Journal of Environmental Management 191 (2017) 83–95

Contents lists available at ScienceDirect

Journal of Environmental Management

journal homepage: www.elsevier.com/locate/jenvman

Research article

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

Casey Furlong [a,*], Saman De Silva [a], Kein Gan [b], Lachlan Guthrie [a], Robert Considine [b]

[a] School of Civil, Environmental and Chemical Engineering, RMIT University, Swanston St, Melbourne, VIC 3000, Australia
[b] Melbourne Water Corporation, 990 La Trobe St, Docklands, VIC 3008, Australia

A R T I C L E I N F O

Article history:
Received 25 May 2016
Received in revised form
29 December 2016
Accepted 4 January 2017

Keywords:
Water reuse
Reclaimed water
Recycled water
Integrated urban
Water management
Water sensitive urban design
Risk

A B S T R A C T

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

* Corresponding author. School of Civil, Environmental and Chemical Engineering, RMIT University, Swanston St, Melbourne, VIC 3000, Australia.
E-mail address: casey.furlong@rmit.edu.au (C. Furlong).

http://dx.doi.org/10.1016/j.jenvman.2017.01.007
0301-4797/

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