as any new entrants (such as RWP_2) must now be more efficient than RWP_1 to enter the market. This results in a more efficient overall industry as the new pricing signal results in only more efficient investments being incentivised to invest in the industry. The question for the wholesale pricing framework is who should receive the benefit of this increased efficiency in the bulk water supply services – the new entrant wholesale customer that created the efficiency (through an efficiency incentive mechanism), or the end-use customers that ultimately pay for the services (through reduced charges).[32] The process should result in the wholesale service provider being indifferent – i.e., not receiving a benefit, but then not incurring additional costs.

In terms of the ongoing pricing signal, from an economic efficiency perspective, once the investment in the recycled water plant is made by the new entrant, it becomes a sunk investment. These new entrants will continue to supply their customers using these now sunk investments where the marginal benefits to do so continue to outweigh the marginal costs of operation. The key consideration from an economic efficiency perspective is whether the pricing signals inappropriately encourage the ongoing operation of these RWOs where the marginal costs are greater than the marginal price for the product.

Figure 5: Impact of changes to LRMC estimate



The shaded areas in the above graph demonstrate the cost savings attributable to each investment – light yellow for RWP_1 and darker yellow for RWP_2. It can be seen from this that as a result of the RWP_1 investment, the reduction in the LRMC (down to $LRMC_2$) results in a lower cost saving that can be attributed to RWP_2. This is purely a reflection of the change in value of security of supply and it being appropriately incorporated into the pricing signal for new entrants.

32 Assuming that the retail price for the end-use customers of the wholesale customer is linked to the retail price of the wholesale service provider (which appears to be the current practice), then the end-use customers of both the wholesale customer and wholesale service provider will receive the benefit.

This issue of the change in LRMC does not impact on the cost savings that are attributable to the recycled water plant, but rather the sharing of subsequent benefits between industry participants. This is similar to other regulatory frameworks where decisions are required to determine the level of sharing of benefits (and risks) between the service providers and end-use customers. In considering this issue, the wholesale pricing framework will need to consider:

- Whether incentive mechanisms are required to ensure the RWP_1 investments that result in a more efficient industry are not discouraged by the pricing signals;
  - This may be influenced by the length of time between updates of the LRMC estimate as that will determine the level of sharing of the benefit
- The probability of such an investment resulting in a material change to the LRMC estimate;
  - This may be more likely if catchment-based LRMC estimates are developed for WWTP augmentations or wastewater network augmentations
- Whether customers should be the beneficiary of the subsequent efficiency in the industry through the investment from RWP_1.