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Research article

Risk management, financial evaluation and funding for wastewater and stormwater reuse projects

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ABSTRACT

This paper has considered risk management, financial evaluation and funding in seven Australian wastewater and stormwater reuse projects. From the investigated case studies it can be seen that responsible parties have generally been well equipped to identify potential risks. In relation to financial evaluation methods some serious discrepancies, such as time periods for analysis, and how stormwater benefits are valued, have been identified. Most of the projects have required external, often National Government, funding to proceed. As National funding is likely to become less common in the future, future reuse projects may need to be funded internally by the water industry. In order to enable this the authors propose that the industry requires (1) a standard project evaluation process, and (2) an infrastructure funders' forum (or committee) with representation from both utilities and regulators, in order to compare and prioritise future reuse projects against each other.

1. Introduction

1.1. Wastewater and stormwater reuse

Traditionally wastewater and stormwater have been seen by water utilities as negative commodities that should be disposed of as efficiently as possible (Asano and Levine, 1996; Grant et al., 2012). In the developed world this has generally meant transferring and discharging untreated stormwater, and secondary treated wastewater, into receiving waterways and oceans (Mitchell et al., 2002). In recent decades this traditional viewpoint has been gradually altered as the water utility sector has faced increasingly serious challenges from population growth, climate change and pollution, which are causing water shortages and ecosystem degradation (Vörösmarty et al., 2010; Vörösmarty et al., 2000; Alcamo et al., 2007; Grimm et al., 2008).

Wastewater and stormwater reuse are now widely considered to be a crucial element in achieving "Sustainable Urban Water Management" (Wong, 2006; Brown et al., 2009; Ferguson et al., 2013; Brown and Clarke, 2007), which is a broad term used to indicate sustainable outcomes in the urban water sector (Furlong et al., 2015). Water shortages have led to a shift away from seeing wastewater and stormwater as a burden towards viewing them as a water resource (Mitchell et al., 2002; Asano and Levine, 1996; Levine and Asano, 2004; Grant et al., 2012). Wastewater reuse has been consistently increasing across the planet over the past two decades (Chen et al., 2013). Stormwater reuse is less common although a large number of these schemes can be found in Australia (Ferguson et al., 2013). Reuse of wastewater and stormwater has the added benefit of reducing negative human impact on the environment, by reducing the amount of pollutants which are transferred into waterways and bays (James et al., 2015; Ferguson et al., 2013).

There are four different types of water reuse schemes. The first involves irrigating farmland and public open space with either secondary (Class B or C) or tertiary (Class A) treated wastewater effluent, or the equivalent quality of stormwater. Secondly there are dual pipe systems which supply tertiary treated (Class A) wastewater, or the equivalent quality of stormwater, to residential and commercial properties for non-potable uses such as garden watering, toilet flushing and clothes washing (Ferguson et al., 2013; Furlong et al., 2016a). Thirdly there are direct potable reuse

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schemes such as the ones operating in California, Texas, Namibia and Singapore (Gerrity et al., 2013). In some cities potable reuse water is rebranded in order to mitigate the community stigma of drinking recycled sewerage, such as "NEWater" in Singapore (Lee and Tan, 2016). The final type of reuse scheme involves treating wastewater or stormwater then releasing to waterways in a particular flow regime in order to have a positive environmental impact (Luthy et al., 2015; Ferguson et al., 2013).

Wastewater and stormwater reuse can simultaneously impact water supply, sewerage, drainage, and waterway management functions that are performed by water utilities, and therefore if these projects are to be effectively planned an Integrated Urban Water Management (IUWM) approach is required (Lazarova et al., 2001; Furlong et al., 2016a). The main principles of IUWM are: (1) the integrated planning of water supply, sewerage and drainage services, (2) collaboration between previously segregated organisations and departments, (3) proactive long-term planning, and (4) increased community awareness and participation in water management functions (Furlong et al., 2016a; Global Water Partnership, 2012; Furlong et al., 2015; Mukheibir et al., 2014).

Aside from requiring an IUWM approach, water reuse projects increase the complexity of urban water management functions in a number of other respects (Bell, 2012, 2015; Furlong et al., 2016b). In particular water reuse projects are difficult for water utilities to manage in terms of risk management, financial evaluation and funding (Institute of Sustainable Futures, 2013; Institute of Sustainable Futures, 2008; Marsden Jacob Associates, 2013; Turner et al., 2016). These issues are the focus of the reminder of this paper.

1.2. Risk management in the planning of reuse projects

Risk management is the process through which project managers identify, consider, and attempt to mitigate potential risks to projects. There are a number of terminological issues discussed in literature relating to risk, such as the difference between risks, hazards, and uncertainties (Trevizan et al., 2007). The word "risk" in this paper is used loosely, in line with common usage of the word, which is defined by the Macquarie dictionary as "the state of being open to the chance of injury or loss". For the purposes of this paper, "risk" is being defined to include any future occurrence which may have a negative impact on reuse projects, as it is argued that project managers should attempt to consider all of these in the planning of reuse projects.

Wastewater and stormwater reuse schemes increase complexity in risk management processes because they involve so many different types of risk (Toze, 2006a). Water quality is often not of potable standard, creating a community safety risk in case of accidental ingestion (Toze, 2006b). Reuse schemes create a specifically designed stream of water, for a specific purpose, and therefore there is a risk that after a scheme is built that customers will use less or none of the water, thus creating a financial risk for utilities (Marsden Jacob Associates, 2013). There is a risk of community rejection of the water, particularly in the case of potable recycling schemes (Dolnicar and Schäfer, 2009). Also there are environmental risks inherent in decisions to either reuse water, or discontinue reuse, as both have environmental consequences (Luthy et al., 2015). In many places water infrastructure decisions are also highly politicised, which creates political risks for practitioners and policy makers (Furlong et al., 2016c).

In order to assist project managers in identifying such a broad range of potential risks, some authors propose the use of the PESTLE (political, environmental, social, technological, legal and economic) risk framework (Turner et al., 2016; Institute of Sustainable Futures, 2013). Consideration of these various types of risks should ideally inform financial evaluation processes, and consequently affect funding outcomes, although as will be discussed in this paper this is not always the case.

1.3. Financial evaluation and funding of reuse projects

Compared to traditional water supplies the financial evaluation and funding of reuse schemes is also complex for a number of reasons. Recycled water schemes do not generally achieve full-cost-recovery, and require some form of subsidy from the wider utility customer base, state or national governments (Hernández-Sancho et al., 2015; Marsden Jacob Associates, 2013). This means that financial evaluations and associated decision making processes must attempt to justify these subsidies (Institute of Sustainable Futures, 2008).

In situations where projects do not pay for themselves, there are a number of possible funding avenues, and determining the most appropriate funding avenues is an important topic for discussion (Productivity Commision, 2011; Hernández-Sancho et al., 2015). Subsidies can be granted from water utilities, local, state or National governments, or funding of these projects can be charged to property developers (Lazarova et al., 2003).

In order to justify subsidies, it is necessary to identify and value a range of benefits (and potentially costs) from the reuse schemes which are often referred to as externalities (Institute of Sustainable Futures, 2008; Hernández-Sancho et al., 2015). Externalities are the costs/benefits from a good or service that accrue to entities other than the transaction parties, thus creating a divergence between private and public costs and benefits. One general example of divergence is immunisation programs, which provide benefits for all members of the community, not only those immunised. In the case of reuse projects the transaction parties are likely to be a water utility and the direct users of water; however the reuse project may have a positive impact on many other groups. In such situations governments often choose to either (a) subsidise private provision of the service, or (b) provide the service itself and recuperate a proportion of the total cost from the direct customer (Barton, 1999).

Commonly associated reuse benefits (positive externalities) include: (1) environmental benefits from reducing human impacts on waterways and bays, (2) liveability benefits from ensuring water supply for public open space and garden watering during times of drought, (3) regional economic benefits from drought proofing farming areas, and (4) potable headworks benefits from reducing strain on traditional water supplies (Marsden Jacob Associates, 2013; Institute of Sustainable Futures, 2013; Hernández-Sancho et al., 2015).

Thus deciding upon the most appropriate financial evaluation model is extremely important. At present there is a high level of inconsistency in regards to how the financial evaluation of reuse schemes is being conducted (Marsden Jacob Associates, 2013). The examples given in this paper will help to illustrate the inconsistencies between the financial evaluation models which are currently being used by water utilities. Calculating the level of indirect benefits (positive externalities) that a project contributes can be particularly difficult, especially when stakeholder and regulator agreement is required. This is complicated even further when considering how potential risks are expected to impact on predicted benefits.

As explained in the previous section, there is a large amount of risk involved in the planning of reuse schemes, and so they often do not perform as well as predicted, in terms of the financial performance, and also in terms of their provision of other benefits (Institute of Sustainable Futures, 2013; Furlong et al., 2016a; Mukheibir et al., 2014). Many of the risks mentioned in the previous section have an impact on the performance of schemes. Such risks can lead to increases in capital or operating costs and lower than expected water use, leading to both reduced revenue and also a reduction in previously estimated positive externalities. However in general the financial evaluation models which are being utilised by water utilities do not generally include a consideration of how financial projections will be affected by potential risks (Turner et al., 2016).

1.4. Focus of this paper

The current paper focuses on the following research questions:

1. What are the major risks associated with wastewater and stormwater reuse projects, and to what extent are planners able to accurately identify risks?
2. How are financial evaluations of reuse projects currently being conducted by project leaders, and what externalities are typically considered?
3. How are reuse projects being funded?

In order to investigate these questions the researchers have selected one case study region within South-Eastern Australia, and selected seven wastewater and stormwater reuse case studies from within this region. The major relevant water industry institutions that operate within this region are: one bulk water, wastewater and stormwater service provider (Bulk Supplier), a number of smaller water utilities which connect bulk services to customers (Water Retailers), a large number of municipalities, known in Australia as Local Government Areas, and a number of government or semi-independent regulators such as the Essential Services Commission (pricing regulator).

The discussion of local contexts is widely acknowledged to be important for understanding water management processes (Hering et al., 2015), but have not been considered in this paper. The reasons for this are that: (1) the case studies for this research have all been drawn from one region within South-Eastern Australian, meaning that they have had similar institutional conditions making comparison easier, and (2) the context of these case studies has been thoroughly explored in parallel research (see acknowledgements) and has been deemed to have little bearing on the specific questions explored by this paper which relate specifically to process. Furthermore it should be noted that the case studies have been made anonymous for the purposes of this paper so as to avoid any potential negative publicity for case study projects and their associated organisations.

2. Method

In order to investigate a variety of topics (see acknowledgements for reference to wider research program) relating to IUWM and water reuse, researchers conducted a wide-ranging water industry consultation process with a total of 43 experts from 25 organisations as shown in Table 1 below.

Table 1
Details of consulted experts.

Organisational type	Number of experts consulted
Retailer	16
Government body	6
Academic	3
Bulk supplier	8
Private	5
Municipality	5
Total	**43**

Through this consultation process it was determined that the most appropriate way to study IUWM and water reuse issues was through project case study analysis. Researchers then worked collaboratively with a major water utility to select seven reuse project planning case studies. Case studies were selected to include: (1) both wastewater and stormwater reuse; (2) both constructed and cancelled projects; (3) water utility, municipality and private projects; and (3) small and large projects.

After the seven case studies were selected researchers conducted interviews with the relevant project managers and also investigated planning documentation. Findings from the investigation for each case study were written up into comprehensive case study reports which have been reviewed and approved by relevant organisations and published by Water Research Australia (Water Research Australia, 2016).

This paper will outline the findings from the case study reports in relation to risk management, financial evaluation and funding. Findings in relation to risk management were determined through two steps. Firstly it involved recording the risk assessment processes undertaken by the project lead organisations of each of the case studies into a risk table. Secondly the risk table was compared against the outcomes of the case study to determine what impacts the risks have had, and also whether other risks have eventuated which were not identified through the risk management processes. For the purposes of this paper the word “eventuated” refers to whether there is evidence that the risk has occurred, and had an impact on the project, between the time the risk assessment was conducted and the time the case study report was developed.

Findings in relation to financial evaluation and funding were determined through three steps. Firstly the financial evaluation process, including associated decision making processes, as undertaken by the project lead organisation, was documented in relation to how project costs were considered and justified. Special attention was paid to any consideration of wider benefits or risks during the financial evaluation process. Secondly the funding sources, both intended and resultant, were recorded. Finally the financial evaluation and funding analysis was considered in relation to actual project outcomes.

The findings in relation to risk, financial assessment and funding were then considered in combination in order to discuss current practices and make recommendations for future efforts.

It should be noted that the risk, financial evaluation, and funding projections and actual outcomes, have been provided to the researchers by the lead organisations. This paper does not include the reproduction of these risk and financial projection processes, but rather intends to evaluate the effectiveness of these previously conducted processes, through comparison with the eventuating case study outcomes revealed through the project narrative.

3. Case studies

This research utilises seven reuse project planning case studies, which will be explained in the following sections. A summary of the information on these case studies is given in Table 2 below. The total list includes four stormwater reuse projects, one of which is currently in operation, and three wastewater reuse projects, one of which is operation.

3.1. Case Study A (stormwater reuse)

3.1.1. Project description

Case study A is a stormwater reuse project that has been led by a municipality and is currently in operation. It has been designed to harvest an average of 69 ML/year from a local drain to irrigate an inner-city park, equating to 59% of the park's total water demands.

Table 2
Summary information for IUWM project case studies.

Case Study	Water source	End quality & use	Project lead	Capacity ML/year	Capital cost[a]	Financial evaluation	Grant requested?	Outcome
A	Stormwater from local drain	Class B for irrigation	Municipality	69 ML	<$10 M	Basic NPV assessment	50%	Grant received & project in operation
B	Wastewater from major STP	Class A (desalted) for industry	Utility	4,700 ML	>$50 M	Cost benefit analysis with potable headworks benefit	0%	Put on hold by pricing regulator
C	Wastewater from local STP	Class B for irrigation	Consortium of farmers	1000 ML	~$10 M	Funding gap justification through nitrogen reduction	30%	On hold because of difficulty sourcing external funding
D	Wastewater from local STP	Class A for irrigation	Utility	1,670 ML	~$10 M	MCA & cost comparison with other RW schemes	15%	Grant received & project in operation
E	Stormwater from constructed wetlands	Water exchange	Utility	~1000 ML	<$20 M	Basic NPV assessment	50%	Funding received but then retracted because unable to reach water exchange agreement. Pilot trial being conducted
F	Stormwater from local drain	Class A for residential	Utility	213 ML	<$20 M	Cost benefit analysis with stormwater treatment benefit	50%	Grant received but then project cancelled due to cost increase
G	Stormwater from constructed wetlands	Potable/ Class A for residential	Utility	360 ML	~$20 M	Cost benefit analysis with stormwater treatment & spending deferment benefit	50%	Grant received, project built, but not operating due to delay in surrounding development

[a] In some cases capital cost is highly confidential, and so all values have been given here in a highly indicative fashion.

Stormwater is sourced from existing drains, stored in a 4 ML buffer storage, treated through a simple treatment train with sedimentation, a bio filter, and UV disinfection, and finally being irrigated through an existing irrigation system. It has been in operation for two years and has collected more stormwater than expected, but utilised less than expected, due to some teething issues.

3.1.2. Risk management

It appears that Case Study A has a low level of associated risk because of its low level of complexity. The treated water is used by the same organisation that produces it (the municipality), and so there is no risk of a water customer deciding not to use the water. The park requires a constant stream of water, and is heritage listed, meaning that the park is guaranteed to exist into the foreseeable future. These two factors in combination result in low demand side risks.

Supply risks have been partially considered through calculating the percentage of time which the supply will be reliable, which has been calculated at 59%. This figure should theoretically hold true as a long-term average. Treatment risks in such a simple treatment train are minimal, although two minor issues have occurred with are explained in Table 3 below.

The impact on project outcomes from eventuating risks has been that contaminated soils being onsite has resulted in increasing the project costs by up to 20%.

3.1.3. Financial evaluation

As part of the official planning of the scheme the only financial evaluation that was conducted was a simple payback calculation, which was done with an analysis period of 50 years. Because this approach was notably inconsistent with the other case studies, the researchers conducted their own approximate financial assessment comparing the stormwater harvesting scheme with the base case of purchasing all required water from the local Water Retailer. This calculation shows that the NPV of Case Study A varies drastically, from -$2 M to +$26 M, depending on the financial assumptions including: assessment period (from 20 to 50 years), increase to the price of potable water (2–6% per annum), and discount rate selected. It was concluded that the project could be expected to lose a maximum of $2.2 M in a worst case scenario. The approximate financial evaluation that the researchers conducted was reviewed and approved by the municipality, and included in the case study report which has been published on the Water Research Australia website (Water Research Australia, 2016).

3.1.4. Funding

A National funding grant from the National Water and Desalination Plan to the municipality contributed 50% of the expected scheme costs ($2.1 M of the expected $4.2 M) to the project, meaning that the municipality has essentially guaranteed itself a positive financial outlook from the project (because the maximum loss is a similar value to the external grant).

3.2. Case Study B (wastewater reuse)

3.2.1. Project description

Case Study B is a wastewater reuse project that has been led by a Water Retailer. It was planned to supply 4.7 GL/year of recycled wastewater from a major Sewage Treatment Plant (STP), which is owned by the region's bulk water, sewerage, and stormwater

Table 3
Risk assessment of Case Study A.

Risk	Explanation	Risk identified?	Risk eventuated?
Less than expected supply	The main risk is that rainfall drops substantially. Although this could have some impact on the amount of water produced by the scheme, the impact would be incremental, and the modelling has been done taking into account dry year data.	✓	–
Catchment pollution incident	The municipality does not have control over the operations within the catchment which include roads. There is a potential risk of a chemical, or any kind of spill incident.	✓	–
Contaminated soil on-site	The unexpected discovery of contaminated soils on-site caused the project to cost 20% more than expected.	✗	✓

service provider (Bulk Supplier), to industrial customers. The intention was for the Water Retailer to purchase Class A reuse water from the Bulk Supplier, and then apply additional treatment processes to the water, particularly for the purposes of salt reduction. Capital works for this project were to include: membrane filtration and reverse osmosis treatment plant, 16 km transfer pipeline, 2.6 ML supply tank and 23 km distribution network. After an Essential Services Commission (pricing regulator) determination to defer the scheme, the project is currently on hold, and may be revisited in the future (5 years after the pricing regulator determination).

3.2.2. Risk management

The major risk that was identified in relation to this scheme was the potential future reductions in customer demands, particularly because the scheme was intended to supply a number of large industrial customers which can be affected by market conditions. An attempt was also been made to investigate other potential users including residential areas. It was considered that if demand was to drop considerably in the first 10 years of the scheme, then alternative demands could be found. If demands dropped after this point it was considered that the financials of the scheme would worsen. Over the considered 35 year lifespan there is a substantial risk that some of the customers will reduce or cease supply. Due to this reason the Water Retailer conducted a sensitivity analysis to see what the impact to the projects financial bottom line would be if they lost customers at different time-steps. Feed water quality and operational issues were considered to be a minor risk. Risks for Case Study B can be seen in Table 4.

The impact on project outcomes from eventuating risks has been that the project has been placed on hold by the pricing regulator, for reasons explained below.

3.2.3. Financial evaluation

The Water Retailer conducted a thorough cost benefit analysis during the planning of this project. The results of financial evaluation found that the scheme is predicted to be NPV positive over a 35 year time period. The conducted financial assessment estimated a benefit (equating to approximately 15% of the total cost) from deferral of the next major potable headworks augmentation such as a new desalination plant. This is an example of attempting to account for something that is generally not included in financial assessments, i.e. an “externality”, see section 1.3.

This was done through calculating the cumulative water savings which would be saving up inside dams, and calculating how much this would defer the next augmentation. However the Water Retailer has no direct mechanism by which to recuperate these headworks benefits, which would in theory be doing a service to a number of neighbouring Water Retailers and the Bulk Supplier. In theory some of these savings would accrue to the Water Retailer in question through lower bills from the Bulk Supplier, but the majority of these savings would accrue to other parties. Therefore the Water Retailer was predominantly attempting to achieve a public good.

However the decision by the pricing regulator to defer the scheme may indicate that the regulator was either (a) sceptical of this headworks benefit assessment, or (b) aware that the risks, as mentioned in the previous section, particular in relation to reduced demands, may impact on the financial performance of the scheme, causing its revenue to be less than predicted.

3.2.4. Funding

No external grants were made available or sought for this project, which is in contrast to the majority of the other case studies investigated by this research program.

Financial impacts to other stakeholder organisations were considered. The included organisations are the Bulk Supplier and scheme customers, with benefit cost ratios of 1.00 and 1.17 respectively. This higher benefit cost ratio for scheme customers is caused due to the fact that they will be given a lower volumetric charge for water if the scheme is ever implemented (recycled water is charged at a lower price than potable water), and therefore stand to make a substantial saving on their water bills.

No net financial impact is predicted for the Bulk Supplier that owns and operates the sewage treatment plant from which the recycled water was to be sourced. This assumes that the agreed Class A water purchase price is enough to cover the Bulk Supplier's treatment and operating expenses. The prices that the Bulk Supplier charges for recycled water are affected by a complex web of interactions with other users and also influence from politics. At many points in time they have sold this water at a financial loss. Therefore whether this price actually covers the Bulk Suppliers operating expenses is an issue which may warrant a revisit if Case Study B's implementation is sought into the future.

3.3. Case Study C (wastewater reuse)

3.3.1. Project description

A consortium of farmers is currently seeking to implement a wastewater reuse scheme to supply 1000 ML of Class B Recycled Water every year from a Water Retailer's local sewage treatment plant to their farms. The farmers originally approached their Water Retailer, hoping that the Retailer would own and operate the scheme for them. The capital cost which the Water Retailer estimated that the scheme would be was higher than what the farmers estimated, or could fund. The farmers have been investigating other options for a number of years since then. This case study provides an example of a purely private enterprise seeking to implement a reuse scheme.

3.3.2. Risk management

An official risk assessment has not been conducted as part of the planning of Case Study C as off yet. Researchers have, in discussion with stakeholders, noted some of the potential risks in the project, as shown in Table 5.

As the project is still in its early stages it is not possible to know

Table 4
Risk assessment of Case Study B.

Risk	Explanation	Risk identified?	Risk eventuated?
Reduced demands	Serious risk that industrial customers may go out of business or move within the 35 year life of the scheme.	✓	–
Feed water quality/operational issues	This is considered to be a low risk for two reasons. Firstly the source water is Class A and it has been in operation for some years. Secondly this risk can be further managed through a Design Build Operate Maintain contract with contractors.	✓	–
Failure to achieve approval from government regulators	The project eventually failed to achieve approval from the Essential Services Commission.	✗	✓

Table 5
Risk assessment of Case Study C project.

Risk	Explanation	Risk identified?	Risk eventuated?
Potential future reduction in recycled water demands	If demands from farmers drop significantly then the financial viability of the scheme would be damaged. This can be partially managed through take-or-pay contracts. However any environmental improvements from the scheme would be reduced if the water utilised by the scheme is reduced.	✓	–
Difficulty achieving external funding of (of $2 M)	If external funding is not achieved then the scheme will not be viable. So far it has proven to be difficult, but may still be possible.	✓	✓
Difficulty finding an appropriate owner and operator of pump and pipeline	There are various options being considered for delivery mechanisms. If a suitable candidate is not discovered then the scheme is unlikely to be able to proceed.	✓	✓
Capital cost increases above what is estimated	The Water Retailer believes that the farmers may have underestimated the scheme costs. If this happens there is a risk that the scheme will run out of funding midway.	✗	–

what the impact of any risks will be. So far the consortium of farmers has had significant trouble achieving external funding and finding an appropriate delivery mechanism. It is also possible that the scheme may prove to be more costly than what they have predicted.

3.3.3. *Financial evaluation*

Financial evaluation that has been conducted for this scheme, by the farmers and the parties that they have been negotiating with, has focused on how the required external funding can be justified. If Case Study C is implemented it will result in reduced nitrogen levels being discharged to a local creek, by removing wastewater effluent. Therefore it is argued that the Bulk Supplier (who is also the stormwater manager for the region) should contribute financially to the scheme for this benefit.

In the study region developers are required to meet minimum requirements for nutrient removal in stormwater captured on their development. If developers are unable or unwilling to meet this nutrient removal requirement then they are required to pay the Bulk Supplier a financial contribution for development of stormwater treatment offsets in another location. This contribution was recently set at $7236 per kg of nitrogen per year (meaning it is a once-off payment calculated by yearly volumes). In this case the nitrogen load removed from the creek is estimated to be 5600 kg per year. This results in a nitrogen reduction equivalent to $40,521,600 in offset charges. However the stormwater offset contribution is set at such a high value because it is used to incentivise stormwater management technologies, such as wetlands, and therefore considers criteria of multiple benefits on top of nitrogen removal such as habitat, recreation facility and community benefits which are not delivered through this project.

Due to this reason, in their consideration of whether to grant external funding, the Bulk Supplier determined that this stormwater benefit calculation was inappropriate, and so determined that the scheme does not warrant funding. The Bulk Supplier proposed as an alternative benefit calculation method, that the value for the Long Run Marginal Cost of nitrogen treatment at one of their large sewage treatment plants be used. This value measures the long term cost of operating a treatment plant, and does not actually consider the potential environmental benefit of removing effluent from the waterway in question.

Table 6 shows the amount of external funding that the project requires, in comparison to the two different methods of calculating the nitrogen abatement benefit that the scheme would provide. The first column shows the Long Run Marginal Cost of nitrogen treatment at a large sewage treatment plant within the study region, the second column shows the amount of funding required, and the third shows the amount of funding that it could be eligible for if it were reducing nitrogen from a stormwater source in a new residential development. Neither of these benefit calculations is entirely appropriate, nor entirely inappropriate, with a more accurate value likely to land somewhere in the middle. See Case Studies F and G, and discussion for further exploration of this issue.

This is another example of attempting to account for "externalities" (see section 1.3) in the planning of reuse projects.

3.3.4. *Funding*

The farmers have predicted the scheme to cost $6 M, and are able to fund $4 M through scheme customers (in this case themselves), so they sought to have the Bulk Supplier fund $2 M. As explained above the Bulk Supplier determined that stormwater benefits did not warrant funding of the scheme. Without funding the scheme may not be able to proceed.

However there are perhaps other, more appropriate, funding avenues through State Government departments that may better align with the goals of the project. This is because the project is providing a mechanism to improve the viability of businesses (with potential environmental benefits as a by-product). If the municipality that the scheme is situated in was purely regional then there would be access to regional economic development funding. However it is a fringe area which is half metropolitan and half regional, and because of this these regional funding sources are not available.

There is a possibility that the state government may provide funding to the scheme as part of the sale of the region's Port. Because some of the value of the Port has been derived from farming exports, some of the money from this sale is expected to be supplied to agricultural infrastructure projects.

Table 6
Difference in nitrogen benefit calculation.

	LRMC of treatment at STP	Amount of funding required	Current MW stormwater offset contribution
Value	$.43/kg	$357/kg/year	$7236/kg/year
Annual or one off payment	Annual (25 year)	One off	One off
Load	5600 kg/year	5600 kg/year	5600 kg/year
Total funding justified	$38,155 (NPV)	$2,000,000	$40,521,600

Table 7
Major risks that have eventuated in Case Study D.

Risk	Explanation	Risk identified?	Risk eventuated?
Stage 2 not going ahead	Not considered in business case. This risk has been identified as part of investigating this case study.	✗	✓
Changing government legislation	During the planning of Case Study D the Cultural Heritage Management Plan (CHMP) government legislation changed adding approximately $250 k to the project cost.	✗	✓

3.4. Case Study D (wastewater reuse)

3.4.1. Project description

Case Study D has been led by a Water Retailer. It is currently in operation and involves the use of recycled water from a local sewage treatment plant (owned the same utility) for irrigation of public open space, market gardens, golf courses and school ovals. The scheme was intended to have two stages, which were planned (and financially assessed) together as a combined package. Stage 1, a 1.67 GL/year scheme began operation in 2009. Stage 2 was never constructed due to lack of demand.

Actual volumetric usage of recycled water has been below 50% of capacity so far. Because take-or-pay contracts (customer is charged regardless of usage) were utilised the level of demand has not been a financial issue for the Water Retailer.

The absence of predicted demand for Stage 2, and subsequently its non-implantation, has had a negative effect on the financial bottom line of Case Study D, in comparison to what was predicted in the business case. This is because Stage 2 would have provided cheaper water than stage 1, and then been sold at the same price, as explained further below. However overall the scheme has been successful in providing water security to the region, and it is likely that the water usage will increase in the next dry period.

3.4.2. Risk management

Interestingly the only two risks which have turned out to be an issue, the non-implementation of stage 2, and changing government legislation were not identified as part of the risk assessment which was completed for the business case, which is shown in Table 7.

Overall the eventuating risks have had a negative impact on this project's bottom line. The risk of Stage 2 not being implemented was not discussed in the risk assessment or anywhere else in the business case. In fact the risk assessment states that because take-or-pay contracts will be used then there is no risk to the Water Retailer's revenue. Changes to Cultural Heritage Management Plan legislation could not have been foreseen by the Water Retailer. However it is probably logical to include changing government legislation as a risk in future projects.

3.4.3. Financial evaluation

The conducted financial evaluation estimated a shortfall of $2.6 M for the recycling option over a 25 year period, in comparison to sewage treatment plant works which were required regardless of any recycling option. This is shown in Table 8.

Following on from the financial evaluation, which determined the level of financial shortfall, the Water Retailer was required to demonstrate that the more expensive recycling option was justified. This was done through a multi-criteria assessment which considered socio-economic and financial factors.

More prominently featured in the business case was a comparison of production costs between Case Study D and other recycling schemes which showed it to have a lower production cost. The reason for this was that because the government had signed off on a 20% water recycling target for the region, all that was required was to show that Case Study D was cheaper than alternative/existing recycling schemes.

Table 8
Financial evaluation results for Stage 1 and 2 combined.

Option	NPV (at 6% rate, 25 year period, 2007$)
Base case (STP upgrade without reuse)	-$13 M
Recycling option	-$15.6 M

3.4.4. Funding

Half of the $2.6 M predicted shortfall was sought, as a $1.3 M external grant from a State Government Water Recycling fund. State Government funding success was aided by council, school and community element associated with this recycled water scheme.

In order to demonstrate how only implementing Stage 1, and not implementing Stage 2, has affected the financial bottom line of the project, the researchers conducted an approximate calculation as shown below in Table 9. It shows an additional loss of approximately $2.2 M for implementing Stage 1 only (which is what has happened), in comparison to the Stage 1 and 2 combined scheme which was included in the business case.

Therefore an approximate total of $3.5 M ($1.3 M predicted, and $2.2 M not predicted) in losses can be expected to accrue over time to the Water Retailer, which then needs to be charged to the wider customer base.

3.5. Case Study E (stormwater reuse)

3.5.1. Project description

Case Study E was designed by a Water Retailer to harvest urban stormwater and then transfer this water to an agricultural water authority in exchange for a permanent share of upstream agricultural water entitlements. The scheme successfully won a 50% grant from National Government funding. However, the agricultural water authority later decided not to accept the scheme in its proposed form because they perceived a risk to supply security.

Conducted modelling results demonstrated that the exchange scheme would have no adverse impact on irrigators, but the agricultural water authority, and the irrigators it represented did not have sufficient confidence in the modelling results to permanently hand over a proportion of their water resource assets. A pilot trial is now being planned to support a potential future scheme with a 1 ML for 1 ML exchange mechanism, although due to the lack of certainty surrounding project outcomes the National Government

Table 9
Financial impact of implementing stage 1 only, compared to both stage 1 and 2.

	Stage 1 (only)	Stage 1 & 2 Combined
Capex (2007$)	$7.7 M	$10.6 M
Volume (25 years)	41,250 ML	75,350 ML
Levelised cost/ML (2007$)	$~410*	$~330*
Customer charge/ML	$~296	$~296
Funding gap/ML	$~116*	$~36
NPV (variation from base case)	-$~4.8 M*	-$~2.6 M

Table 10
Risk assessment of Case Study E.

Risk	Explanation	Risk identified?	Risk eventuated?
Inability to reach water exchange agreement with agricultural water authority	This risk has eventuated and caused the project to be put on hold. A pilot scheme is in operation however the future of the larger scheme is questionable.	✓	✓
Funding issues including having the funding retracted	This risk has eventuated. When the urban Water Retailer was unable to reach agreement with the agricultural water authority National funding was withdrawn.	✓	✓
Hydrology modelling proves to be incorrect	Extensive water resource modelling was undertaken to support preparation of the business case. It is not yet known how accurate and conservative this analysis will prove to be.	✓	–
Delays in development	Urban development in the area is proceeding consistently but has been slower than expected.	✓	✓

funding agreement was terminated by mutual agreement in early 2015.

3.5.2. Risk management

A selection of the risk assessment which has been included in the final Case Study E report is shown below in Table 10. This risk assessment demonstrates that the lead organisation had significant concerns that risks would cause the project not to proceed.

The eventuating risks have had the impact of the project not proceeding in its original form, although it may proceed in a different form in the future. The Water Retailer accurately assessed the potential risks associated with the scheme. Most of the identified risks have eventuated. The Water Retailer was not able to achieve agreement with the agricultural water authority over the permanent water entitlement transfer. This caused the National government to end the funding agreement. The Project Team has learnt from previous water industry experience with developers and determined that development forecasts are notoriously unreliable, as has also been the case in this example.

3.5.3. Financial evaluation

An NPV assessment of possible stormwater harvesting schemes was conducted to determine which was the most cost effective. Present values of benefits and costs (under Historical Climate conditions) for the potential project scenarios (at a 5% real discount rate and for a 20 year evaluation period) were calculated. The main conclusions able to be drawn from the Historical Climate assessment were that: the stormwater project provides a net financial benefit to the Water Retailer.

3.5.4. Funding

National Government funding was granted for Case Study E was capped at 50 per cent of eligible capital costs. Because agreement was not able to be reached between the Water Retailer and agricultural water authority over the exchange mechanism the National Government cancelled the funding agreement by mutual agreement in 2015. $410,000 of National funding and $600,000 of Water Retailer funding was spent on planning.

A pilot trial is currently being constructed to test the potential benefits of the scheme; there are no results available yet from this trial. The pilot trial was predominantly funded through a separate state government grant, which has been kept financially disconnected from the larger project.

3.6. Case Study F (stormwater reuse)

3.6.1. Project description

Case Study F was led by a Water Retailer. It was designed to harvest stormwater from two transfer drains for non-potable use within new apartment buildings. Flows were to be directed into an 8 ML underground concrete storage tank. This underground tank was designed to supply a new up-to 1 ML/day Class A treatment plant and .5 ML above ground balancing storage tank. The project was expected to supply approximately 213 ML of recycled water each year via a 3rd pipe system to new apartment buildings, as well as irrigation of parks.

The project won a 50% funding grant from the National Government, although the project was later cancelled by the Water Retailer due to a cost increase from the original estimate of $13.28 M to a total of $16.5 M which was revealed through tendering. The major reason for the cost increase was unexpected geological conditions, as well as some stakeholder requirements.

3.6.2. Risk management

A selection of the risks associated with Case Study F is shown below in Table 11.

Overall the eventuating risks have resulted in the project being cancelled due to a cost increase. This cost increase was caused partially by stakeholder requirements and partially by unexpected geotechnical conditions. The Water Retailer project team has effectively identified the two out of three key risks which have eventuated. Risks around planning estimates and risks around receiving design support from stakeholders did turn out to be significant issues. Developments in the area are currently over two years behind schedule.

Table 11
Risk assessment of Case Study F.

Risk	Explanation	Risk identified?	Risk eventuated?
No users for recycled water (development delays)	It was identified that there was risk of development not proceeding or proceeding slower than expected. A number of strategies were in place to mitigate this risk such as regular engagement with developers.	✓	✓
Difficulty obtaining planning permit and design support from relevant stakeholders	Difficulty in attaining a planning permit and design support from relevant stakeholders, such as local government was correctly identified as a risk. During the detailed design some stakeholder requirements added to project costs.	✓	✓
Cost increases from geotechnical conditions	A risk that was not predicted was cost increases from geotechnical conditions. This substantially added to the costs of the project causing it to be cancelled.	✗	✓

3.6.3. Financial evaluation

Once initial technical evaluation was conducted the Water Retailer determined that cost effectiveness of the project was marginal over its 25 year assessment period, and that they would need to receive an external grant to go ahead with the scheme.

Therefore as additional justification for the project the Water Retailer put forward the case of indirect financial benefits to the Bulk Supplier, in the form of nitrogen reduction, similar to Case Study C. Case Study F would have reduced nitrogen levels discharged to local waterway. In the planning of this scheme it was determined that the appropriate nitrogen benefit value was:

$$1110\ \$/kg/year \times 658\ kg/year = \$730,380\ (one\ off\ payment)$$

It is potentially a cost saving to the Bulk Supplier because it could theoretically be done instead of another nitrogen reducing project elsewhere in the drainage system. There is a precedent for this due to the fact that the Bulk Supplier has been considering the construction of a wetland in the area predicted to cost up to $14 M. Implementing Case Study F would have lessened the requirement, or size, for such a wetland.

3.6.4. Funding

The estimated capital cost of the project was $13.28 M. Funding was sought from the National Urban Water and Desalination Plan for 50% of the capital cost which equated to $6.64 M.

During development of this case study the researchers noted that in some components of the business case the Water Retailer has only attempted to justify internal costs, by investigating whether there were enough project benefits (scheme revenue plus indirect benefits such as stormwater as discussed above) to justify internal expenditure ($6.64 M), rather than total expenditure ($13.28 M). In other words the Water Retailer considered National Government money as “free money”, which did not need to be justified. Without Government grant money, the benefits of the scheme were able to offset only about half of the projects total costs.

Over the years that this project was delayed, this estimated cost increased from $13.3 to $16.5. This new cost of the scheme gradually became more unfeasible for the Water Retailer. A variety of attempts were made to reduce costs and also find additional funding sources. However there was no conceivable way to get project costs down to a level whereby the Water Retailer would not incur a significant loss, and therefore the project was eventually officially cancelled by the Water Retailer's Board.

3.7. Case Study G (stormwater reuse)

3.7.1. Project description

Case Study G has been led by a Water Retailer. It is an innovative project to deliver sustainable potable water supply to a new industrial/commercial complex on a Greenfield (previously undeveloped) site. The scheme intends to source stormwater from a 160ha commercial catchment through a wetland system and 65 ML storage basin. Water will then be transferred to an extensive 1 ML/day treatment plant. Water will be initially utilised within a newly created non-potable recycled water network. Monitoring and testing will be conducted for a number of years to provide evidence that produced water is safe for drinking, and then the treated water will begin to be injected directly into the local potable network.

Due to the poor economic conditions arising during the Global Financial Crisis, the commercial development which forms the source catchment has not yet been constructed. A time-restrictive funding arrangement has resulted in the plant being constructed anyway, before the surrounding development, leaving the plant temporarily without a water source or water user. The treatment plant now sits unused awaiting development. The first development in the area is about to commence, and so in the near future the plant is likely to begin operation.

3.7.2. Risk management

The major risks which were included in the planning of Case Study G can be seen in Table 12.

Overall the impacts of the risks have been that the project has been unused for an extended period of time. In terms of demand for the treated water, so far because of the lack of development there is currently no demand, having a significant negative impact of the financial bottom line of the project. Due to the commercial/industrial development, which is the feed water catchment, not having been constructed yet it is currently unknown whether the final feed water quality will match what was predicted. After 2–3 years of operation the Water Retailer will still need to prove the quality of supplied water to the Department of Health and also convince residents that it is safe to drink.

When the development is completed in the future, there is still a significant risk that the community will not want to drink the treated stormwater. In this region there is currently an excess of non-potable Class A quality recycled water, and so this would be a negative result.

3.7.3. Financial evaluation

Financial evaluation was conducted over a 25 year period and determined that 50% external funding was required. With the external funding the project was expected to be cost neutral for the Water Retailer. The Water Retailer justified the project by showing how the levelised cost of produced water is impacted by the inclusion of indirect financial benefits. Nitrogen reduction benefits were calculated similarly to Case Study F above. Some infrastructure augmentation deferral benefits were also included.

The project is expected to eventually reduce the nitrogen load discharged to downstream waterways. The nitrogen load reduction due to stormwater harvesting is expected to be 1461 kg per year.

Table 12
Risk assessment of Case Study G.

Risk	Explanation	Risk identified?	Risk eventuated?
Feed water quality risks from chemicals and pollutants	There was considered to be an operational and public safety risk from worse than expected feedwater quality. A variety of mitigation measures were put in place to manage this.	✓	–
No users for recycled water	A financial risk was identified in regards to less than expected demands for recycled water. This has eventuated because the development has been behind schedule.	✓	✓
Failure to gain necessary approvals	There is a risk that even after 2 years of monitoring it may not be possible to gain approval to use the treated stormwater for potable uses as intended.	✓	–
Failure to convince future residents that it is safe to drink treated stormwater	If approval of potable reuse is gained then there may still be an issue convincing the community that it is safe. Planners have discussed this issue but it was not considered in the official risk assessment.	✓/✗	–

Table 13
Comparison of time periods used in financial evaluation.

Case study	Project lead	Time period
A	Municipality	No detailed assessment, 50 years used for simple payback calculation
B	Utility	35
C	Consortium of farmers	No detailed assessment
D	Utility	25
E	Utility	20
F	Utility	25
G	Utility	25

Using the same value as Case Study F it was found that nitrogen reduction benefits from the scheme can be calculated as:

$$1,110\ \$/kg/year \times 1461\ kg/year = \$1,621,710$$

Therefore this project results in a nitrogen reduction equivalent to $1.6 M in total offset charges. Even though the project is expected to provide these benefits to the Bulk Supplier, the Water Retailer did not attempt to seek contribution for this benefit.

In the area of Case Study G new infrastructure assets will soon be required that include two water supply tanks and a major water pipeline. Case Study G does not eliminate the need for these assets; however it may (if everything goes according to plan) enable their construction to be deferred. Development forecasts indicated a deferral period of at least 3 years. Assuming an interest rate of 5% per annum and a total capital cost of $34 M, the Water Retailer is likely to save approximately $1.7 M in financing costs through deferral. This calculation includes the assumption that Case Study G will eventually supply drinking water.

If the Water Retailer received the National grant, and didn't include any of the indirect benefits calculated above (~$3.3 M), the project was expected to pay for itself over approximately 20 years. However due to delays in development this estimate would need to be recalculated.

3.7.4. Funding

A National grant was received for 50% of the expected costs. In this case due to a minor cost increase of approximately $900,000 due mostly to the developer deciding against expectations to charge for the land under the treatment plant, it has resulted in the Water Retailer paying slightly over 50% of the total capital cost. Because of delays in the pace of surrounding development the overall financial bottom line of the project has become more negative for the Water Retailer, however to what extent has not been calculated.

4. Discussion

The case studies have revealed a variety of interesting issues in relation to risk management, financial evaluation and funding of Australia's wastewater and stormwater reuse projects. Overall from this research it can clearly be seen that each reuse project is unique, with each project differing not only in terms of technical aspects, but also in terms of planning processes, critical risks, financial justifications and funding issues.

4.1. Risk management in the case studies

Risk management in the case studies has revealed insights into the relationship between complexity and risk, and which risks should be given greater weight in the future. The case studies show that the more complex and large a scheme is, the more risk it involves. Case Study A is an example of a lower complexity scheme. By having the one organisation both producing and using the water, for a well-understood end use, most of the demand side risks were avoided. Case Study D is relatively low complexity because it is relatively small, is operated by a Water Retailer that has experience in similar schemes, and was able to utilise take-or-pay contracts with customers to secure revenue streams.

In contrast many of the other schemes are far more complex in a variety of ways. Case Study B is large and intends to produce water for industrial users who may go out of business, or relocate facilities in the future. Case Study C scheme is complex because it is a private enterprise, and does not have a clear owner/operator mechanism. Case Study E is complex because it involves an innovative exchange mechanism between urban and agricultural water authorities. Case Study G is complex because it intends to treat stormwater to a potable standard which has not been done before in Australia.

The case studies reveal two particular risks which should be given additional weight in future planning processes. The first is development forecasts; these have been shown to be unreliable in Case Study E, Case Study F and Case Study G. The second is the risk that later stages of a project do not proceed, negatively affecting a

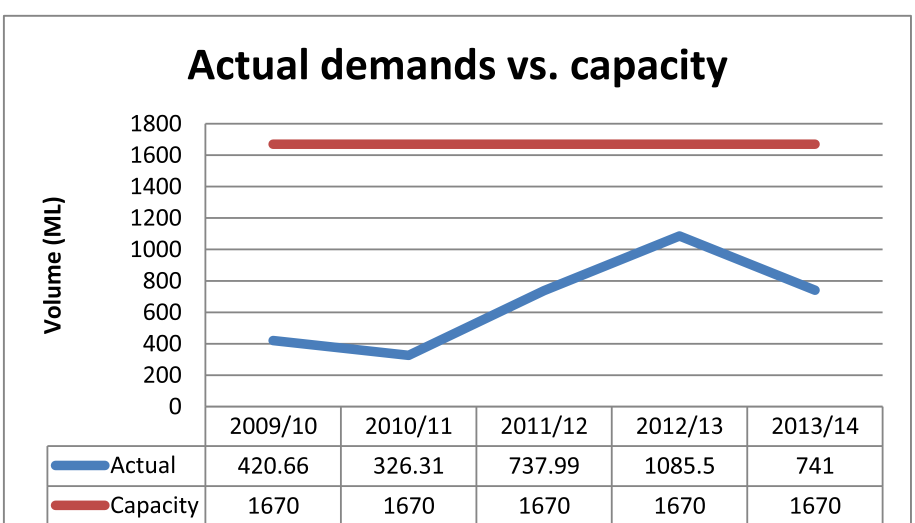

Fig. 1. Actual demands versus capacity of Case Study D.

projects bottom line, as occurred in Case Study D. Reasons why later stages of a project would not proceed include land-use changes, changes to consumer preferences and demand patterns, changes to financial outlooks for utilities etc.

4.2. Financial evaluation in the case studies

Financial evaluation in the case studies has shed light on a number of topics including: (1) the time period used for financial assessments; (2) which externalities are considered; (3) how stormwater system benefits are valued; (4) how infrastructure deferral benefits are valued; (5) using maximum volumes in benefit calculations; and (6) consideration of external costs.

The time period used for financial assessments varied drastically as shown in Table 13. Two of the case studies, the ones undertaken by local government and private enterprise, did not include a detailed cost benefit analysis, with the local government planners informally adopting 50 years as an appropriate analysis period. The others, conducted by water utilities, had an evaluation period ranging from 20 years to 35 years. Changing the evaluation period can have a very serious impact on the financial evaluation outcome. For reuse projects, in the majority of cases, a longer evaluation period results in a higher NPV, because the major expenses generally occur at the beginning of the project (design and construction), and then subsequently project revenues are consistent per year (based on water used/sold in accordance with water demands and scheme capacity). Therefore if evaluation period lengths are different between projects, without a justifiable reason for this variation in length (such as lifespan of equipment), then in some cases this is likely to mean that project NPVs cannot be directly compared.

Considered case studies attempted to deal with divergence between private and public costs and benefits (see Section 1.3) by calculating indirect benefits (positive externalities) and using these as project justifications. Three of the case studies, Case Study C, Case Study F and Case Study G, attempted to value benefits (positive externalities) to the wider stormwater system. Interestingly Case Study E did not attempt this even though it would likely have provided further justification of the project. As shown in Table 6, the monetary value of removing stormwater from waterways can be calculated in a variety of ways, differing by a factor of up to 1000 (from $40 k benefits to $40 M benefits in the case of Case Study C). Case studies F and G have selected a middle value for nitrogen removal, which, if the same nitrogen abatement value was adopted within the planning of Case Study C, would have provided enough justification for external funding, allowing the project to proceed. In reality different waterways have different environmental, social and economic values, and so this value should be set on a case by case basis, but through a consistent process, which does not currently exist.

Two of the case studies, Case Study B and Case Study G, attempted to include infrastructure augmentation deferral benefits: Case Study B in regards to potable headworks; and Case Study G in regards to local transfer and storage assets. This is another example of attempting to consider externalities in the financial evaluation process.

Case Study D, as shown in Fig. 1, demonstrates that for schemes that have demands influenced by weather patterns (i.e. most outdoor uses) it is inappropriate to use scheme maximum capacity when calculating indirect scheme benefits (positive externalities). For agricultural/irrigation schemes it can be seen that “take-or-pay” contracts (where users pay regardless of if they use) are important to ensure financial sustainability of schemes, but if the water is not being used, then indirect benefits, such as to the stormwater system, are not being generated.

Investigated case studies are also interesting in terms of “financial ring-fencing”, which is how internal costs are considered in comparison to external costs. Case Study F and Case Study G projects, which both sought to receive 50% subsidies, effectively considered National funding as “free money”, only seeking to justify internal Water Retailer funds. Also Case Study B had an assumption that the Bulk Supplier would not lose money when providing feedwater, which may require further investigation if the project is to proceed.

Overall the case studies have highlighted both difficulty and subjectivity involved in trying to value the indirect benefits (externalities) from reuse schemes. It is clear that if there is to be any consistency and validity to these assessments they must be made through a standard process and scrutinised by a highly informed, and at least semi-independent, assessment process. Furlong et al. (2016a) discusses this notion in relation to various spatial scales, and suggests that valuation techniques should be set ideally at either the metropolitan, regional or state government scale depending on the circumstances, and then applied consistently at the local scale.

4.3. Funding of case study projects

Funding processes in the case studies have shown that almost all of the case studies required external funding to proceed; with four of the seven requiring a 50% subsidy, one 30%, one 15% and one 0%. Most of these were funded from the National Government. Case Study C project attempted to gain funding from the Bulk Supplier and the state government and, as there was no established process for a private scheme to do so, this proved to be very difficult.

Case Study G's outcomes suffered from a lack of time flexibility in the National Funding agreement. Planners of Case Study E learnt from this experience and so requested a time flexible agreement. In future external funding agreements, the more time-flexible an agreement can be, the better the community outcomes are likely to be.

The practice of giving National grants to fund local water infrastructure projects in a financially stable water sector only existed for a short time window during Australia's millennium drought. In 2011 the Australian Government's Productivity Commission recommended that the National government cease this practice (Productivity Commision, 2011). This raises questions about such wastewater and stormwater reuse schemes in the future, seeing as minimal National funding is likely to be available. This is not to say that no subsidies will be provided to reuse schemes, but simply that they are unlikely to come from National grants.

Interestingly the only project not considered to require an external government grant has been put on hold by the Essential Services Commission (pricing regulator). This provides additional evidence that a consistent and transparent evaluation process is required for future projects.

Due to the fact that the case studies indicate some level of subjectiveness in financial evaluation processes, and that risks can have an unpredictable impact on financial outcomes, it is often very difficult to have confidence about what overall financial impact reuse projects will eventually have on their lead organisations. In Case Study A however, because the grant essentially equals the greatest possible financial loss that the organisation can incur (because in this case water usage is guaranteed), in this one example the organisation is almost guaranteed to not have a financial loss from the project.

5. Conclusion and recommendations for future projects

It appears likely that National Government funding is becoming less common (Furlong et al., 2016c). Although there will always be some exceptions, in general it can be said that if more of these projects are to be implemented in the future there are a number of things that must happen.

The water industry will need to create an internal funding model to justify future project subsidies, which would then be paid for by charging the wider customer base. Cost-sharing in this way requires justifiable calculations of benefits and costs (both direct and indirect). Without such a process it may be difficult for the water industry to justify the construction of these projects. Indirect benefits such as reduced pollutants to waterways are difficult to objectively value (by a factor of 1000), and determining which water industry body they accrue to can be difficult.

Therefore a standard planning and evaluation process, including financial evaluation, risk management, and other processes must be agreed on at a city, regional, state (or potentially national) scale. Such a process would specify time periods, discount rate determinations, expected potable water price increases, identifies which costs, benefits and externalities should be considered, and sets calculation procedures for this. This task would be extremely difficult and time consuming. Indeed most attempts at it in the past, at least in the case study region, have had very little success (Furlong et al., 2016c). However the fact that it has proven to be difficult does not imply that it is impossible.

As the water industry is likely to be internally funding the costs of these projects, by charging their wider customer bases, the industry must also continue to improve on risk management processes. Currently the industry does quite well at predicting and attempting to mitigate against certain risks. However, there is room for improvement in the matter of considering risks in overall decision making and option selection processes. There was a tendency in some case studies to only consider risks at an abstract level which are then effectively ignored in final recommendations. It is also important that projects which are already assessed as NPV negative (such as almost all of the considered case studies) take an extra conservative view of risks to cushion against further negative financial impacts on the project owner.

One possible way of tackling this issue in the future is the use of risk assessment results as a “pass or fail” test. If a project has any major risks which cannot be effectively mitigated then it may be unwise to pursue that project further.

An issue which has not been directly addressed this paper is whether any benefit would be derived from conducting such wastewater and stormwater reuse schemes through public/private partnerships. Some experts suggest that the inclusion of private financing, can increase project costs in the short term, due to profits, but decrease costs in the long term due to private companies taking a more realistic view of risks in the planning process (Flyvbjerg et al., 2003), and reducing the tendency of public organisations taking an over-optimistic view of project costs (National Audit Office, 2013). From the case study narratives presented in this paper, particularly the only private case considered (Case Study C), the inclusion of private capital in these projects would likely add another level of complexity. Whether doing so would also cause risk assessment and management to be conducted more effectively is a question beyond the scope of this research, and warranting further investigation.

There is also a serious question about who should have the authority to determine if a project is worthy of funding subsidies. The authors of this paper hereby propose a new approval pathway for such projects: an infrastructure funders' forum (or committee) which includes senior members of all relevant water authorities and utilities as well as government regulators (and potentially other stakeholders), at a regional scale. In this way it would be possible to ensure that projects are objectively compared against each other and prioritised on merit, by the foremost experts on the topic who have a good understanding of the whole system. Such a group would be well placed to make judgements around the value that projects provide to the wider system (externalities) and therefore whether subsidies are justified.

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