

National Needs Analysis:

Life Cycle Costing Data and Tools For Water Sensitive Urban Design Assets

Prepared for: WSUD Program,
Sydney Metropolitan Catchment Management Authority.

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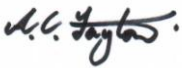
Document Control Sheet	
Report title:	National Needs Analysis: Life Cycle Costing Data and Tools For Water Sensitive Urban Design Assets.
Suggested reference:	Taylor, A., Leinster, S., and Allison, R. (2010). <i>National Needs Analysis: Life Cycle Costing Data and Tools For Water Sensitive Urban Design Assets</i> . Report for the WSUD Program, Sydney Metropolitan Catchment Management Authority, Sydney. André Taylor Consulting, New South Wales.
Version:	Final.
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Review process:	A draft was circulated to industry practitioners in Sydney, Melbourne, Adelaide, Brisbane and Perth for comment in October 2010 via the WSUD Program (Sydney Metropolitan Catchment Management Authority).
Approved by:	André Taylor.
Signed:	
Date:	9 November 2010.
File name:	Final LCC report (9 November 2010).
Distribution:	1 e-copy to Ms Kate Black, WSUD Program, Sydney Metropolitan Catchment Management Authority, Sydney.

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Executive Summary

In order to make sound, holistic decisions regarding water sensitive urban design (WSUD) assets, Australian practitioners need access to financial, social and ecological information. Such information includes the likely cost of WSUD assets. This report presents the findings of a national needs analysis that:

- Mapped the process that involves the design, construction and maintenance of WSUD assets¹.
- Identified key stakeholders involved in each stage of this process.
- Identified stakeholder needs for life cycle cost (LCC) information and estimation tools.
- Prioritised stakeholder needs and benchmarked these priorities against other WSUD-related capacity building initiatives.
- Used the findings of the needs analysis to recommend a set of tasks that would gather LCC information and build an estimation tool to meet high priority needs of key stakeholders.

The needs analysis involved a series of workshops in Sydney, Melbourne, Adelaide, Perth and Brisbane. These workshops involved a diverse group of industry practitioners who planned, designed, assessed, constructed and maintained WSUD assets (e.g. bioretention systems and stormwater recycling systems). Each workshop involved a series of open questions, group discussions, the completion of worksheets by small groups and an anonymous survey. Feedback from participants on the workshops was strongly positive. On average, participants thought the workshops successfully met their objectives, were well designed and facilitated, and were valuable. Strengths of the workshops included the diversity of participants and the interactive small-group work. Opportunities for improvement included providing more time for discussion.

A two-page summary of the major findings of the need analysis is provided in Figure 6 (see Section 4.8). Findings included:

- The process of WSUD asset delivery typically includes three primary stages (i.e. design and planning, construction and establishment, and maintenance and asset management), as well as 15 secondary stages (see Section 4.1).
- A surprisingly diverse range of practitioners are involved in this process and need some LCC information (see Section 4.2), from strategic planners to maintenance service providers.
- Practitioners commonly make decisions regarding 19 different types of WSUD asset (see Section 4.4). At a national level, there is greatest demand for LCC information regarding rain gardens / bioretention basins, stormwater reuse systems (at scales greater than the lot scale), and constructed wetlands. Some cities also have site-specific costing needs (e.g. the need for costing information relating to swales in Perth).
- Whilst the large number and diversity of practitioners with a need for LCC information creates complexity, there are three broad groups of shareholders with different needs:
 - 1) *Technical design specialists* (e.g. teams preparing conceptual designs): They require reasonable estimates of all cost elements (e.g. construction and different types of maintenance costs) and the LCC, as well as performance information for WSUD assets (e.g. pollutant removal efficiencies). They use this information to examine 'cost-performance relationships', using modelling tools like MUSIC. Cost estimates need to allow for a limited number of factors that strongly affect cost (e.g. size, context and service level). In this report, these estimates are called "WSUD cost estimates" (see Section 4.5).
 - 2) *High-level decision-makers / planners* (e.g. strategic planners): They also need "WSUD cost estimates", but need to be able to access this information directly (e.g. via a downloadable database) rather than through specialist modelling software. They also need good information about how these costs are spread over time for planning purposes.

¹ This project focussed on WSUD assets that primarily involve the treatment and/or reuse of urban stormwater.

3) *Detailed design, construction and maintenance professionals* (e.g. designers, construction project managers and maintenance coordinators): They require more detailed estimates of capital and maintenance costs. Specifically, these elements need to be broken down into typical lists of unit rates / 'bills of quantities'. They also need to be able to access this information directly. In this report, these estimates are called "WSUD construction rates estimates" and "WSUD maintenance rates estimates" (see Section 4.5).

- Seven possible cost estimation 'tools' were identified by practitioners (see Section 4.6). This report has recommended one (i.e. a downloadable database linked to a national website) as it is flexible enough to service the vast majority of stakeholders with a need for LCC information. This tool would draw on real costing information across Australia to generate:
 - "WSUD cost estimates" (i.e. estimates that could be quickly generated by users such as conceptual designers and strategic planners). Such estimates would be in a similar form to those currently available via the MUSIC software, but updated and covering a broader range of assets. These estimates would also allow for a range of local factors that can significantly affect cost (e.g. geographic location, development context and service level).
 - "WSUD construction rates estimates" (i.e. typical lists of construction items for each WSUD asset type, and rates for WSUD-specific items that are not currently available in documents like 'Rawlinson's Australian Construction Handbook').
 - "WSUD maintenance rates estimates" (i.e. typical lists of maintenance activities and their frequencies, unit rates, human resource requirements and equipment requirements). These rates would also be linked to a range of factors such as asset size, development context, level of service, geographic location, vegetation type, planting density, etc.

The tool would initially be built to provide estimates for asset types with the greatest need (e.g. rain gardens). It would be designed to allow users to enter locally-derived cost information if they did not want to use default values. It would also capture this local information, so future developers of the tool could easily access it (i.e. by simply requesting practitioners to send them a digital copy of the database). A guideline / manual would also be provided that explains how to use the tool, the basis for the estimates, the algorithms embedded in the tool, caveats, limitations and resources for further information. A description of this tool is provided in Sections 4.6a) and 5.

- An anonymous survey of workshop participants found that, on average, there was a very strong need for LCC tools and investment in the development of such tools. In addition, practitioners believed such tools were important for good decision-making and helped to deliver more sustainable solutions. On average, participant ratings for these questions were around 8 on the relevant 1-9 Likert scales (i.e. around 88%). Participants were also asked to indicate the extent to which investing in the development of such tools represents a relatively high capacity building priority. The average participant rating for this question was around 7 on the relevant 1-9 Likert scale (i.e. around 75%).

Recommendations (Section 5) and a project plan (Section 6) have been provided to describe how the findings of the needs analysis could now be used to improve decision making with respect to WSUD assets in Australia. There are some relatively simple steps that can be taken in the short term to make progress, such as establishing a national website to provide WSUD practitioners with easy access to the best available costing information. In the medium to long term, however, the task of building a new, national LCC estimation tool to meet the needs of WSUD practitioners is more challenging. A critical step is to engage a major project sponsor to help provide resources needed to build the proposed LCC tool and to become the long-term 'owner' of the tool.

1. Introduction

1.1. Objectives and desired outcomes

This report presents the findings of a national needs analysis that aimed to:

- Map the process that involves the design, approval, construction and maintenance of water sensitive urban design (WSUD) assets.
- Identify key stakeholders involved in each stage of the process.
- Identify stakeholder needs for life cycle cost (LCC) data and estimation tools.
- Prioritise stakeholder needs and benchmark these priorities against other WSUD-related capacity building initiatives.

The report also uses the findings of the needs analysis to recommend a set of tasks that would gather LCC information and build the tools necessary to meet high priority needs of key stakeholders.

Outcomes from this work include a deeper understanding of the key stakeholders who are making decisions regarding WSUD assets in Australia and their specific needs for costing information and estimation tools. Another outcome is a revised 'project plan' (Section 6) to help guide a national WSUD life cycle costing project (see Section 2.2).

1.2. Target audience of this report

This report has been written for three audiences. First, it has been prepared for the Steering Group of a national project that aims to provide WSUD practitioners with better costing information and estimation tools in order to make more informed decisions regarding WSUD assets. This group was initiated by the WSUD Program (Sydney Metropolitan Catchment Management Association) at a workshop in November 2009. This group currently includes several WSUD capacity building programs, industry representatives (e.g. the City of Sydney), eWater Pty Ltd, and specialist consulting businesses.

Second, it aims to provide potential funding organisations (e.g. government agencies) with detailed information regarding the needs of stakeholders for specific types of LCC information and tools, the tasks needed to address these needs, and the approximate cost of undertaking these tasks. In short, it provides an information base that could be used during future funding requests and grant applications.

Third, it provides broad guidance to people who may, in the future, be asked to deliver the tasks needed to fill critical knowledge gaps with respect to LCC information and build new cost estimation tools.

1.3. Scope and terminology

Due to budget limitations, the scope of the needs analysis was restricted to the *stormwater* treatment and recycling component of WSUD. As such, it focussed on costing needs commonly associated with assets such as rain gardens / bioretention systems, stormwater harvesting systems and constructed wetlands. In addition, the project's budget allowed face-to-face consultation with WSUD practitioners to occur in five capital cities (i.e. Sydney, Melbourne, Adelaide, Perth and Brisbane). The identified needs therefore reflect the views of practitioners in these cities.

It is also acknowledged that decisions involving WSUD assets are informed by many inputs, which include costs. Increasingly, decisions are made using triple-bottom-line assessment frameworks where the social, ecological and financial pros and cons of various water management options are

considered (see Taylor, 2005). The focus of the needs analysis, however, was limited to stakeholder needs regarding the various *financial costs* of common WSUD assets. Consequently, the new LCC cost estimation tool that is recommended in this report (see Section 5) would only help practitioners with one component of a triple-bottom-line assessment process. That is, the *financial costs* associated with constructing, maintaining and replacing / decommissioning WSUD assets.

Water sensitive urban design

The following definition of WSUD was adopted throughout the project: WSUD is a planning and design approach that addresses the impacts of urban development on the hydrological cycle and aquatic ecosystem health. It aims to:

- minimise the impact on existing natural features and ecological processes in and around waterways (e.g. through the reduction of pollutants entering waterways);
- minimise the impact on the natural hydrologic behaviour of catchments;
- protect the quality of surface and ground waters;
- minimise the demand on the reticulated water supply system;
- incorporate the collection, treatment and/or reuse of runoff, including roof water and other forms of stormwater / runoff;
- reduce runoff volumes and peak flows from urban development;
- re-use treated effluent and minimise wastewater generation;
- increase social amenity in urban areas through multi-purpose greenspace, landscaping and integrating water into the landscape;
- add value to urban developments while minimising development costs (e.g. drainage infrastructure costs);
- account for the nexus between water use and wider social and environmental issues (e.g. global warming); and
- harmonise water cycle practices across and within the institutions responsible for waterway health, flood management, pollution prevention and protection of social amenity. (Modified from: Water by Design [2009].)

In the context of *stormwater* management, the primary aim of WSUD is to:

- treat stormwater to remove pollutants;
- manage stormwater hydrology to protect downstream aquatic ecosystems; and
- reuse stormwater (including roof water) to reduce the demand on the reticulated water supply system.

Life cycle costing terms

The needs analysis sought to be consistent with respect to the terms used to describe different types of costs. Firstly, life cycle costing was defined as a “process to determine the sum of all expenses associated with a product or project, including acquisition, installation, operation, maintenance, refurbishment, discarding and disposal costs” (Australian Standards, 1999, p. 4) .

The life cycle cost (LCC) of an asset is the sum of all discounted costs over an asset's life (similar to a ‘net present value’). These costs are typically broken down into the following ‘cost elements’:

- Total acquisition cost (TAC) / capital: This typically includes all design costs, project management costs, construction and establishment costs.

- Typical annual maintenance (TAM) cost / routine maintenance: This includes frequent maintenance activities, such as mowing a grassed swale. These maintenance costs may be elevated in the first few years of vegetated WSUD assets, such as constructed wetlands.
- Renewal and adaptation cost (RC) / corrective maintenance: This includes infrequent maintenance activities, such as replacing the media in a bioretention system and replanting it. Practitioners also need to know the frequency that this cost is likely to be incurred.
- Decommissioning cost (DC) / disposal cost: This is the cost of removing the asset and returning the site to its original condition. It may be incurred for some stormwater treatment / reuse assets (e.g. gross pollutant traps or assets that cannot be maintained).

In addition, to undertake life cycle costing, practitioners need to know a 'real discount rate' (so costs that are incurred in the future can be discounted back to a 'base date') and the 'life cycle / span' (LC) of various WSUD assets (see Taylor, 2003).

1.4. Structure of this report

The next section of this report describes the background to the needs analysis and how it is connected to a national project to help WSUD practitioners to gain access to better LCC information and tools in order to improve decision-making. The report then describes the methodology used for the needs analysis and summarises feedback from practitioners on the workshops that were completed in each city. It then presents key findings with a summary presented in Section 4.8. These findings reflect the views of leading practitioners in five cities. Consequently, the report highlights national stakeholder needs as well as those that were significant within particular cities / regions. A set of recommendations is then presented which responds to the key findings. Finally, a revised version of the draft project plan that was prepared following a planning workshop in November 2009 (see Taylor, 2010) is provided. This plan describes the tasks that could be undertaken to continue the process of improving the costing information and tools that are available to WSUD practitioners across Australia.

2. Background

2.1. Why the project was undertaken

Research at the national and regional level across Australia over the last decade has consistently identified that inadequate LCC information and tools are significant barriers to the adoption of WSUD (see Lloyd , 2001; Lloyd *et al.*, 2002; Colmar Brunton, 2005; Taylor & Fletcher, 2007; Wong, 2001). Some attempts have been made to overcome this barrier (see Taylor, 2010), such as the inclusion of a LCC module in versions 3 and 4 of the MUSIC model (see www.toolkit.net.au), and the collation of real costs associated with WSUD assets in various cities. These attempts, however, have not:

- Fully identified the different needs of stakeholders who are involved in the design, approval, construction, operation and maintenance aspects of WSUD assets.
- Provided all of these stakeholders with easily accessible, reliable, up-to-date LCC data and estimation tools that meet their specific needs. For example, the LCC module in MUSIC currently uses costing data that was gathered from around Australia in 2003-4. At that time, reliable costing data was sparse, and since then the design of many WSUD assets has evolved. In addition, MUSIC is typically used in the conceptual design phase of the process that delivers on-ground WSUD assets, so this tool is not often used by construction, maintenance, planning or asset management professionals.

Previous projects involving the collection and analysis of LCC data has found that this work can be time-consuming and limited by poor record-keeping in relation to the various costs of WSUD assets. As such, future attempts to gather costing information should learn from these experiences and identify the most cost-effective ways of collecting data. To do this, detailed knowledge is needed of: the various stakeholders who need LCC information; and their specific needs for information and estimation tools. This is the primary purpose of the national needs analysis.

2.2. Linkage to a national life cycle costing project

On 23 November 2009, a workshop was convened by the 'WSUD Program' capacity building program (Sydney Metropolitan Catchment Management Authority) that involved representatives from the Victorian 'Clearwater' program, the Queensland 'Water by Design' program, the eWater CRC, Landcom and the City of Sydney, as well as specialist consultants. The primary aims of this workshop were to:

- Consider and critically review options to address this barrier to the adoption of WSUD from a national perspective.
- Design an initiative with a national focus that would provide stakeholders with the LCC information and tools they need to make critical decisions about WSUD assets.
- Build a draft 'project plan' for this initiative that defines the necessary tasks, timeframes and resources, as well as clarifying who is responsible for delivering funded tasks.
- Pool resources to begin work on the initiative.

The workshop produced a draft project plan (see Taylor, 2010), and funds were secured to begin Task 1 (the needs analysis). The following stakeholder groups provided funding for this task:

- The 'WSUD Program', Sydney Metropolitan Catchment Management Authority.
- The 'Clearwater' capacity building program, Victoria.
- The 'New Waterways' capacity building program, Western Australia.
- The 'Water by Design' capacity building program, Queensland.
- The South Australian government, via the South Australian Murray-Darling Basin Natural Resources Management Board.

At the November 2009 workshop, it was agreed that the project partners ('Steering Group') would meet again after that needs analysis task was complete. The Sydney Metropolitan Catchment Management Authority agreed to convene this meeting. Its purpose would be to "review the outcomes of the needs analysis, review available funding and revise the project plan" (Taylor, 20010, p. 3).

3. Methodology

3.1. Overview of the approach

The needs analysis involved five steps. First, a series of five workshops were planned and designed to gather information from a diverse group of WSUD practitioners in Sydney, Melbourne, Adelaide, Perth and Brisbane. The primary aim of these workshops was to identify the LCC data and tools that are needed to make decisions regarding WSUD assets. More specifically, they aimed to:

- Identify and reach agreement on the stages that WSUD assets typically move through, from conceptual design to ongoing maintenance.
- Identify the groups of practitioners who need costing data for WSUD assets during each stage.
- Characterise the WSUD LCC data needs within each stage (i.e. the type of data that will satisfy key practitioners and the form such data needs to be in).
- Understand the 'tools' that could be developed to address identified costing needs (e.g. spreadsheets and models to help estimate costs).

A critical element of the workshop design was ensuring a diverse range of practitioners were involved. Specifically, each workshop sought to engage one or two experienced practitioners from each of the following stakeholder categories:

- People who undertake planning / policy activities in relation to WSUD assets.
- People who design WSUD assets.
- People who undertake development assessment activities for WSUD assets.
- People who construct WSUD assets or manage the construction process.
- People who plan and/or undertake maintenance activities for WSUD assets.
- People who undertake asset management activities for WSUD assets (e.g. strategic asset planning).

The first workshop in Sydney was used to trial and refine the process of gathering the necessary information from WSUD practitioners. As such, it was four hours long, whilst the remaining workshops were only three hours long. The workshops were kept as short as possible to enable the participation of busy people and reduce the project's overall cost.

The workshop's design enabled interaction between the participants, discussion as one group (typically around 10 participants) and discussion within small groups (typically around three to five participants). The core of the workshops involved small group work. Groups were formed to represent major stages in the WSUD asset delivery process (e.g. design and planning; construction and establishment; and maintenance and asset management). These groups worked through a series of worksheets to discuss and document their views on a range of questions relating directly to the aims of the workshop.

Second, invitations were prepared for each workshop and the local host organisation (i.e. the organisations helping to fund the project) invited suitable participants. Each host organisation was provided with a description of the 'ideal participants' to assist the invitation process.

Third, the workshops were facilitated by members of the consulting team (i.e. Dr Robin Allison and Shaun Leinster from DesignFlow, and Grahame Collier from T Issues Consultancy). The primary product from each workshop was a set of completed worksheets from each small group. Feedback from participants was also gathered after each workshop using paper-based and on-line feedback forms. This feedback helped to refine the workshop process, and gather additional information. For

example, it gathered information on the relative importance participants placed on addressing cost-related barriers to the adoption of WSUD compared to other capacity building activities (see Section 4.7).

Fourth, data from each workshop were organised, condensed and analysed. A conceptual framework (see Section 4.8) was also used to structure and highlight key findings. The findings from each workshop were used to formulate a set of recommendations and a revised project plan which represent a set of actions to cost-effectively address high priority LCC-related stakeholder needs.

Fifth, a draft report was prepared and circulated to the five funding organisations, as well as all participants at the November 2009 workshop (i.e. members of the ‘Steering Group’ for the national initiative). Following consultation, the final report was prepared.

3.2. Feedback from participants on the workshops

Participants at the five workshops were asked to rate the extent to which their workshop met its key objectives using a 1 to 9 Likert scale (1 = “very poor”; 9 = “excellent”). Figure 1 presents average ratings from participants at each of the workshops, plus an overall average for all workshops. These data indicate that participants, on average, thought that the extent to which the workshops met their objectives was “good” (i.e. around 7 on the scale).

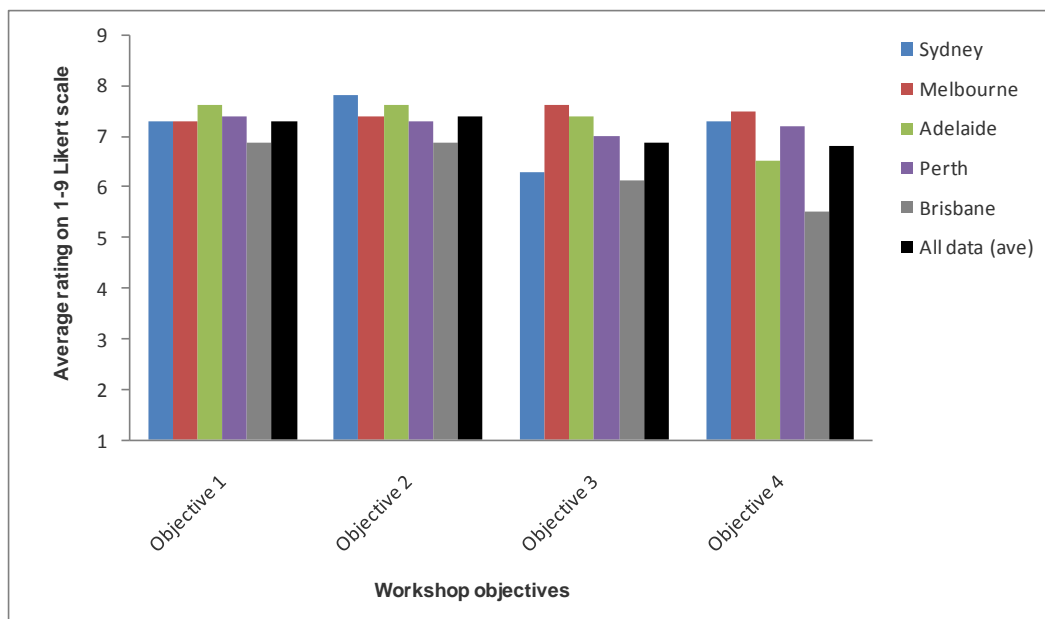


Figure 1 – The extent to which the workshops met their objectives

Legend:

- Objective 1 = To identify and reach agreement on the stages that WSUD assets typically move through from conceptual design to ongoing maintenance.
- Objective 2 = To identify the groups of practitioners who need costing data for WSUD assets at each stage.
- Objective 3 = To identify the WSUD life cycle costing data needs within each stage (i.e. data that will satisfy key practitioners).
- Objective 4 = To propose ‘tools’ to address identified costing needs, including a description of the tools’ design features.

There were some relatively low ratings at three of the workshops (see Figure 1). The relatively low score for objective number 3 in Sydney (6.3) was a result of a problem with the relevant worksheet, which was rectified in subsequent workshops. The relatively low score for objective number 4 in Adelaide (6.5) was due to the group running out of time towards the end of the workshop when the possible cost estimation tools were discussed. In addition, the relatively low ratings for objectives number 3 (6.1) and 4 (5.5) in Brisbane were due to running out of time towards the end of the

workshop and possibly the smaller, less diverse group making the discussion of needs and tools less satisfying for participants.²

Participants were also asked to rate the quality of their workshop’s design, the quality of its facilitation, and the overall value of the workshop using the same 1 to 9 Likert scale. Figure 2 presents average ratings. These data indicate that participant ratings for the quality of the workshop’s design and facilitation were consistently high, around the 7 to 8 range (i.e. between “good” and “excellent”). Ratings for overall value were slightly lower, being around 7 (“good”), with Sydney being considered the most valuable. The slightly higher rating in Sydney is likely to be the result of this workshop being an hour longer than the subsequent workshops.

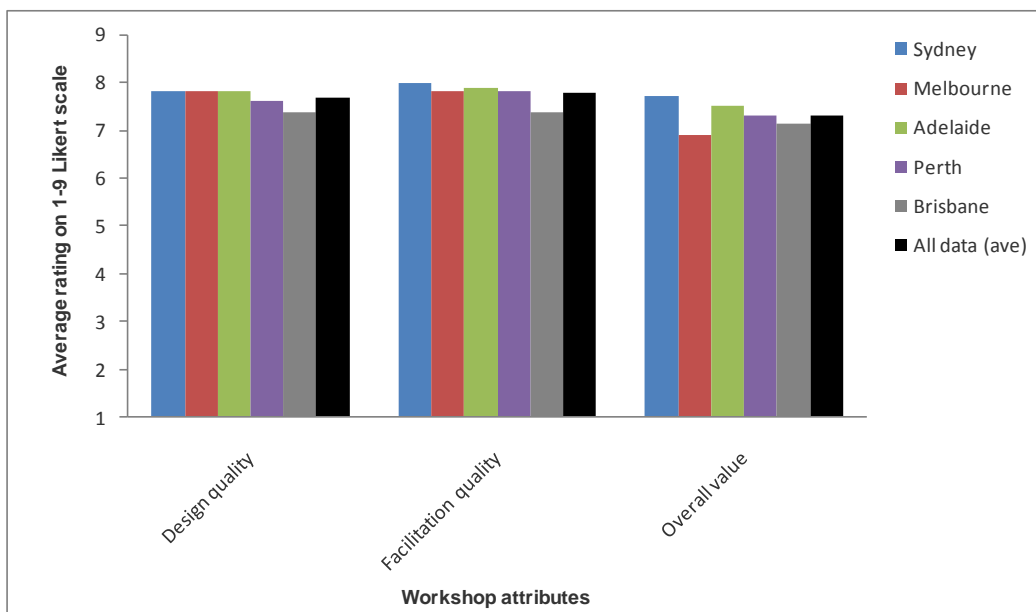


Figure 2 – The quality of the workshop’s design and facilitation, as well as its overall value

Legend:

Design quality = How would you rate the quality of the workshop’s design (e.g. structure, timing, opportunity to participate, etc.)?

Facilitation quality = Overall, how would you rate the quality of the facilitation of the whole workshop?

Overall value = How you would rate the over-all value of the workshop?

Participants were also asked to indicate what they thought were the strengths of the workshop, as well as areas for improvement (weaknesses). Repeatedly mentioned strengths and weaknesses are summarised in Tables 1 and 2, respectively³. The most commonly mentioned positive features of the workshops were the highly diverse nature of participants, and the opportunity to interact and discuss issues (particularly during small-group work). The most significant opportunities for improvement were providing more time (particularly in Sydney and Adelaide) and inviting a broader range of stakeholders. There was no opportunity for improvement that was repeatedly highlighted by

² The participants in Brisbane may have also been suffering from “consultation fatigue” as a significant body of work had been done in the preceding year regarding WSUD maintenance and asset management practices (see www.waterbydesign.com.au). The ratings in Brisbane may also have been affected by the view that cost information and tools are unlikely to greatly accelerate the adoption of WSUD in parts of South East Queensland as WSUD is now required on private sector developments. The participants in Brisbane were also surveyed via an *on-line* instrument which was conducted a week after the workshop. This was done as time constraints made the administration of a paper-based survey at the end of the workshop impractical. The lag between the workshop and the on-line survey may have also affected the results for Brisbane.

³ Only strengths / weaknesses that were repeatedly mentioned at each workshop have been considered to filter out minor and/or trivial comments.

participants at all workshops, indicating there was no fundamental flaw in the design or delivery of these events.

Table 1 – Major strengths of the workshops

Strengths repeatedly mentioned at the workshops	Sydney	Melbourne	Adelaide	Perth	Brisbane	All data
Having a diverse group (i.e. a cross-section of industry).	-	4	4	4	-	12
Interactive small-group work.	2	3	4	-	1	10
Discussing common issues and sharing views / information.	3	3	-	-	3	9
Identifying the information needs and possible tools.	2	-	-	2	1	5
Networking with fellow practitioners.	2	-	-	-	2	4
Facilitation.	-	-	3	-	-	3
The workshop's design / structure.	2	-	-	-	-	2
Having 'roving experts' and worksheets.	2	-	-	-	-	2

Note: The numbers in this table indicate the number of participants who mentioned each issue. Data reflect strengths that were mentioned by more than one person at each workshop.

Table 2 – Major opportunities for improvement with respect to the workshops

Opportunities repeatedly mentioned at the workshops	Sydney	Melbourne	Adelaide	Perth	Brisbane	All data
Could have taken more time.	2	-	3	-	-	5
Could have invited a broader range of stakeholders.	-	-	2	-	2	4
Could have provided more background information before the workshop.	-	-	3	-	-	3
Could have provided more opportunities to share knowledge across the small groups.	-	2	-	-	-	2

Note: The numbers in this table indicate the number of participants who mentioned each issue. Data reflect opportunities that were mentioned by more than one person at each workshop.

4. Findings

4.1. The process of WSUD asset delivery

At each workshop, participants provided feedback on the typical *stages* in the process of WSUD asset delivery. The stages are summarised in Table 3. Note that some of the secondary stages in Table 3 overlap. There was a high degree of consistency in these stages across the five cities. The only significant difference was that in some cities (e.g. Brisbane) there was a stronger emphasis on including erosion and sediment control (ESC) activities in the process, as there can be significant costs associated with this part of the construction and establishment stage.

Table 3 – Typical stages within the WSUD asset delivery process

Primary stages	Secondary stages (may overlap)
1. Design and planning	Planning activities (e.g. strategic asset planning, and early 'due diligence' work associated with development proposals).
	Setting WSUD-related objectives and/or policy.
	Conceptual design (includes site assessment work, stakeholder consultation and may involve development assessment).
	Business case development / cost assessment.
	Functional / sketch design.
	Detailed design (may involve development assessment).
2. Construction and establishment	Tendering.
	Construction (including erosion and sediment control activities).
	Establishment (including erosion and sediment control activities).
	Handover of assets.
3. Maintenance and asset management	Operation of assets.
	Inspections and routine maintenance.
	Monitoring and auditing performance.
	Rectification / corrective maintenance (e.g. of poorly designed assets).
	Decommissioning, replacing or renewing.

4.2. The key stakeholders

Table 4 provides a summary of the key stakeholders involved in the three primary stages of the WSUD asset delivery process. Table 4 also indicates which stakeholders particularly need good LCC information and/or tools.

Table 4 – Key stakeholders typically involved in the WSUD asset delivery process

Design & planning stage	Construction & establishment stage	Maintenance & asset management stage
<ul style="list-style-type: none"> ▪ Private sector designers / consultants (incl. engineers, planners, landscape architects, urban designers, ecologists, surveyors, horticulturalists, soil scientists). (S), (M), (A), (P), (B) ▪ Specifically, design and subdivision engineers - civil, hydraulic and environmental (private and public sector). (M), (P), (B) ▪ Financial officers / economists / property economists. (S), (A), (B) ▪ DA (development assessment) 	<ul style="list-style-type: none"> ▪ Developers / asset owners (public and private). (S), (A), (P) ▪ Designers (including consulting engineers) (e.g. at handover stage). (S), (P) ▪ Project managers. (S) ▪ Site superintendents / supervisors (private and public sector). (M) ▪ Contractors (civil and landscape). (A) ▪ Private certifiers and council compliance officers. (P) 	<ul style="list-style-type: none"> ▪ Asset planners / managers / engineers / owners. (S), (A), (B) ▪ Financial managers, staff and planners. (A), (B), (S) ▪ Maintenance crews / service providers (staff and contractors) – bush regeneration, landscape / open space, drainage, waste / cleaning / sweeping and irrigation. (S), (B) ▪ Risk managers. (S), (P) ▪ Development / local works

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Design & planning stage	Construction & establishment stage	Maintenance & asset management stage
<p>staff, typically in local government agencies (may also involve compliance officers). (S), (B)</p> <ul style="list-style-type: none"> ▪ Developers / owners / builders. (M), (A) ▪ Local government project sponsors / managers. (M), (P) ▪ Business development managers (private and public sector). (M), (B) ▪ Strategic and land use / town planners. (S) ▪ Water-related policy and planning staff in government agencies / water agencies. (S) ▪ Project managers (private sector). (B) ▪ Asset managers / planners (ultimate asset owners). (A) ▪ Boards and staff of publicly owned development organisations. (M) ▪ Local government councillors / politicians. (M) ▪ Peak industry bodies (e.g. UDIA). (A) ▪ Executives (e.g. in local government agencies). ▪ Private sector marketing specialists. ▪ Infrastructure Developer Contribution officers (local government). ▪ Community consultation specialists. 	<ul style="list-style-type: none"> ▪ Asset managers. (M) ▪ A wide variety of council staff (e.g. engineers (A), contract managers, supervisors, landscape architects, planners and environmental managers). ▪ State agencies / water agencies. ▪ Suppliers of materials (e.g. plants and soil). ▪ Development managers (private sector). ▪ Council maintenance staff. ▪ Engineering surveyors. ▪ Quantity surveyors. ▪ Geotechnical specialists. ▪ Hydrologists. ▪ Natural Resource Management boards. ▪ People contributing finance to the project. ▪ Community (e.g. school groups involved with wetland planting). ▪ Some others (miscellaneous): traffic engineers, residents, plumbers, service providers (e.g. Telstra), etc. 	<p>managers. (A)</p> <ul style="list-style-type: none"> ▪ Environmental managers, environmental health officers, parks maintenance coordinators and roads and drainage coordinators / engineers. (P) ▪ Horticultural service managers. (A) ▪ Capital works planners / engineers / project managers (e.g. for corrective maintenance). (B) ▪ Senior staff in local government agencies. (B) ▪ Contract managers and administration officers. ▪ Landscape architects / coordinators. ▪ Specialist consultants (e.g. to troubleshoot problems). ▪ Asset inspectors. ▪ The community (including local community groups).

(S), (M), (A), (P), (B) = these stakeholders "particularly need LCC data / tools" in Sydney, Melbourne, Adelaide, Perth and Brisbane, respectively.

The information provided the Table 4 indicates that a very wide variety of stakeholders are involved in each of the three primary stages of the asset delivery process. In addition, a significant portion of the stakeholders have a significant need for good costing information and tools, particularly in the 'design and planning' stage. This finding highlights that LCC tools will need to be flexible enough to service a wide variety of stakeholders.

The data in Table 4 also indicates that there are some key stakeholder groups in each stage that were nominated in more than one workshop as having a significant need for LCC information and tools. For the 'design and planning' stage, the most strongly nominated stakeholders were:

- private sector designers / consultants (i.e. members of multi-disciplinary design teams), and more specifically, design and subdivision engineers (civil, hydraulic and environmental);
- financial officers and economists;
- development assessment (DA) officers;
- developers, owners and builders;
- local government project sponsors / managers; and
- business development managers.

For the 'construction and establishment' stage, developers, designers and asset owners (private and public) were strongly emphasised. Whilst for the 'maintenance and asset management' stage, asset

planners, managers, engineers and owners were highlighted, along with financial managers and planners, maintenance service providers and risk managers.

4.3. Drivers and opportunities for change

During the longer workshop in Sydney, the opportunity was taken to briefly explore drivers and opportunities. In this context, ‘drivers’ are the factors that are creating or building the need for good LCC information and tools (e.g. statutory requirements for 10 year asset management plans to be prepared in NSW local government agencies). ‘Opportunities’ are circumstances that could be used to improve the use of WSUD costing information and tools (e.g. asset management ‘crises’ that are occurring in some local government agencies). The information collected from workshop participants is summarised in Tables 5 and 6.

Table 5 – Drivers to improve the use of WSUD costing information and tools

Design & planning stage	Construction & establishment stage	Maintenance & asset management stage
<ul style="list-style-type: none"> ▪ Greater education of stakeholders about WSUD. ▪ Demand for cost information as a result of financial planning activities. ▪ Sustainability leadership driving WSUD, which creates a demand for cost information and tools. ▪ Uncertainty in relation to WSUD costs during planning and budgeting activities. ▪ Requirements to do cost-benefit analyses to support decisions relating to WSUD assets, to justify policy decisions and to lobby for funding. ▪ An increasing need to address fears and minimise risks associated with the long-term cost of WSUD assets (especially in local government agencies). ▪ Developers wanting cost-effective regulatory processes, with access to good costing information being part of these processes. 	<ul style="list-style-type: none"> ▪ Dedicated funding sources (e.g. environmental levies in some local government agencies) driving the construction of WSUD assets and therefore a need for costing information and tools. ▪ The need to ‘fine-tune’ construction budgets using reliable and detailed cost information. ▪ The need to understand the cost implications of options that emerge during construction. 	<ul style="list-style-type: none"> ▪ The limited funds available for WSUD maintenance in local government agencies creating a need for the optimisation of these resources. ▪ Legislative requirements for long term strategic asset planning (e.g. 10 year ‘resource plans’ in New South Wales). ▪ An escalation of WSUD maintenance costs in local government, primarily as a result of inherited assets from developers. ▪ Increased awareness of the need to undertake programming decisions for maintenance works (e.g. deciding when to spend resources on rectification to minimise expenditure across the asset’s life span). ▪ Greater awareness of the need to understand and plan for the investment that is required to ensure levels of service from WSUD assets. ▪ The need for good maintenance cost information to help influence future design decisions (i.e. to reduce the long term maintenance burden).

The drivers in Table 5 are numerous and some of them are significant. For example the legislative driver that requires local government agencies in New South Wales to prepare detailed 10-year strategic asset management plans creates a significant demand for reliable costing information and estimation tools. Other drivers relate to fears, risks and ‘crises’ concerning the financial sustainability of WSUD assets that are maintained by local government agencies. In addition, increasing sustainability leadership, the accelerating delivery of WSUD assets, and the increasing need to better justify investing in WSUD assets are acting as drivers.

Table 6 – Opportunities to improve the use of WSUD costing information and tools

Design & planning stage	Construction & establishment stage	Maintenance & asset management stage
<ul style="list-style-type: none"> ▪ Planning instruments provide an opportunity to require developers to consider and provide LCC information. ▪ Legislative instruments that require sound, long term financial / asset management planning. ▪ An increasing awareness of the need to better manage natural assets. ▪ Greater recognition of the true value of water creating new opportunities for some WSUD assets. ▪ Greater community interest, awareness and willingness to pay for environmental protection (e.g. via local government environmental levies). ▪ Commitments by major developers to sustainable development. 	<ul style="list-style-type: none"> ▪ As more WSUD assets are constructed, the knowledge of the industry builds, and the need for good LCC information and tools also increases. ▪ Where Councils have environment levies, good costing information is needed to justify council-funded WSUD assets and to meet reporting requirements. 	<ul style="list-style-type: none"> ▪ Asset management 'crises', particularly in local government agencies, create an opportunity to improve financial planning in relation to WSUD assets. ▪ Training activities create an opportunity to build understanding of life cycle costing and the use of costing tools. (Applies to all stages.)

Most of the 'windows of opportunities' in Table 5 are likely to be open for some time, such as opportunities created through growing community interest and awareness. More transient opportunities relate to legislative instruments (e.g. requirements to undertake long-term asset management planning in NSW) and the potential to connect new LCC tools to relevant types of training (e.g. training around Australia on the 'Construction and Establishment of Vegetated Stormwater Systems'⁴).

Overall, the information in Tables 4 and 5 indicate that numerous drivers are building demand for, and creating opportunities to use, good LCC information and tools in order to make better decisions about WSUD assets. It is suggested that the majority of the drivers will be sustained or build in intensity in the foreseeable future (i.e. in the next 5-10 years). This suggests that *early investment* in gathering LCC information and providing practitioners with cost estimation tools is warranted.

4.4. Types of WSUD assets for which LCC data are needed

During each workshop, participants brainstormed the types of WSUD assets they were involved with, and then highlighted which ones particularly needed good costing information. The asset types practitioners were involved with are listed in Table 7. The information in this table indicates that a large number of WSUD asset types are being managed across Australia; especially considering some of these categories have many sub-categories (e.g. gross pollutant traps). This information also highlights that stormwater reuse assets are now a significant part of WSUD. It also indicates that some, but not many, asset types are more common in particular regions of Australia (e.g. the use of soil amendment in Perth).

⁴ Developed by the Water by Design program in South East Queensland.

Table 7 – The types of WSUD assets that workshop participants managed

WSUD asset type	Sydney	Melbourne	Adelaide	Perth	Brisbane
Rain gardens / bioretention basins (incl. tree systems, street and regional systems, and those with or without a saturated zone).	√	√	√	√	√
Stormwater reuse systems (3 parts):					
a) Stormwater harvesting storage – tanks, ponds and lakes.	√	√	√	√	√
b) Stormwater harvesting post-storage treatment systems (includes control and monitoring systems).	√	√	√		
c) Stormwater recycling pump and irrigation systems (including subsurface irrigation and private reticulation).	√	√	√	√	
Stormwater harvesting systems – roof water only.	√	√			√
Constructed wetlands.	√	√	√	√	√
Swales (with or without a bioretention component).	√	√	√	√	√
Rehabilitated channels / natural channel designs / living streams.	√	√	√		√
Gross pollutant traps: proprietary systems, floating booms, end of pipe nets and pit liners / traps.	√	√	√	√	√
Detention basins (wet and dry).	√			√	√
Infiltration systems – basins and pits.	√	√	√	√	
Sand filters.	√				√
Paving – permeable, porous.	√	√	√	√	
Aquifer storage and recovery systems.	√	√	√		
Vegetated buffers, filter strips and riparian vegetation zones.	√		√	√	√
Sediment basins.	√	√	√		√
Diversion structures.		√	√	√	√
Green roofs and walls.		√	√	√	
Media filtration / cartridge filtration systems.		√	√		√
Erosion and sediment control during the construction phase.			√		√
Soil amendment (to bind nutrients) and sub-soil drainage in sandy, low lying areas.				√	

√ = mentioned by workshop participants as being relevant to their work.

Each workshop participant was given three nominations / votes to highlight specific WSUD asset types for which good LCC information was most needed. The nomination data are plotted in Figure 3.

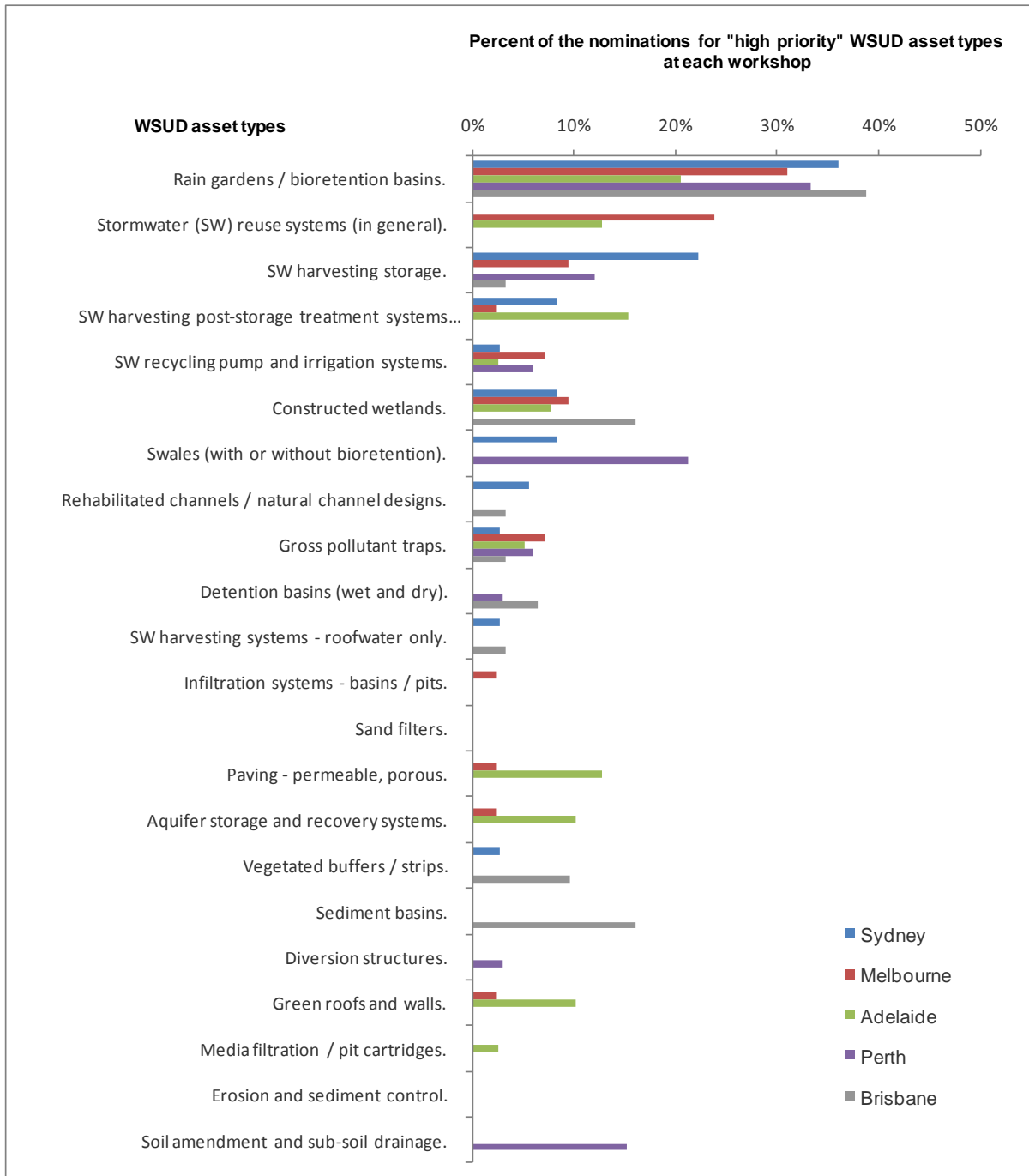


Figure 3 – The WSUD asset types for which better LCC data are most needed

The data in Figure 3 indicate that at a *national* level, there is a strong need for better LCC information relating to:

- Rain gardens / bioretention basins.

- Stormwater reuse systems larger than the lot scale (incl. storage, treatment, pump and irrigation / reticulation, and monitoring elements).
- Constructed wetlands⁵.

Whilst at a *regional* level, a number of significant local costing needs also exist. For example, there is a need for better costing information relating to:

- Swales (with or without bioretention components) in Perth.
- Permeable and porous paving, and aquifers storage and recovery systems in Adelaide.
- Sediment basins in Brisbane.

4.5. Specific LCC data needs

The workshops produced a large amount of detailed information on the LCC needs of various stakeholders. This section presents a *synthesis* of key findings and commonly expressed views. Tables 8, 9 and 10 summarise the specific needs of key stakeholder groups involved with the design and planning, construction and establishment, and maintenance and asset management stages, respectively.

Overall, the information in these three tables indicates there are three broad groups of stakeholders with different LCC needs. First, some stakeholders, such as technical specialist developing conceptual designs, need information that allows them to generate reasonable estimates of cost elements (e.g. TAC, TAM, RC and DC) and life cycle cost (LCC) in a form that allows them to examine 'cost-performance relationships'. Currently, this group of stakeholders use tools such as MUSIC to do this⁶. They may also use size – cost relationships they have developed through their own project work (e.g. \$/m² rates for TAC for different types of WSUD assets). Ideally, this group of stakeholders would be able to quickly generate cost estimates that allow for a limited range of factors that can significantly affect cost (e.g. the development context, level of service, design, geographic location). This report refers to these types of estimates as “**WSUD cost estimates**”.

Second, other stakeholders, such as strategic planners, also need to be able to generate “**WSUD cost estimates**” but need to be able to access this information directly, rather than through design tools like MUSIC. These stakeholders also need to know when costs are incurred over time (e.g. for financial and asset planning).

Third, other stakeholders, such as maintenance coordinators, designers and construction managers, need cost elements (e.g. TAC and TAM) to be broken down into lists of unit rates / 'bills of quantities'. These stakeholders also need to be able to access this information directly (e.g. through a downloadable spreadsheet or database). They currently have access to unit rates for common construction activities but limited information on WSUD-specific construction costs (e.g. bioretention filter media) and maintenance costs.

More specifically, *construction* practitioners need a typical list of cost items for each WSUD asset type, as well as rates for WSUD-specific items that are not available in documents like 'Rawlinson's Australian Construction Handbook'. This report refers to this type of cost information as “**WSUD construction rates estimates**”.

⁵ It is acknowledged that workshop participants indicated there is little need for good LCC information for constructed wetlands in Perth at present.

⁶ It is noted that MUSIC has limited use in Western Australia at present.

Maintenance practitioners need to know typical maintenance activities, unit rates for these activities, as well as information on the frequency of various maintenance activities, the human resources needed for these activities, and the plant / equipment requirements. They also need to be able to generate estimates that allow for a range of factors that affect cost such as the development context (e.g. greenfield vs. retrofit), size, level of service, geographic location, design, season, vegetation type, etc. For vegetated assets, they also need to know how maintenance cost elements (e.g. TAM) and the cost of various activities (e.g. weed control) vary over the asset's life. This report refers to this type of cost information as "**WSUD maintenance rates estimates**".

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Table 8 – The LCC data needs of key stakeholders during the ‘design and planning’ stage

Stakeholders	The type of cost information / data they need	The degree of confidence they need in the data (High / Medium / Low)	The form the data needs to be in	Other important WSUD asset information / data needs
<p>Technical practitioners and managers: developer consultants; designers; DA officers; development managers; and project managers.</p>	<p>Estimates of all cost elements (TAC, TAM, RC and DC) and LCC. Detailed breakdown of these cost elements (e.g. for rain gardens: planting costs, media costs, drainage, etc.).</p>	<p>L-M (conceptual / functional design) H (detailed design)</p>	<p>Conceptual / functional design: broad estimates of cost elements (e.g. TAC, TAM, etc.) per size descriptor (e.g. KL, m²). Similar to the MUSIC model's LCC module but also allowing for major factors that can affect cost (e.g. development context, location, service level). Where relevant, cost elements should also be linked to particular events (e.g. TAM broken down into the cost per maintenance event). Also, TAC needs to be broken down (e.g. to allow the design costs to be removed). Detailed design: unit rate breakdown for all major cost elements (e.g. not just the 'TAC' estimate for rain gardens, but how this cost element is typically broken down into costs for soil, plants, drainage, etc.). In other words, create a "bill of quantities" for the stages of construction. Cost information that can be used to examine the relationship between cost and performance (e.g. \$ per kg of N/P removed over the asset's life). Note: In general, all cost estimates may need to be linked to at least the following factors:</p> <ul style="list-style-type: none"> ▪ Development context: greenfield / brownfield; retrofit; streetscape; lot. Likely to affect all cost elements. ▪ Size of assets: large; small. Likely to affect all cost elements. ▪ Design: best practice; common but poor designs. Likely to affect TAM and RC (incl. major rectification) costs. ▪ Level of service: Standard; high. Likely to affect all cost elements. ▪ Geographic location: TAM and RC likely to be strongly affected by location (due to a range of factors such as climate). 	<p>Also need tools to compare cost and performance in order to optimise cost-effectiveness (e.g. MUSIC). Ideally, practitioners would have access to databases that provide cost and performance data for all WSUD assets. Assumptions in costing data need to be explicit. Need to link cost estimates to specific designs and maintenance regimes. Need the ability to generate cost estimates for individual assets and treatment trains. Also need information on 'land take', impact of WSUD on surrounding property values, social benefits, energy related costs (e.g. for reuse systems), etc. Such information goes beyond the LCC of just the WSUD assets to consider triple-bottom-line benefits and costs. Useful to also have costs associated with the 'do nothing' or 'base case' scenario to help justify the project. TAM costs need to include operation costs (e.g. running a reuse system). Stakeholders also need broad guidance on relevant targets / design objectives, policy, legislative requirements and applicable detailed guidelines. TAC needs to include construction, establishment and project management costs. Photographs should also be used to communicate the types of designs for which cost estimates are available.</p>

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Stakeholders	The type of cost information / data they need	The degree of confidence they need in the data (High / Medium / Low)	The form the data needs to be in	Other important WSUD asset information / data needs
<p>High-level decision-makers: strategic planners; developers; councillors; board members; executives.</p>	<p>High level estimates – e.g. TAC and LCC / size relationships, % 'rule of thumb' estimates (e.g. relating to costs per development size), and probable 'land take' associated with WSUD assets. Needed to build business cases.</p> <p>The contingency amount that should be allowed in case cost estimates are inaccurate.</p> <p>The relationship between the cost and performance of WSUD assets (i.e. the 'cost-performance curve') to help decision making. Applies to capital and LCC costs.</p> <p>How costs are spread over time.</p>	<p>M-H – TAC estimates. M-L – other cost estimates.</p>	<p>TAC and LCC per size descriptor (e.g. m², KL) for each WSUD asset type.</p> <p>TAC and LCC costs per lot, where relevant (e.g. the costs of rainwater tanks per lot on a subdivision).</p> <p>% 'rule of thumb' estimates that relate the development's size to: typical WSUD TAC / LCC costs; and the loss of developable land.</p> <p>Contingency allowance (e.g. a % of TAC to allow for increased construction costs and DC to allow for asset removal).</p> <p>The relationship between cost elements and each year of the asset's life.</p> <p>Cost data in a form that allows relationship between cost and performance to be examined (e.g. \$ per kg of N/P removed over the asset's life).</p>	<p>There is no need to service this group of stakeholders via design tools / models like MUSIC.</p> <p>Also interested in the costs associated with the 'do nothing' / 'base case' scenario (e.g. traditional water management) in order to build a business case.</p> <p>Also interested in all of the information needed to do triple-bottom-line assessments (with costs being one input).</p> <p>Information to examine the efficiency of WSUD assets (e.g. treatment performance versus cost), and their ability to meet targets (e.g. design objectives).</p> <p>The time needed to get the asset in place (this is often a significant driver for the private sector).</p> <p>Photographs should also be used (see previous comment).</p>
<p>Representatives of the eventual owner / operator (e.g. financial planners and asset managers in councils).</p>	<p>All cost elements: LCC, TAC (less significant), TAM, RC, DC, discount rates, life span / cycle and depreciation rates.</p> <p>How LCCs are spread over time, including the costs that fall into discrete budget periods (i.e. 1, 4, 10 and 20 year periods).</p>	<p>M-L – TAC. H – other cost elements.</p>	<p>Cost elements and LCC per size descriptor (e.g. m², KL) for each WSUD asset type.</p> <p>Need estimates of each cost element that are linked to a given year, so costs can be grouped into budget periods for asset / financial planning purposes (e.g. all maintenance costs over the next 10 years).</p> <p>Standard unit rate cost estimates for individual asset components (e.g. filter media, plants, etc.). In particular, TAM needs to be broken down into unit rates.</p>	<p>Need to state all financial assumptions associated with cost estimates.</p> <p>Also need guidance on how to use this information in asset management plans, as well as relevant legislative requirements. [Such comments highlight the need for capacity building activities to support the provision of LCC information and tools.]</p> <p>Photographs should also be used (see previous comment).</p>

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Table 9 – The LCC data needs of key stakeholders during the ‘construction and establishment’ stage

Stakeholders	The type of cost information / data they need	The degree of confidence they need in the data (High / Medium / Low)	The form the data needs to be in	Other important WSUD asset information / data needs
Developers, contract managers, consulting engineers.	Primarily TAC. May also need to know DC (as a contingency measure). May also need to provide other stakeholders (e.g. ultimate asset owners) with TAM and RC estimates.	H – TAC. L-M – other cost elements.	TAC and DC per size descriptor (e.g. m ² or KL). TAC broken down into unit rates / ‘bills of quantities’. See previous comments about the need for cost elements to reflect a range of factors (e.g. size, context, level of service, geographic location, etc.).	Guidance on WSUD asset specifications. Guidance on what costing information needs to be supplied during the approval process.
Detailed designers / design teams, project managers, construction managers, lead contractors, sub-contractors, developer superintendants.	Primarily TAC. LCC. TAM and RC (especially in the first few years after construction). Costs savings (helps to sell benefits) – e.g. reduced trunk drainage costs. Compliance costs (e.g. filter material tests).	H – TAC (ideally within 10% of final budget). Typically confirmed through market mechanisms. M – other cost elements.	LCC and TAC per size descriptor (e.g. m ² or KL). Also, TAC per lot, where relevant. Unit rates / bills of quantities for TAC (i.e. typical ranges for common items). Need to understand how the capital (TAC) and early maintenance costs (TAM / RC) are spread over the assets life, especially the first few (e.g. 3-5) years. Need to be able to compare the costs associated with alternative options (e.g. WSUD Vs. traditional design).	Life span of assets / asset components. Benchmarking information (e.g. typical TAC and LCC/m ² ranges for well designed, cost-effective rain gardens in particular cities / regions). Needed to demonstrate value for money. Guidance on the pros and cons of using different construction service providers (e.g. landscapers, civil contractors, etc.).
Asset owners, maintenance contract managers, local government subdivision engineers.	All maintenance costs (TAM, RC). DC. Time frames for all maintenance costs (i.e. frequencies).	H – TAM. M – RC. L – DC.	Cost (TAM, RC, DC) per m ² per event or year. Also need a typical schedule of maintenance visits, costs, staff requirements and plant / equipment requirements. See previous comments about the need for cost elements to reflect a range of factors. Need to break vegetation-related maintenance costs (e.g. TAM) down into several categories (e.g. year 1, years 2-5, years 6+). Need to break down maintenance costs to include items like the cost of disposing contaminated material (\$/m ³) in various locations.	Also need guidance on the life span of WSUD asset <i>elements</i> (e.g. filter media in bioretention systems). This guidance could use a range of factors to estimate the life span. Also need a clear maintenance plan / inventory at the asset handover stage that specifies maintenance processes, timing, and requirements for equipment and staff.
Regulators / compliance officers.	All cost elements, as these stakeholders need to know the long-term cost implications.	M	The same as “asset owners”.	-

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Table 10 – The LCC data needs of key stakeholders during the ‘maintenance and asset management’ stage

Stakeholders	The type of cost information / data they need	The degree of confidence they need in the data (High / Medium / Low)	The form the data needs to be in	Other important WSUD asset information / data needs
Asset owners / managers.	TAM (focus), RC, DC. TAC and LCC. Contingency cost. [Note that DC can be used as a contingency cost.]	H – TAM. M – RC, DC and LCC. L-M – TAC.	LCC and cost elements per size descriptor (e.g. m ² or KL). For maintenance related cost elements, these would also be related to time (e.g. cost per event or year). LCC: estimates able to be converted to cost per kg of trapped pollutant, and cost per area of treated catchment. Maintenance costs (TAM) would be broken up into establishment, operational and typical maintenance costs. Renewal costs need to address the issue of fixing common problems (e.g. design and construction faults). Some asset managers also need a breakdown of maintenance costs (i.e. unit rates), that include: costs per visit, inspection and maintenance event; costs associated with specific maintenance tasks; and how these costs are affected by factors such as size, level of service, geographic location, etc. Costs also need to be comparable to alternatives (e.g. recycled stormwater costs versus potable water cost / KL).	Need to keep track the asset’s performance objectives during the maintenance phase. Need to be clear about what components were included in cost estimates (e.g. for wetlands with pre-treatment features). Need information on the life span of the overall asset as well as its components. Need maintenance information from developers (e.g. plan, inventory, history). Some asset managers also need information on the environmental benefits the WSUD assets provide (e.g. the monetary value of a trapped kg of target pollutant).
Maintenance works managers / coordinators, contract managers and maintenance service providers (typically there are three categories of coordinator / service provider: vegetation and parks; sediment and gross pollutant removal; and stormwater harvesting).	Cost elements (TAM, RC, DC) and maintenance frequencies. Focus = TAM. Costs elements broken down into unit rates. People and hours needed for maintenance tasks. Plant / equipment required for maintenance tasks. For vegetation-related maintenance, need to distinguish between: establishment maintenance; routine vegetation maintenance (TAM); and corrective maintenance (RC). May need a new cost element category (i.e. EM = establishment maintenance in the first five years). Costs need to include administration, inspections and monitoring.	H – TAM. M – RC L - DC	Need the following 4 sets of data: <ul style="list-style-type: none"> ▪ Cost elements: estimate of cost elements per size descriptor (e.g. TAM), as well as a more detailed break-down of costs (i.e. unit rates).* ▪ Event frequency: The frequency of various maintenance tasks (including monitoring). ▪ People: The person hours per maintenance event (or year). Needs to be linked to specific maintenance activities. ▪ Plant / equipment: The type of equipment and hours needed per maintenance event (or year). Needs to be linked to specific maintenance activities. <p>* See previous comments about the need for cost elements to reflect a range of factors (e.g. size, level of service, geographic location, etc.). This is particularly important for <i>vegetation-related</i> maintenance, with factors including season, vegetation type, maintenance method, planting density, level of service, etc.</p>	Need information on how maintenance costs vary over time. Also need information on the life span of WSUD assets and their individual components.

4.6. Possible LCC tools to assist practitioners

Workshop participants identified seven possible tools to provide practitioners with the costing information they need to make better decisions regarding WSUD assets. This section briefly describes these tools.

a) Downloadable spreadsheet / database linked to a national WSUD LCC website

This tool was most commonly suggested, and represents a single tool that could potentially provide all of the key stakeholders with the raw cost information they require. Practitioners would be able to download a national spreadsheet or database that provides the costing information described in Section 4.5 as:

- **“WSUD cost estimates”** (i.e. estimates that could be quickly generated by users such as conceptual designers and strategic planners). Such estimates would be in a similar form to those currently available via MUSIC, but updated and covering a broader range of assets.⁷ These estimates would also allow for a range of local factors that can significantly affect cost (e.g. geographic location⁸, development context and service level).
- **“WSUD construction rates estimates”** (i.e. typical lists of construction items for each WSUD asset type, and rates for WSUD-specific items that are not currently available in documents like ‘Rawlinson’s Australian Construction Handbook’).
- **“WSUD maintenance rates estimates”** (i.e. typical lists of maintenance activities and their frequencies, unit rates, human resource requirements and equipment requirements). These rates would also be linked to a range of factors such as asset size, development context, level of service, geographic location, vegetation type, planting density, season, design, etc.

Users could download the tool and use default cost estimates or add their own, locally obtained cost estimates. The tool would be designed to capture local information so it could be used to inform the next version of the tool (i.e. inform default values⁹). It would include a standard template to break down costs associated with each WSUD asset type. The template format would be informed by knowledge of how contracts are typically divided (e.g. different types of maintenance contracts to service assets such as constructed wetlands).

The tool would also provide information on how the costs are spread over time, and allow users to easily calculate the total costs incurred over various planning intervals (e.g. the next 10 years). It would be designed to interface with Excel and a variety of different asset management systems. It would also have the flexibility to be able to interface with future asset management systems. It would also have a supporting manual / guideline¹⁰ and potentially be accompanied by some form of training (e.g. freely available on-line training).

⁷ TAM would also be split into several parts to reflect establishment maintenance, operational and routine maintenance costs.

⁸ This tool would generate cost estimates for common WSUD asset types in different geographic regions (e.g. tropical, subtropical and temperate regions), rather than national averages.

⁹ This feature would mean that local costing data could be easily gathered in future without having to rely on practitioners doing much ‘extra work’. When updating the tool, developers would simply ask agencies to provide a digital copy of their database if it includes some locally generated costing information.

¹⁰ This guideline would describe the basis for the estimates, communicate caveats and limitations, provide the costing algorithms embedded in the tool, list supporting information and provide a stepwise process to use the tool. A similar approach was taken with the MUSIC software’s life cycle costing tool.

The tool would be updated periodically (e.g. every 5 years¹¹) and be the central repository of costing information that could be used by models like MUSIC. Outputs could be printed or exported into other spreadsheets / databases. There would be a modest fee to use the tool that would pay for its maintenance. The fee system could have two levels: a modest fee for users who want the “WSUD cost estimates” (like those currently in MUSIC); and a larger fee for users who want more detailed information (i.e. the “WSUD construction / maintenance rates estimates”).

Workshop practitioners flagged the issue of tool ownership as being critical. Suggested stakeholder groups who could own such a tool included industry associations such as IPWEAQ, eWater, research groups, major water agencies, the Commonwealth government (e.g. the National Water Commission), or a private company.

b) On-line spreadsheet / database for cost and performance data

This tool is an extension of the first idea as it would provide practitioners with information on the *performance* of various WSUD assets (e.g. pollutant removal efficiencies) as well as their cost. The idea is similar to the ‘International’ Stormwater Best Management Practices (BMP) Database (see www.bmpdatabase.org). The purpose of this American project is to “provide scientifically sound information to improve the design, selection and performance of BMPs” (source: www.bmpdatabase.org). The US database essentially provides information in a structured case study format.

Such a tool would provide a downloadable database that could be searched to access cost and performance information for specific WSUD assets. Users would need to locate information relating to assets that are similar to theirs (e.g. in terms of design, geographic location, level of service, etc.).

c) Strengthening life cycle costing modules in existing design tools

This idea seeks to add, update and/or expand LCC modules within existing design tools such as MUSIC (eWater) and STORM (Melbourne Water). In particular, it would build on the costing module in version 4 of MUSIC by adding the capability of building cost estimates by using unit rates and information on local factors that affect cost (e.g. design, location, service level, etc.).

It is noted that STORM has been developed for use in Victoria and MUSIC is not currently endorsed by regulators in Western Australia. Consequently, there is currently no single tool that could be modified to service practitioners in all States and territories.

d) Handbook of rates (‘Rawlinson equivalent’)

This suggestion involves creating a WSUD equivalent to the “Rawlinson’s Australian Construction Handbook” and/or “Rawlinson’s Construction Cost Guide” (see www.rawlinsons.com). It could be in form of a handbook or online resource. It would provide detailed unit cost rates for construction and maintenance activities (i.e. break down the TAC and TAM cost elements).

This proposal is similar to the first idea, but aims to use the Rawlinson approach / format, so that the costing information for WSUD assets eventually gets incorporated into future commercial publications as ‘mainstream practice’. This handbook could also provide practitioners with other information they need such as the life span of assets, real discount rates, etc. A drawback of this approach is that the Rawlinson publications focus on construction, whereas much of the cost information needed by

¹¹ This frequency will depend on the extent to which the WSUD evolves in Australia. The 5 year estimate is based on the experience of the life cycle costing module in the MUSIC software.

practitioners relates to maintenance (e.g. detailed information on the cost of specific tasks, equipment requirements, people-hours and frequencies).

e) Example 'bill of quantities' for WSUD assets

This suggestion involves preparing example 'bills of quantities' for typical WSUD asset types to be used as a guide. It would help designers, construction practitioners and local government staff who are preparing costings and making tendering and bonding decisions. It is understood that some Councils in South East Queensland (e.g. Logan) are starting to prepare such materials.

f) Provision of model plans, specifications, procedures and drawings with costing information

This idea involves providing practitioners with on-line guidance materials (e.g. model maintenance plans, standard drawings, standard construction specifications and maintenance procedures) which would include cost information. This approach would primarily provide practitioners with costing material in a case study format (e.g. maintenance plans for different assets and different conditions). Users would need to find materials that are relevant to their local context.

This would be a very significant undertaking as such materials are costly to develop and usually tailored for a particular geographic region (e.g. the standard WSUD drawings in South East Queensland). Thus, many areas of Australia would need to invest in the development of the materials and then add costing information. In addition, a large number of model documents (e.g. maintenance plans) would be needed to cover the range of factors that strongly influence cost.

g) Collect costing information using 'D-Spec' or 'ADAC' for WSUD assets

D-Spec stands for 'consultant / developer specifications for the delivery of digital asset data to local government'. ADAC stands for 'As Designed As Constructed'. Both of these tools aim to provide "survey enhanced 'as constructed' digital data of drainage and/or telecommunication conduit information as a GIS ready format to the D-Spec consortium" (source: www.dspect.com.au). In short, they are national specifications to help convert important drainage-related asset information into GIS systems operated by asset managers, particularly in local government. A WSUD module for D-Spec and ADAC has been proposed. Some workshop practitioners suggest that D-Spec or ADAC could be used to encourage WSUD practitioners to gather the information needed to build future cost estimation tools. This would therefore be an initiative to *supplement* other tools, such as the proposed downloadable spreadsheet.

4.7. The relative importance of building costing capacity

During the workshop in November 2009, some stakeholders expressed uncertainty about whether limited resources should be invested in collecting LCC information and building LCC estimation tools, as there were many other capacity building activities that could be funded to advance WSUD. Consequently, it was agreed to gather information from practitioners to examine the relative importance of addressing this issue. This information was collected via six questions in the feedback survey that was administered after each workshop.

Stakeholders were asked to rate the extent to which they agreed / disagreed with the statement: "Practitioners need good WSUD life cycle costing tools" using a 1 to 9 Likert scale (1 = "disagree strongly"; 9 = "agree strongly"). The average ratings for all five workshops (and the overall average rating) are shown in Figure 4. The ratings indicate that practitioners at all the workshops, on average, agreed relatively strongly with this statement (i.e. around 8 on the scale).

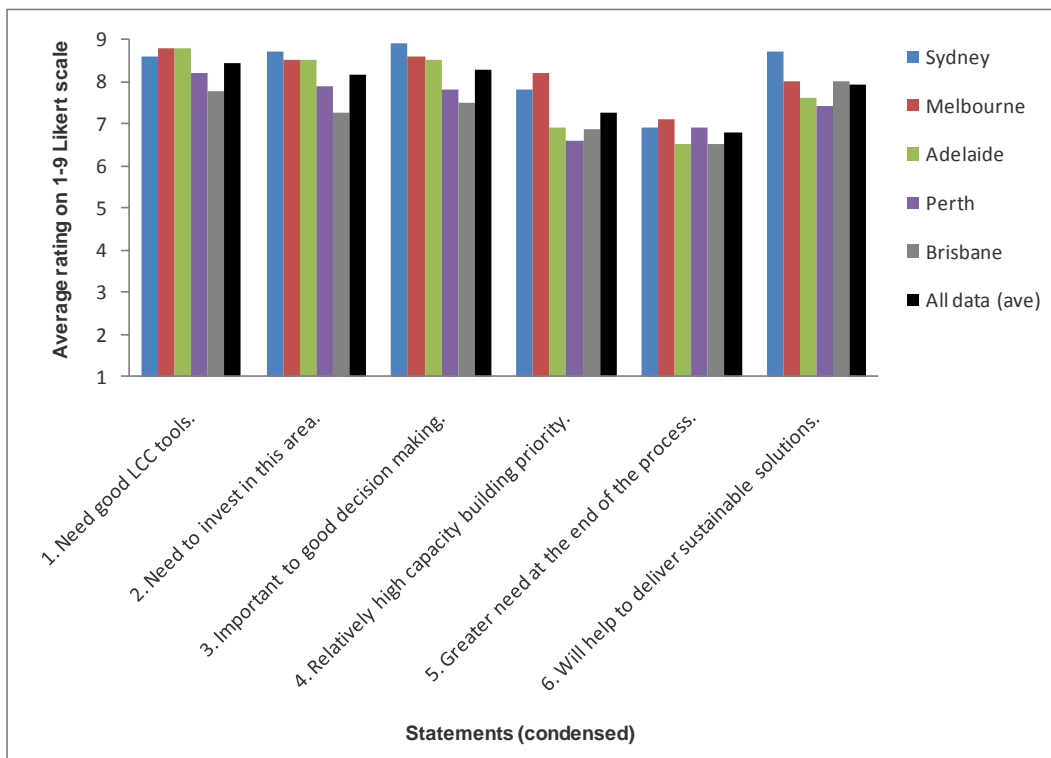


Figure 4 – Stakeholder feedback on the need for WSUD life cycle costing data and tools

Legend:

- 1 = Practitioners need good WSUD life cycle costing tools.
- 2 = There is a need to invest in projects to gather life cycle costing data and build life cycle costing tools for WSUD assets to help improve decision-making.
- 3 = Having access to good life cycle costing data and tools is important to support sound decision making in relation to WSUD assets.
- 4 = Compared to other WSUD-related capacity building activities (e.g. development of more guidelines and training), investing in life cycle costing data / tools is a high priority.
- 5 = There is a greater need for life cycle costing data and tools at the WSUD asset management / maintenance end of the asset delivery process than at the design / construction end.
- 6 = The availability of a range of good WSUD life cycle costing tools will help to deliver sustainable WSUD solutions.

Similar ratings were recorded for the statements: “There is a need to invest in projects to gather life cycle costing data and build life cycle costing tools for WSUD assets to help improve decision-making”; and “Having access to good life cycle costing data and tools is important to support sound decision making in relation to WSUD assets” (see Figure 4). Average ratings were slightly lower in Perth and Brisbane, reflecting that the relative importance of projects to gather good costing information and build new tools varies depending on the location. This local variation is likely to reflect the strength of other capacity building needs (e.g. good design guidelines), what capacity building work has already been done, and the strength of local drivers that create a need for better costing information and tools (e.g. legislative drivers in NSW to undertake 10 year asset management plans in local government authorities).

Workshop participants, on average, supported the statement: “Compared to other WSUD-related capacity building activities (e.g. development of more guidelines and training), investing in life cycle costing data / tools is a high priority” (see Figure 4). Average ratings were typically in the range 6.5 to 8 range on the 1 to 9 Likert scale. Ratings in Adelaide, Brisbane and Perth were lower, indicating there were other capacity building activities in these cities that were also important.

There was not a consensus amongst workshop participants in relation to the statement: “There is a greater need for life cycle costing data and tools at the WSUD asset management / maintenance end of the asset delivery process than at the design / construction end”. As shown in Figure 5, most of the survey respondents agreed relatively strongly with this statement (particularly in Sydney, Melbourne

and Perth), but a significant proportion disagreed to some extent. Comments from participants indicated that those who disagreed often thought that there was an *equal* need for good cost information across the entire WSUD delivery process. Overall, these data indicate that there is a need for good costing data and tools across the WSUD asset delivery process, but currently, most practitioners think the need is greatest towards the asset management / maintenance end of the process. This perspective is particularly strong in Sydney, Melbourne and Perth.

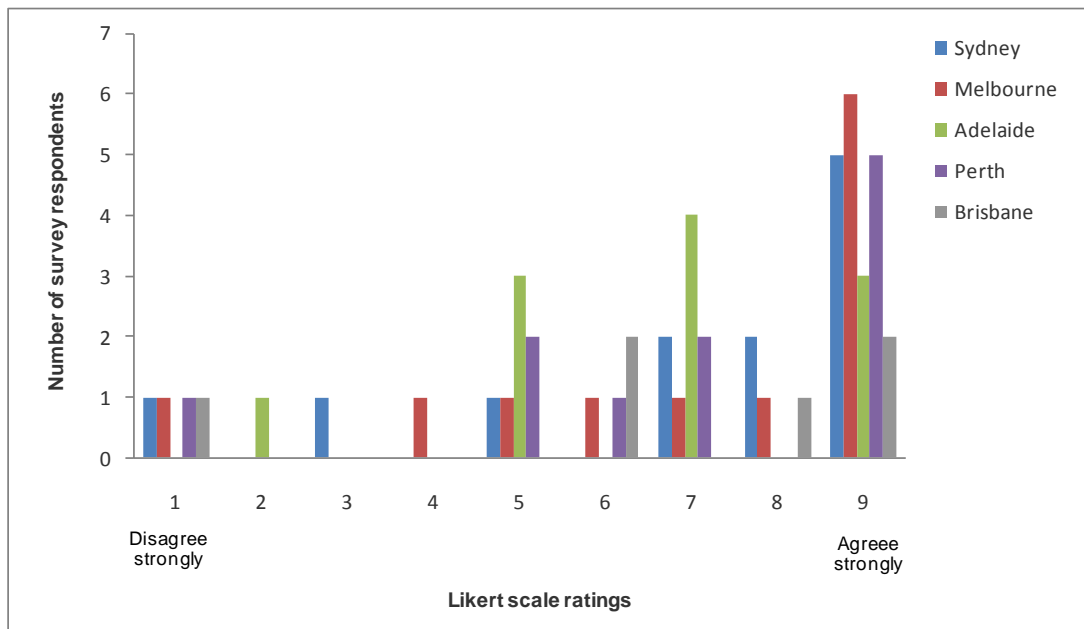


Figure 5 – Stakeholder feedback on who needs LCC data / tools the most

Legend:

Statement = There is a greater need for life cycle costing data and tools at the WSUD asset management / maintenance end of the asset delivery process than at the design / construction end.

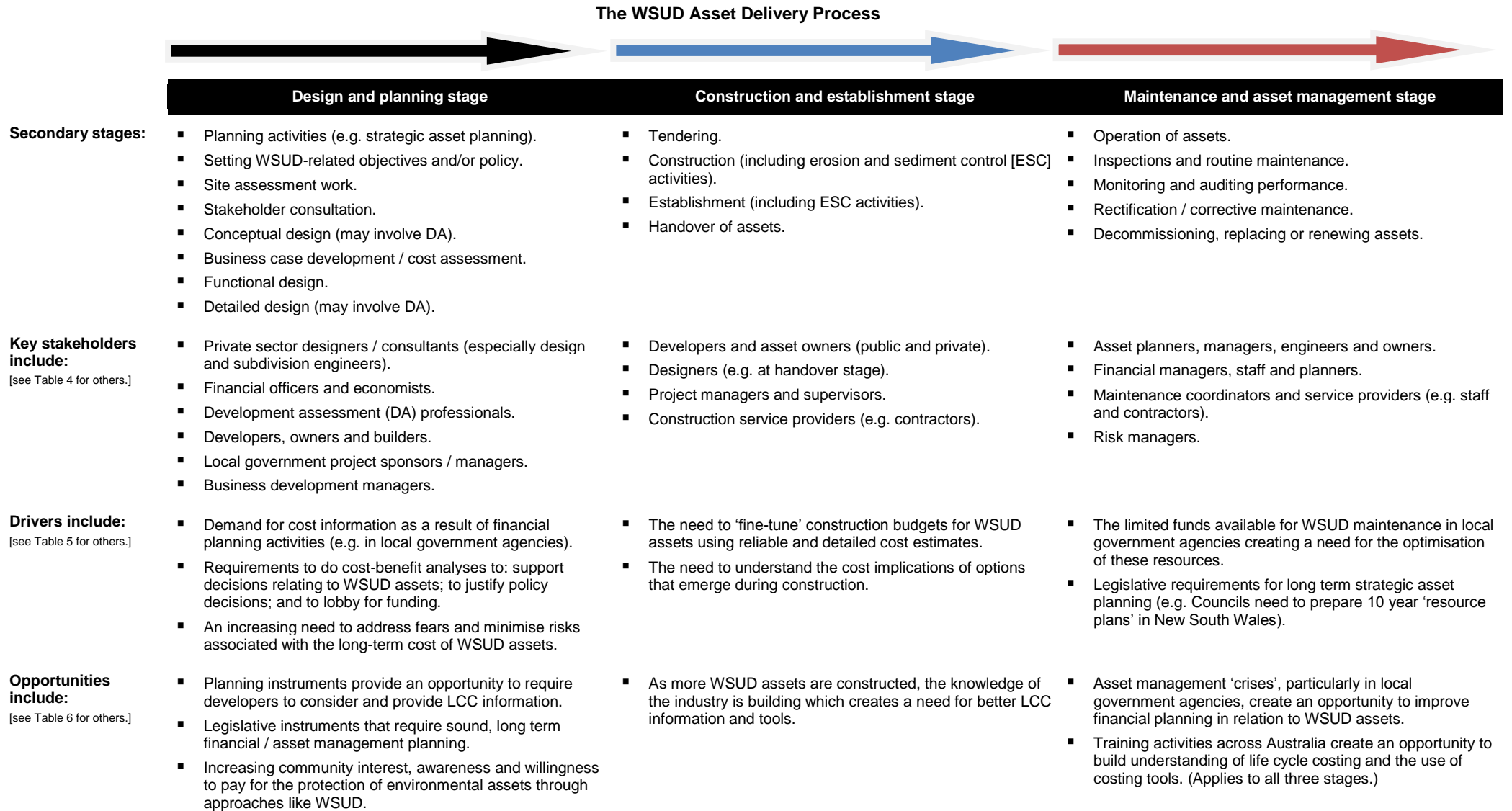
Finally, in relation to the statement: “The availability of a range of good WSUD life cycle costing tools will help to deliver sustainable WSUD solutions”, workshop participants supported this statement (see Figure 4). Ratings were generally within the 7 to 8.5 range on the scale.

Overall, these data indicate that the workshop participants were, on average, strongly of the view that WSUD practitioners in the five cities need access to good LCC information and estimation tools in order to make sound decisions that deliver sustainable WSUD solutions. There was strong support to invest in this area of capacity building, particularly in Sydney and Melbourne. There was not a consensus about whether asset managers and maintenance practitioners had a greater need for LCC data and tools than design and construction practitioners. Whilst most agreed with this proposition, some thought that their needs were of equal importance.

4.8. Summary framework

A summary of the key findings from the needs analysis are presented in Figure 6.

Figure 6 – The key findings from the needs analysis (summary framework)



Continued on the next page...

National Needs Analysis: Life Cycle Costing Data and Tools For Water Sensitive Urban Design Assets

The WSUD Asset Delivery Process



LCC information needs include:

[see Section 4.5 for more information.]

Broadly, there are three groups of shareholders with different needs:

1) **Technical design specialists** (e.g. teams preparing conceptual designs): They require reasonable estimates of all cost elements (e.g. TAC, TAM, RC and DC) and the LCC, as well as performance information for WSUD assets (e.g. pollutant removal efficiencies, volume of recycled stormwater). They use this information to examine 'cost-performance relationships', using modelling tools like MUSIC. These cost estimates need to allow for a limited number of factors that strongly affect cost (e.g. size, context and service level). [They need **"WSUD cost estimates"** – see Section 4.5 for a description.]

✓	x	x
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2) **High-level decision-makers / planners** (e.g. strategic planners): They also need **"WSUD cost estimates"**, but need to be able to access this information directly (e.g. via a downloadable database) rather than through specialist modelling software. They also need good information about how these costs are spread over time for planning purposes.

✓	x	x
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3) **Detailed design, construction and maintenance professionals** (e.g. designers, construction project managers and maintenance coordinators): They require more detailed estimates of capital and maintenance costs. Specifically, the TAC and TAM cost elements need to be broken down into typical 'bills of quantities' and lists of unit rates, respectively. They also need to be able to access this information directly. [Construction practitioners need **"WSUD construction rates estimates"** and maintenance practitioners need **"WSUD maintenance rates estimates"** – see Section 4.5.]

✓	✓	✓
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Possible LCC tools:

[see Section 4.6 for more information.]

1) Downloadable national WSUD spreadsheet / database for LCC information. Provides information to generate "WSUD cost estimates", as well as more detailed "WSUD construction / maintenance rates estimates" (see Section 4.5). [Recommended tool.]

✓	✓	✓
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2) On-line spreadsheet / database for WSUD cost and performance information (an extension to tool no. 1, like the USA's www.bmpdatabase.org).

✓	✓	✓
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3) Strengthened LCC modules in existing WSUD design tools (note: such tools could use the information from tool no. 1).

✓	x	x
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4) Handbook of rates (i.e. a WSUD 'Rawlinson-type handbook' for detailed design, construction and maintenance professionals).

✓	✓	✓
(would satisfy some stakeholders in this stage)		

5) Example 'bill of quantities' for WSUD assets.

✓	✓	x
(would satisfy some stakeholders in this stage)	(would satisfy some stakeholders in this stage)	

6) Provision of model plans, specifications, procedures and standard drawings with locally applicable costing information in regions across Australia.

✓	✓	✓
(would satisfy some stakeholders in this stage)	(would satisfy some stakeholders in this stage)	(would satisfy some stakeholders in this stage)

5. Recommendations

The following recommendations are made to the Steering Group of the national LCC initiative for WSUD (see Section 2.2).

1. Reconvene the Steering Group to discuss the implications of the needs analysis and agree on the actions required to progress the initiative over the next 12 months. The project plan in Section 6 aims to assist this process.
2. Focus on developing the first tool listed in Section 4.6 (i.e. the downloadable spreadsheet / database linked to a national LCC website), as the primary tool to service all stakeholder needs. Features of this tool would include:
 - a) Having two levels of cost information:
 - i. “WSUD cost estimates” for users like conceptual designers and strategic planners who need to be able to quickly generate reasonable LCC estimates.
 - ii. “WSUD construction / maintenance rates estimates” for users like construction managers and maintenance coordinators who need a more detailed breakdown of cost items and relevant rates.
 - b) The tool would have a single base date for all cost estimates. It would also be designed to undertake a LCC analysis for a single asset, but could export costs into an Excel spreadsheet where the cost of several assets (e.g. those in a treatment train) could be easily added. The tool would also clearly indicate whether its cost estimates are based on actual costs or expert estimations.
 - c) Users of the tool would be given access to a user’s manual / guideline, worked examples and possibly an on-line video providing a brief overview of the tool. The guideline would explain how to use the tool, the basis for estimates, caveats and limitations. It would also provide the equations embedded in the tool, like the MUSIC software’s user’s manual.
 - d) Users of “WSUD cost estimates” (e.g. conceptual designers, strategic planners, developers, etc.) would be able to obtain estimates for the following costs: TAC¹² (split into design costs and construction costs), TAM (split into building phase costs, establishment maintenance costs, operational costs and routine maintenance costs), RC, DC and therefore, LCC. They would also be able to access several sets of these cost elements. These sets would relate to: WSUD asset size; geographic location (tropical, subtropical and temperate); development context (greenfield, brownfield, retrofit, streetscape and lot); design (current best practice design and common, outdated designs); service level (high and standard); topography (flat, moderate and steep); and soils (standard and challenging).

These users would also be provided with information on real discount rates and the frequency of renewal costs (RC). Cost estimates and numerical cost-size relationships (algorithms) would be in a form that could be directly imported into design models such as MUSIC. Outputs of the tool would include graphical presentations of how costs are distributed over time, as well as numerical outputs that could be directly exported into Excel. These users would pay a relatively modest fee to access high-level costing information.
 - e) Users of “WSUD construction / maintenance rates” (e.g. designers, construction managers, maintenance coordinators) would also be able to obtain more detailed estimates by accessing: templates bills of quantities (for detailed design and construction); and unit rates for WSUD-specific items (for maintenance and asset management).

¹² For explanations of these acronyms, see Section 1.3.

For the *construction* phase: Typical bills of quantities would be provided for each common WSUD asset type. Cost rates would be provided for WSUD-specific items only (e.g. bioretention filter media). Cost rates for typical civil and landscape activities (e.g. earthworks) will not be provided because these costs rates can be accessed through other existing information sources (e.g. Rawlinson's Australian Construction Handbook). So, this level wouldn't provide these users with a lot more new costing information. These users would also be provided with information on contingency budgets to cover unforeseen construction costs.

For the *maintenance* phase: Typical unit rates would be provided for each common WSUD asset type. These rates would relate to typical maintenance activities¹³. Information would also be provided on the frequency of maintenance activities and their timing after construction, as well as the necessary human and equipment resources. Users would also be able to access several sets of these unit rates. These sets would relate to: WSUD asset size; geographic location (tropical, subtropical and temperate); season (wet and dry); maintenance context (isolated and small assets, clusters of small assets, and medium to large assets); ease of access (good and difficult); and service level (high and standard). The list of unit rate estimates that the tool produces would be structured into categories that reflect common maintenance contracts (e.g. costs associated with civil and landscaping works). So, it would provide these users with a lot more new costing information.

- f) The tool would always allow users to enter local cost information in preference to default values if they wished to take this option. It would also automatically capture this information so that it can be easily accessed when future versions of the national tool are being prepared.¹⁴
3. Establish a national WSUD costing website (e.g. www.WSUDcost.com.au) that has a clear identity as the primary source of up-to-date information on the cost of WSUD assets in Australia. This website would not be owned or branded by any one WSUD capacity building program, as this may diminish its reputation as a national resource.
4. As an interim measure, place on the website information relating to: the national WSUD costing project; and all *readily available* costing resources (e.g. published papers on life cycle costing, case studies with costings, the best available size-cost relationships, links to relevant web sites, etc.). Several leading water agencies and consultants have such information that could be contributed.
5. Focus on finding a lead agent / major sponsor to help fund and maintain the proposed costing tool. Options include an industry association such as IPWEAQ, eWater, a research group, a major water agency, the Commonwealth government, or a private company. Significant investment will be required to build the costing tool and gather enough costing data so that it is a useful tool when first released. This step is therefore critical in the delivery and future of the tool. A well considered strategy is needed to identify possible sponsors / lead agents and seek their assistance.
6. Prepare a brief for a software engineer to build the LCC tool. This brief would include a detailed description of the *framework / template* needed to obtain user inputs, present cost estimates (i.e. cost elements and unit rates) and capture locally obtained data for various WSUD assets.

¹³ These activities have been documented in recently developed guidelines such as *Maintaining WSUD Assets* and *Rectifying WSUD Assets* (see www.waterbydesign.com.au).

¹⁴ Previous attempt is to gather LCC data from practitioners in Australia have found that this process is ineffective unless it is *very easy* for these practitioners to assist. The envisaged process involves simply asking practitioners to provide a digital copy of their database if they have entered locally derived costing information.

It is likely this framework / template would be prepared as a spreadsheet in Excel. This work is needed to get a reliable estimate of the cost to build the tool.

7. Prepare a business case to support responsible investment in the development of the tool. It is likely that a business case will be needed to secure investment from funding organisations and an 'owner' of the tool. The business case would also address key issues such as ownership of intellectual property, risks, maintenance of the tool, and pricing.
8. Assuming a sponsor and funding is available to proceed with the development of the tool, commission: its development using specialist software engineers; and the first phase of data collection to populate the first version of the tool. This first phase of data collection could involve:
 - a) Gathering data from two groups of practitioners in several cities (i.e. construction and maintenance service providers)¹⁵.
 - b) Initially gathering LCC data for three, high priority asset types (e.g. bioretention systems, constructed wetlands and stormwater recycling systems).
 - c) Providing the practitioners with a template that reflects the structure of the new costing tool (in paper or electronic format) and asking them to provide cost estimates using real data where possible, and expert estimates / quotes where real data is not available. This process would ensure that cost estimates would be available for all combinations of factors (e.g. geographic location, service level, design, etc.). This process would seek to gather real costing information from approximately 10 examples of each asset type (e.g. bioretention systems) per city.
9. Analyse the collected costing data, and develop numerical relationships (algorithms or 'rules of thumb') between cost elements / unit rates and the factors that affect these costs (e.g. size, geographic location, service level, design, etc.).
10. Add the numerical relationships to the tool and trial it. It is anticipated that the trial process would only take a month, assuming a range of industry stakeholders were willing to test the tool.
11. Develop a user guideline / manual and worked examples of how to use the tool. The user's manual for the MUSIC software provides a good example of how this can be done.
12. Develop a short guideline for regulators that describes the costing information that regulators should require from developers, and how the tool should be used in this process. Linking the tool to regulatory processes across Australia is important for its uptake by industry and therefore its long-term sustainability.
13. Prepare a marketing strategy to promote the tool and educate stakeholders on its use.
14. Launch the tool in accordance with the marketing strategy.

¹⁵ The number of cities would reflect who is funding the work. Ideally, they would span tropical, subtropical and temperate climatic zones. Based on previous experience, leading practitioners would need to be paid for their time to do this task well.

6. Revised project plan

Given below is a project plan which focuses on the tasks that could be completed in the next 12 months (i.e. Tasks 1 to 5). It is consistent with the recommendations provided in Section 5. It does not address the tasks needed to *maintain* the online costing tool once it is established (e.g. every 5 years), which includes the process of progressively building the quality and scope of costing information in the tool.

Task Summary	Products	Timeframe	Resources
<p>1. Reconvene the project's Steering Group. Review the recommendations of the needs analysis and proposed project plan. Determine the next steps to be taken.</p>	<ul style="list-style-type: none"> ▪ Agreed tasks to be undertaken in the following 12 months. ▪ Finalised project plan. 	Late 2010.	Minimal if done as a telephone meeting.
<p>2. Establish a national WSUD costing website. a) Establish a website / on-line resource centre that can provide a central point to access up-to-date Australian WSUD life cycle costing data, tools and other resources (e.g. key papers, costing guidelines, summarised costing information, etc.). b) Add all <i>easily accessible</i> costing data to the site (e.g. key documents). c) Provide details of the national costing project on the site.</p>	<ul style="list-style-type: none"> ▪ On-line resource centre for WSUD practitioners across Australia. 	Late 2010.	Minimal (mainly in-kind resources). Allow \$5,000 to gather easily obtainable resources. The eWater CRC has previously offered to assist with this task given their information technology capacity and experience.
<p>3. Find a lead agent / sponsor. Develop and implement a strategy to identify a suitable lead agent / major sponsor to help fund and maintain the costing tool. It is likely that this task would be undertaken in two phases. First, a short list of possible sponsors would be identified through a series of face-to-face discussions at an executive level. Second, an agreement would be reached following the preparation of a business case for the tool (see Task 5).</p>	<ul style="list-style-type: none"> ▪ A lead agent / sponsor who is prepared to contribute to the development and maintenance of the tool. 	First phase: Late 2010. Second phase: Late 2011.	First phase: Minimal (mainly in-kind resources). Executive involvement would, however, be needed. Some travel expenses would also be involved (allow \$2,000).
<p>4. Prepare a brief for a software engineer (including a framework / template). Develop a detailed brief for a software engineer so that a quote can be attained for the tool's development cost. This brief would describe the framework of the tool, features, etc. in detail as a spreadsheet in Excel. It therefore represents a significant task.</p>	<ul style="list-style-type: none"> ▪ A framework / template in Excel to communicate the features and structure of the tool to the software engineer. ▪ A written brief. ▪ A quote (or quotes) from software engineers to prepare the tool. 	Mid 2011.	Allow \$20,000.
<p>5. If necessary to secure investment, prepare a business case. As the development of the tool is likely to be a significant investment which will require ongoing maintenance, potential sponsors will probably request a business case.</p>	<ul style="list-style-type: none"> ▪ A business case for the development and maintenance of the tool. 	Late 2011.	Allow \$15,000.
<p>6. If tool is funded: Commission the development of the tool's software. The cost and timing of this task would be informed by the quote(s) obtained via Task 4.</p>	<ul style="list-style-type: none"> ▪ A trial software tool. 	Mid 2012.	Unknown at this stage.
<p>7. If tool is funded: Commission the first phase of data collection. This task is described in Recommendation no. 8 (see Section 5). The cost would depend on the number of cities that are involved, which would probably be affected by the source of funding. Ideally, data would be collected in the five largest cities plus a city in a tropical climatic zone (e.g. Townsville).</p>	<ul style="list-style-type: none"> ▪ Costing data to initially populate the tool for bioretention systems, constructed wetlands and stormwater recycling systems. 	Mid 2012.	Allow \$25,000 per city.

National Needs Analysis: Life Cycle Costing Data and Tools For Water Sensitive Urban Design Assets

Task Summary	Products	Timeframe	Resources
8. If tool is funded: Analyse the costing data and develop numerical relationships to include in the tool.	<ul style="list-style-type: none"> ▪ Numerical relationships to include in the tool (e.g. size-cost algorithms). 	Late 2012.	Allow \$10,000 per city.
9. If tool is funded: Trial and finalise the tool.	<ul style="list-style-type: none"> ▪ A finalised version of the tool. 	Early 2013.	Allow \$3,000 plus some in-kind resources from users who test the tool.
10. If tool is funded: Develop a user's guideline / manual and a separate guideline for regulators.	<ul style="list-style-type: none"> ▪ A user's guideline / manual with worked examples. ▪ A guideline for regulators. 	Early 2013.	Allow \$15,000.
11. If tool is funded: Prepare a marketing strategy to alert potential users to the tool's existence and benefits.	<ul style="list-style-type: none"> ▪ A marketing strategy. 	Early 2013.	Minimal (mainly in-kind).
12. If tool is funded: Launch the tool.	<ul style="list-style-type: none"> ▪ A fully operational tool which <i>initially</i> would provide good costing estimates for three types of WSUD asset. 	Mid 2013.	Allow \$5,000 as a contingency for troubleshooting as the tool gets used. Allow \$5,000 for targeted marketing.

7. References

- Australian Standards (1999). *AS/NZS 4536:1999 Life Cycle Costing – An Application Guide*. Standards Australia, Homebush, New South Wales.
- Colmar Brunton (2005). *Water Sensitive Urban Design: Research into the Barriers to Adoption, Opportunities and Stakeholder Needs in South East Queensland*. Report for the Moreton Bay Waterways and Catchments Partnership, Brisbane, Queensland.
- Lloyd, S. (2001). *Water Sensitive Urban Design in the Australian Context. Synthesis of a Conference Held 30-31 August 2000, Melbourne, Australia*. Cooperative Research Centre for Catchment Hydrology, Melbourne, Victoria.
- Lloyd, S., Wong, T., & Chesterfield, C. (2002). *Water Sensitive Urban Design – A Stormwater Management Perspective*. Technical Report No. 02/10. Cooperative Research Centre for Catchment Hydrology. Melbourne, Victoria.
- Taylor, A. (2003). *An Introduction to Life cycle Costing Involving Structural Stormwater Quality Management Measures*. Cooperative Research Centre for Catchment Hydrology, Melbourne, Victoria.
- Taylor, A. (2005). *Guidelines For Evaluating the Financial, Ecological and Social Aspects of Urban Stormwater Management Measures to Improve Waterway Health*. Technical Report 05/11. Cooperative Research Centre for Catchment Hydrology, Melbourne, Victoria.
- Taylor, A. (2010). *Life Cycle Costing Information and Tools to Help Drive Water Sensitive Urban Design: A Workshop to Design a National Project*. Draft workshop report for the 'WSUD Program' capacity building program (Sydney Metropolitan Catchment Management Authority), New South Wales.
- Taylor, A., & Fletcher, T. (2007). Estimating life cycle costs of stormwater treatment measures. *Australian Journal of Water Resources*, 11(1), 79-92.
- Water by Design (2009). *Meeting the Proposed Stormwater Management Objectives in Queensland: A Business Case (Version 1, Draft)*. South East Queensland Healthy Waterways Partnership, Brisbane, Queensland.
- Wong, T. (2001). A changing paradigm in Australian urban stormwater management. Keynote address in *Proceedings of the 2nd South Pacific Stormwater Conference*, Auckland, New Zealand, 27-29 June, available at www.toolkit.net.au.