

ADVANCING THE INFRASTRUCTURE SELECTION PROCESS –Case Study

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Introduction

This case study presents the work that Yarra Valley Water has undertaken to help it select more sustainable infrastructure options. The work aimed to address perceived barriers to adopting systems different from conventional servicing options. Prior to this work, debate existed as to whether alternative servicing options could deliver improvements. The perception was that such options would cost more, would require additional material and energy resulting in increased environmental burden, and would increase the business risks. Unaddressed, this uncertainty stopped any future exploration of alternative servicing options.

The case study is presented as part of the National Urban Water Governance Project. The NUWGP was established to understand how we can consciously encourage and support greater uptake of water sensitive technologies in Australia. It is well acknowledged that in transitioning to more sustainable urban water futures, the urban water sector has been limited by a range of institutional impediments including fragmented organisational responsibilities, disconnected regulatory and policy frameworks, and prohibitive capital and/or maintenance costs (Brown and Farrelly, 2007; Brown et al, 2007). Previous research with the Facility for Advancing Water Biofiltration (FAWB) highlighted that one of the key enabling context factors for providing resilience to the institutional network for change and learning was demonstration projects (Brown and Clarke, 2007). Additionally, during late 2006, a series of interviews were conducted by the NUWGP in Brisbane, Melbourne and Perth where respondents were asked to nominate a solution or 'way forward' to overcome the litany of barriers identified, to which again, a common response was demonstration projects.

Why Yarra Valley Water undertook this work

Yarra Valley Water is committed to environmental sustainability. It recognises that the well-being of the community and the strength of the economy is dependent on the health of the environment, and accordingly strives to provide water and sewerage services within the carrying capacity of nature.

Yarra Valley Water has a clear and bold commitment to achieve environmental sustainability. It is articulated in a business policy, endorsed by its Board, integrated into day to day business activities, and monitored monthly by the Executive through a Balanced Scorecard reporting process. Moreover, environmental sustainability is one of the four key strategic objectives that define Yarra Valley Water's existence. Along with targets for customer service, business culture, and efficiency, Yarra Valley Water aims to "provide services within the carrying capacity of nature and inspire others to do the same".

Getting to this stage was in itself quite a journey. Reflecting on the steps the organization had to take, four major challenges were identified and progressively tackled over a number of years. Organisational buy-in was required as was an agreed definition of sustainability, awareness of the challenges was necessary, and a means of moving from the philosophical to pragmatic was needed (Pamminger and Crawford, 2006).

It is a requirement of the Melbourne retail water companies to apply the "Sustainable Management Principles" in providing their services (Clause 26 in Statement of Obligations, 2008). These principles include water conservation, integration of short and long-term economic, environmental and social considerations, and conservation of biodiversity. The application of these principles is an important element in Yarra Valley Water's aim to deliver services in the best way possible.

It is with this background that Yarra Valley Water recognises that a number of environmental constraints are faced in providing infrastructure services to Melbourne. There is insufficient water to meet future growth. Port Phillip Bay, which already processes in the order of 3,500 tonnes of nitrogen a year discharged from Melbourne's sewage treatment plant, has reached its carrying capacity. Moreover, commonly adopted solutions to generate additional water and reduce nutrient discharge are energy intensive, leading to an increase in greenhouse gas emissions, which in turn exacerbates the very problems we are trying to solve.

Hence Yarra Valley Water considers it a core responsibility to find alternative means to provide infrastructure services in a more environmentally sustainable way.

Key challenges

Innovators seeking alternative servicing options face significant barriers. The barriers are inherently interwoven in the very processes that have delivered our significant societal improvements, which have come from separating water and sewage and adopting a centralised system. One could argue that this centralised service delivery is a central paradigm embedded in water industry culture. From this perspective, some water practitioners consider alternative decentralised options as a problem. They argue that the environment will be worse off if we use more materials, that costs will increase, and that there will be greater risk to the community.

The site chosen for the research was a typical greenfield site, which in this instance was 3062ha and approximately 40 km north of Melbourne. Over the next 15 years, it is planned to house a population of 85,000. Yarra Valley Water engaged RMIT and CSIRO to find the best environmentally infrastructure solution for its new developments, which are split between Greenfield and infill sites, CSIRO and RMIT (2005). They were specifically asked to help identify ways to quantify environmental impacts, total community costs, and to compare risks between alternative serving options.

Process adopted to address challenges

The methods selected to quantify environmental impacts, community costs, and risk follows.

Environmental impacts

Prior to this study the general industry view was that selecting a third pipe system in this region would lead to an additional environmental burden. It was argued that the recycled water pipes and corresponding pumps would require additional material and energy to operate; hence any water savings would be offset by a larger environmental impact.

An LCA was used to quantify the actual environmental differences between alternative servicing configurations. LCA looks at the environmental impacts of a product or service throughout its entire life cycle. The traditional definition of LCA is "a cradle-to-grave environmental assessment that accounts for all resource use and releases related to the system being studied, and translates this information to the possible harm (or benefit) to the environment and human health" (Curran, 1999).

The LCA methodology can be summarised into the following stages (ISO 14040, 2006):

- Goal and scope definition. Here, the purpose of the LCA is identified and the scope and boundaries of the study are set.
- Inventory analysis. This involves quantifying the environmental inputs and outputs at each stage of the life cycle.
- Impact assessment. The inputs and outputs from the previous step are translated into potential environmental impacts.
- Interpretation. The results hitherto are interpreted with regard to the study objectives.

An LCA of the servicing options identified that all of the alternative options analysed deliver an environmental benefit when compared against a traditional servicing configuration. Figure 1 shows the reduction in water

consumption, greenhouse gas and nutrient impacts from each alternative option, compared to traditional servicing.

The options are respectively:

- **Conventional** – traditional centralised servicing with reticulated water and sewage pipes connected to an existing central network. Water efficient (3A) appliances.
- **Third pipe from STP** – third pipe recycling using treated water from local sewage treatment plant.
- **Third pipe from stormwater** – third pipe recycling using treated stormwater.
- **Onsite water supply and greywater** – water supply solely from rainwater tanks and greywater treatment at each property.

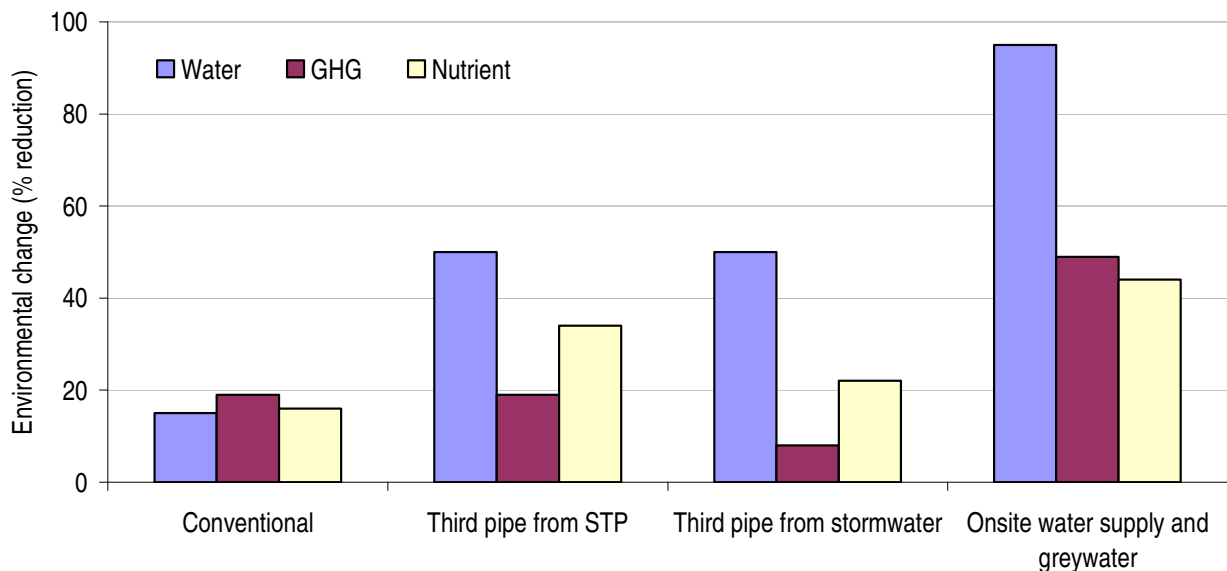


Figure 1 Life Cycle Assessment results

Community costs

Prior to this study, the general industry view was that selecting a third pipe system would cost more than a conventional water and sewerage system, due to increased capital and operating costs for the additional infrastructure.

Life cycle costing was used to quantify the total costs borne by all sections of the community. This is particularly important with the analysis of decentralised servicing options which can move infrastructure such as rainwater tanks and greywater systems onto the customer's property. To conduct a true comparison of costs, it is necessary to compare all costs independent of who will be paying for them.

All costs were monetised under this assessment. This included environmental costs such as water, greenhouse gas emissions and nutrient discharges in addition to the usual capital and operating costs. Water was costed at the market rate of water auctions. Greenhouse gas emissions were monetised at the market abatement rate. Lastly, nutrients were monetised at the rate charged by Melbourne Water in their water quality offsets program for all new developers.

Results from the Life Cycle Costing showed that when all environmental elements were costed, the decentralised options had a lower community cost. A summary of the results is shown in Figure 2.

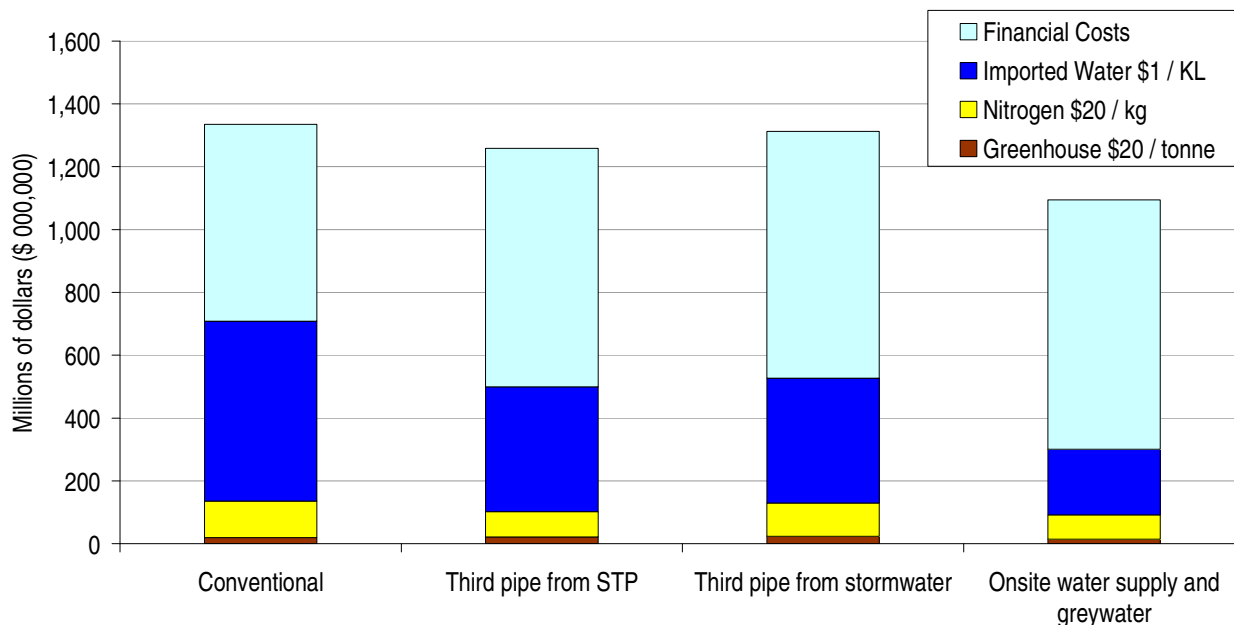


Figure 2 Community cost results

Risk assessment

Prior to this study, the general industry view was that selecting a third pipe system would bring additional risks above those occurring with a conventional water and sewerage system. The added complexity of third pipe systems was considered counterintuitive to the existing adopted industry paradigm to simplify and reduce risk. Third pipe systems were seen to increase potential for cross connections, and this in itself was considered a high enough risk to disregard them.

A means to quantify all risks as a cost was required, and a “Total Cost Assessment” methodology was adopted for this purpose. Total Cost Assessment can be defined as “the consideration of all environmental and health costs associated with a decision, including direct costs, risks and liabilities, and costs borne by others” (Earthshift Consulting, 2008). The procedure was developed in the early 1990s by the Tellus Institute for the US EPA and the New Jersey Department for Environmental Protection. Amongst other things, risk costs can include lawsuits, penalties due to non-compliance and intangible costs such as damage to worker morale, corporate image and community relations (Tellus Institute, 1998).

Yarra Valley Water selected the TCace package to undertake a Total Cost Assessment. Data was populated using a group of industry experts who identified all potential risks. A probability density function was then fitted to each risk. This was done by identifying the lowest, median and maximum probability of an event taking place. A business cost for each of these was then added. The end result was the production of a risk-cost curve for each alternative servicing option, which is shown in Figure 3. The options shown are respectively:

- **Centralised** – conventional servicing using reticulated water and sewage pipes connected to an existing central network.
- **Dual reticulation** – third pipe recycling from a local sewage treatment plant.
- **Decentralised** – fully self contained, utilising rainwater tanks and package treatment plant (SBR) on each property.

More information on the TCace package can be found at <http://www.earthshift.com/tcace.htm>.

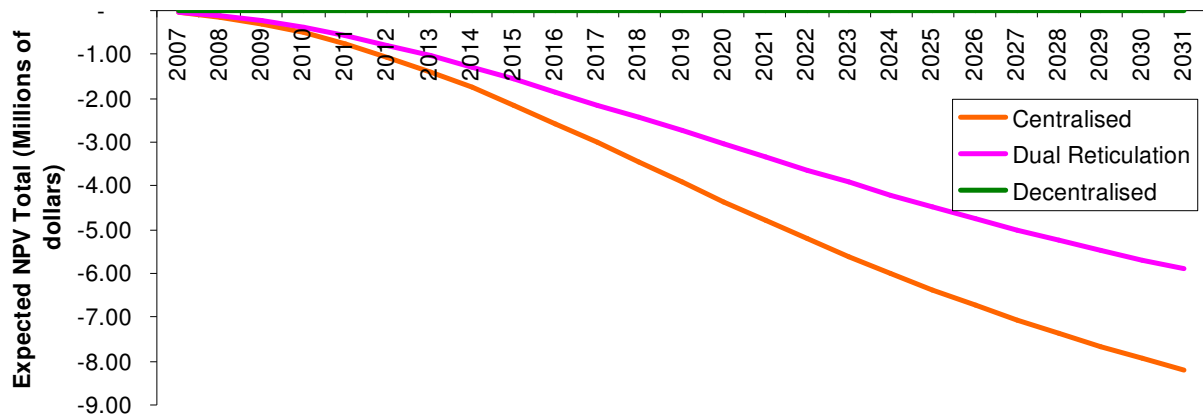


Figure 3 Total Cost Assessment results

When risks were costed for a dual reticulation system, decentralised option and centralised system, it was surprising to see that the centralised system had the highest risk-cost. In essence, this was due to the relatively high probability that drought, fire in the catchments or algal blooms could occur, and the large number of people that would subsequently be impacted. On the other hand, failures to decentralised systems would impact a relatively small number of people, hence the lower risk-cost.

Conclusion and Learnings

This project analysed a range of different servicing options for a large 3,062 ha development in Melbourne. They included both stormwater and sewage recycling, together with on-site options like rainwater tanks and greywater recycling.

Prior to this work, debate existed as to whether alternative servicing options could deliver improvements. The perception was that such options would require additional material and energy use resulting in an increased environmental burden, would cost more, and would increase the business risk. The use of robust, quantitative assessments has shown that this is not the case for all alternative options in this case study area.

- Life Cycle Assessment was used to quantify the environmental impacts and this revealed that alternative servicing options could deliver a solution with a lower environmental impact than traditional servicing.
- Life Cycle Costing was used to analyse the costs borne by all and found that while many options cost more to some individuals, they delivered an overall lower total community cost.
- Total Cost Assessment allowed a comparative risk assessment to be undertaken of options, and this highlighted that most of the alternative options investigated reduced risks.

The use of Life Cycle Assessment, Life Cycle Costing and Total Cost Assessment has accordingly contributed to changing strongly held views in the industry about the environmental impact of third pipe systems, community cost, and actual risk.

While it is important to recognise that specific infrastructure options recommended in this study are site specific, independent on option selection, this work has shown that infrastructure assessments can be made more robust by selecting quantitative methods for critical variables. Critical variables are those variables that most impact the final result.

Introducing scientific methods to an engineering industry, which bases its decisions on scientific principles, has been instrumental in bringing about the change. Barriers to adopting alternative services that previously existed have been removed, allowing a consensus to be reached that will now deliver more sustainable results.

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