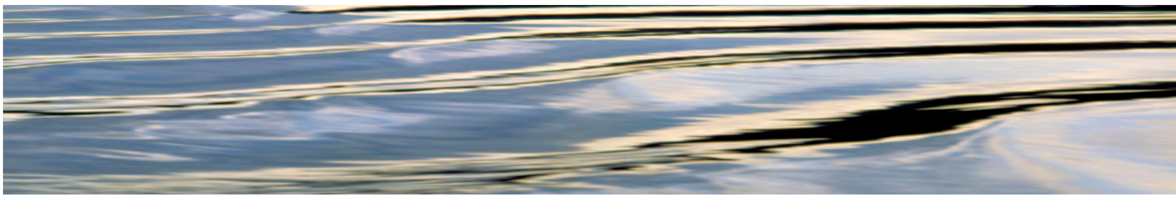
COOPERATIVE RESEARCH CENTRE FOR **CATCHMENT HYDROLOGY**

GUIDELINES FOR EVALUATING THE FINANCIAL, ECOLOGICAL AND SOCIAL ASPECTS OF URBAN STORMWATER MANAGEMENT MEASURES TO IMPROVE WATERWAY HEALTH

TECHNICAL REPORT
Report **05/11**
September 2005

André Taylor



COOPERATIVE RESEARCH CENTRE FOR
CATCHMENT HYDROLOGY

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Guidelines for Evaluating the Financial, Ecological and Social Aspects of Urban Stormwater Management Measures to Improve Waterway Health

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> "The challenge for stormwater managers of the next century, will be to integrate the multiple objectives of equity, environmental integrity and economic efficiency into water cycle management decisions for the future"
>
> *(Gomboso and Morrison, 1996, p. 231)*

Preface

Increasingly, urban stormwater managers in Australia are seeking to make decisions about the use of management measures within the context of the so-called 'triple-bottom-line'. That is, such decisions consider the potential financial, social and ecological impacts.

The Cooperative Research Centre for Catchment Hydrology (the CRC) has developed these guidelines to assist triple-bottom-line assessment of new stormwater projects that aim to improve waterway health. For example, the assessment process may be used to help choose a design of a stormwater treatment and re-use system or the location of new infrastructure. The guidelines are flexible enough to be used on structural and non-structural projects.

These guidelines allow users to choose one of three levels of assessment which are commensurate with the scale, complexity and potential impact of the project. This approach has been taken to allow stormwater managers to find an appropriate balance between the degree of rigour undertaken in the assessment and the resources needed to undertake the assessment.

To assist the financial element of the assessment, a life cycle costing module has recently been built into version 3 of the CRC's MUSIC model (i.e. the 'Model for Urban Stormwater Improvement Conceptualisation': see www.toolkit.net.au). This module allows users to estimate likely cost elements and the overall life cycle cost of common structural stormwater measures to improve waterway health. This module was developed following an analysis of the cost of Australian measures, and the development of algorithms that relate the size of measures to their cost elements.

For the financial, social and ecological elements of the assessment, these guidelines explain how to use a multi criteria analysis procedure as a decision support tool. Users will also need to make reference to other sources of information when using the procedure (e.g. expert opinion, local stakeholder opinion, outputs from pollutant export models such as MUSIC, relevant ecological objectives for stormwater management, relevant environmental valuation studies, etc.). Guidance on key sources of information and appropriate stakeholder participation techniques have been built into the assessment procedure.

These guidelines also contain condensed information from the literature on a wide variety of costs and benefits that may result from stormwater projects (i.e. externalities) to help stormwater managers make decisions during the assessment process. This is needed as high-quality, local benefit-cost data on social, ecological or water infrastructure-related externalities is often not available and/or not practical to collect given the resources typically available to stormwater managers (e.g. time and money).

These guidelines, supported by the new life cycle costing module in MUSIC should substantially assist urban stormwater managers to make more structured, informed, rigorous, participatory, transparent, defendable, socially acceptable, ecologically sustainable and more cost-effective decisions.

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1. Introduction

1.1 Aim of the Guidelines

These guidelines primarily aim to provide urban stormwater managers with a step-wise process and supporting material to assess the merits of proposed stormwater management measures to improve waterway health within the context of the 'triple-bottom-line' (TBL). That is, the financial, ecological and social aspects of the proposed measures are systematically assessed to identify the option with the greatest net benefit. The use of such a process is part of the journey towards more sustainable urban water management in Australia.

These guidelines also aim to ensure that the assessment methodology conforms to the following *principles*. The process should:

- Be flexible to accommodate projects of different scale, so that the effort required to assess a project is proportional to its size, complexity and potential impact.
- Be described in plain English (with examples) and be practical to use in the context of stormwater management agencies, such as small to medium sized local government authorities.
- Be logical, systematic, rigorous and transparent.
- Help to increase the chances of reaching a consensus on a preferred option amongst an assessment body (e.g. an expert panel).
- Take opportunities to enhance human and social capital[1] (where practical) through the involvement of affected stakeholders, the use of experimental learning and the creation of information-rich environments for decision making.
- Be flexible enough to accommodate a wide variety of stormwater-related measures, be they structural or non-structural. In addition, the process should be developed with a view to its future modification to incorporate *any* water cycle management project.
- Encourage users to be explicit about the uncertainty associated with elements that may be used during the assessment.
- Seek to maximise the net benefit to the community from the proposed project, without compromising the principles of ecological sustainable development (including intra- and inter-generational equity) or safety.
- Encourage users to align their project objectives (and therefore their assessment criteria) with the principles of ecologically sustainable development so that the TBL assessment process can be used to examine the *relative* sustainability of options.
- Only be a decision <u>support</u> tool (not a decision <u>making</u> tool), representing a way of examining options.

1.2 The Intended Audience for the Guidelines

The primary audience for these guidelines is Australian stormwater management authorities (e.g local Councils and drainage authorities) who are proposing to invest in stormwater infrastructure and/or major non-structural projects to improve waterway health.

For example, a drainage authority may wish to assess the financial, ecological and social merits of three possible scenarios for a drainage scheme covering a large residential area:

- Traditional kerb, channel and enclosed drainage leading to a large constructed wetland.
- Source controls at the housing lot and streetscape scale (e.g. rainwater tanks, bioretention systems, and a targeted estate-scale education / participation program).
- The 'business as usual scenario' (i.e. traditional stormwater drainage with little, if any, treatment).

[1] See the Glossary in Section 5 for definitions of such terms.

Developers and their consultants may also use these guidelines (e.g. when demonstrating to the development approval authority that the chosen measures are optimal when the financial, ecological and social impacts of the proposed measures are considered). In time, development approval authorities in Australia may start to use town planning controls to require developers to undertake a TBL assessment for major stormwater, water and/or sewerage infrastructure as part of the development assessment process. Such authorities have a keen interest to ensure such infrastructure has merit when assessed against the TBL, as many of these assets soon become their responsibility.

1.3 When to Use the Guidelines

These guidelines can be used whenever a significant decision needs to be made about the most suitable stormwater management measure to use to address a given problem. Both structural and non-structural stormwater management measures can be assessed.

Typical decisions that may involve a TBL assessment for stormwater projects include:

- examining alternative strategies to deliver an existing service (e.g. litter management options in a central business district);
- asset management planning (e.g. making strategic decisions involving the selection and location of stormwater infrastructure in a given area);
- policy choices (e.g. what type of 'water sensitive' stormwater treatment designs will be encouraged in streetscapes within new estates);
- project-related choices (e.g. choosing between different stormwater treatment designs for a given site);
- major development assessment-related decisions (e.g. assessing the merits of a major stormwater treatment train that has been proposed by a developer); and
- decisions relating to the location of new services (e.g. determining the best location to spend limited stormwater funds on retrofit projects in established urban areas).

Triple-bottom-line assessment processes require a significant investment in time, regardless of the level of assessment. Consequently, the process is best suited to decisions involving larger projects or projects with potentially significant impacts. For the sake of practicality, the following thresholds are recommended to determine when to consider using a TBL assessment process on structural or non-structural urban stormwater projects:

- the total acquisition cost (i.e. capital) exceeds \$50,000; and/or
- the life cycle cost (i.e. the sum of all discounted costs over an asset's life cycle) exceeds \$100,000.

1.4 Overview of the Methodology

The process outlined in these guidelines represents a 'Multiple Objective Decision Support System' (MODSS) that uses 'multi criteria analysis' (MCA) techniques.

It is a MODSS as it:

- Is a systematic and transparent planning tool that is designed for decisions that typically have multiple and sometimes conflicting objectives.
- Provides the assessment body with a process to gather and display data to assist decision making (QDNRM & CZA, 2003).

The MCA component of the process allows options to be ranked in order of preference, through the use of assessment criteria and methods for ranking alternatives based on how well they meet these criteria (e.g. by using scores, weights and weighted summation aggregation techniques). Note however, that the value of MCA is more than just highlighting an 'optimal' alternative. The learning that takes place during the process of assessing options, particularly in a deliberative environment involving stakeholders with different skills and opinions, can be as valuable as the resulting ranked list of options (Chapman and Reichstein, 2005). As Roy (1990) stated in relation to the decision aid process, the principal aim is not necessarily to discover a pre-existing but unknown solution, but "to construct or create something which ... is viewed as liable to help an actor [i.e. participant] taking part in the decision process:

- either to shape, and/or to argue, and/or to transform his preferences; or
- to make a decision in conformity with his goals" (p. 28).

The rationale for choosing MCA over other forms of assessment (e.g. benefit-cost analysis) is briefly explained in Section 2.3 and more fully examined in Appendix A.

The assessment steps used by these guidelines are summarised in Figure 1.1. Note that for the sake of practicality, the guidelines allow the user to choose one of three possible levels of TBL assessment (i.e. 'high', 'intermediate' or 'basic'), corresponding to projects of differing size, complexity and potential impact. This is to ensure that the assessment process is as simple as possible for small projects and more rigorous for larger projects where major impacts could occur. Section 3 provides advice on how to choose a level of assessment and how to do the assessment for each level. Examples are also provided of how to apply each step in the assessment process.

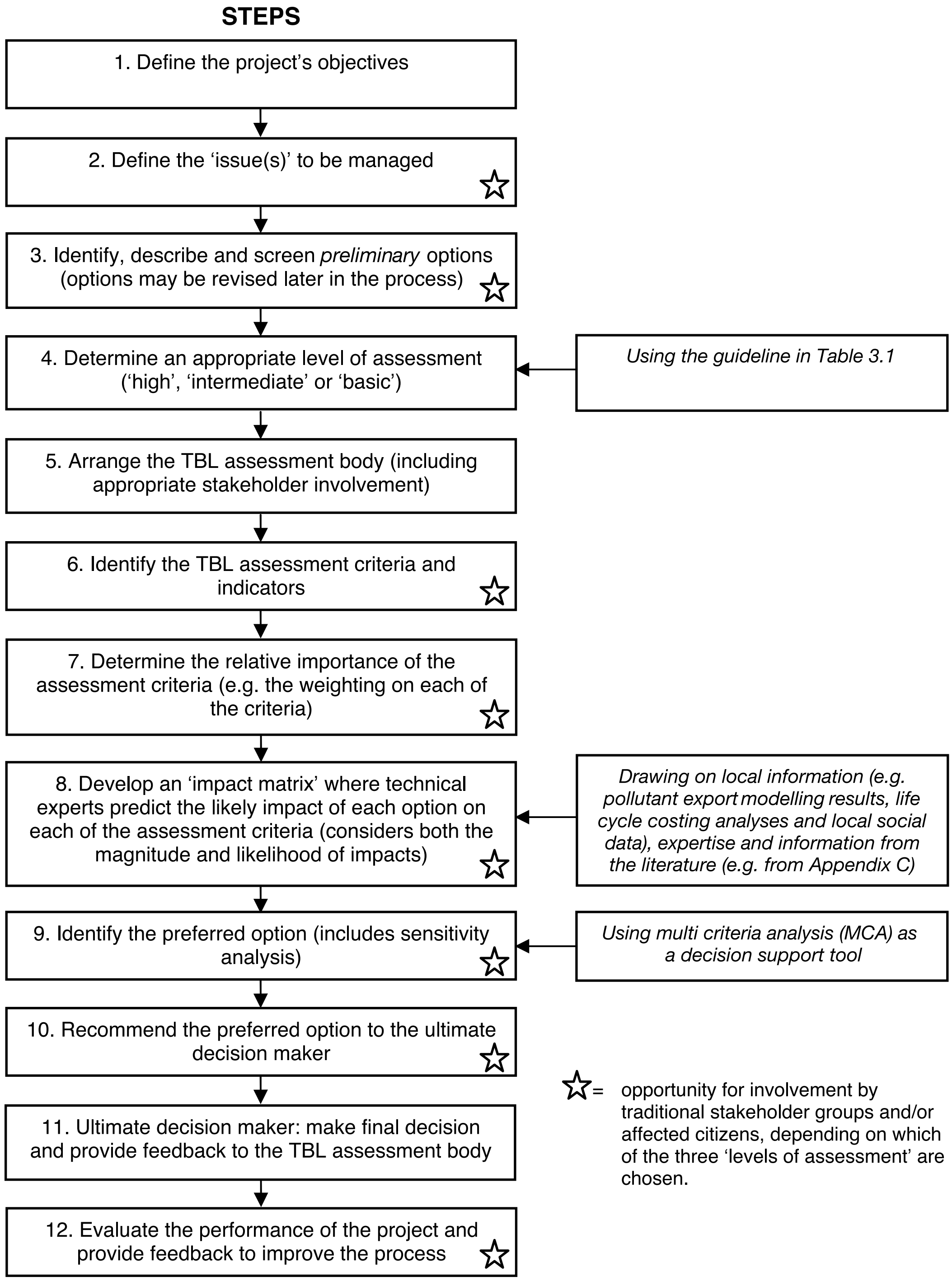
The assessment process also incorporates public participation techniques that are suitable to the chosen level of assessment. Information on relevant public participation techniques is provided in Appendix B. This information includes brief descriptions of each technique, an analysis of strengths and weaknesses, recommendations concerning their use and references for more information.

The TBL assessment process is also supported by Appendix C. This appendix summarises information from the literature on costs and benefits that may result from major stormwater projects (i.e. externalities[2]). For example, Appendix C includes a large amount of material on how various drainage designs affect residential property values in Australia and overseas. This material is provided in a condensed form to help the assessment team to make more informed decisions during the TBL process, where equivalent local information is not available.

The methodology summarised in Figure 1.1 and described in Section 3 has incorporated knowledge from many case studies and papers, the most significant of which are Renn *et al.,* (1993), Land and Water Australia (2001), Gold Coast City Council (2003) and Ashley *et al.,* (2004).

Note that a glossary is provided in Section 5 to help users understand unavoidable technical terms that are used throughout the guidelines.

[2] An 'externality' can be defined as a cost or benefit that arises from an economic transaction (e.g. the construction of a wetland by a local Council) and falls on people who don't participate in the transaction (e.g. people living next to the wetland). These costs / benefits may be positive or negative and the values affected may be tangible (i.e. have markets) or intangible.



Note: Steps in the assessment process may need to be repeated in an iterative manner (e.g. initial weightings on assessment criteria may need to be revised to accommodate views held by the assessment body that evolve throughout the process).

Figure 1.1 Overview of the Process to Undertake Triple-Bottom-Line Assessment of Urban Stormwater Projects to Improve Waterway Health

1.5 The Necessary Strategic Framework for the Guidelines

The use of these guidelines *without preceding work* cannot guarantee a good outcome. For example, the TBL guidelines could be used by a stormwater agency to choose the best stormwater management option from several very poor options.

Before using these guidelines, users in public water management agencies are encouraged to ensure that their organisation has in place a strategic framework that is characterised by the following four elements.

1. There should be a high-level, *strategic management strategy* for water / stormwater within the organisation that specifies the organisation's strategic vision and objectives. This is needed to ensure that subsequent TBL assessment criteria and weights (or rankings) are formulated by an assessment body that has a clear understanding of the 'big picture'. For example, an assessment team evaluating a major stormwater treatment and re-use project will need to be clear about the organisation's policy on energy efficiency and greenhouse gas emissions, as some re-use schemes can use a significant amount of energy.
2. A city-wide or catchment based *stormwater / water management plan* should be developed that carefully selects a suitable range of measures to tackle local stormwater-related problems. Such plans may include programs on erosion and sediment control, education and participation, water sensitive urban design, pollution prevention practices for industry, illicit discharge elimination, etc. Guidelines on developing stormwater-related plans of this type are available in Victoria, Western Australia, Queensland, the United States (e.g. US EPA, 2004), and are being developed in New South Wales.
3. For stormwater-related capital works programs that are run by stormwater management authorities, a *city-wide / catchment-based process* should be in place to generate and short-list sites for possible projects.
4. An organisational culture should be fostered that is prepared to invest in a structured, transparent and rigorous assessment process, involving stakeholders with varying skills and opinions.

Once these elements are in place and a significant decision needs to be made (e.g. a choice between several designs for a major stormwater treatment project) TBL assessment guidelines can then be used to undertake a detailed assessment of the pros and cons of the options. If the organisation's strategic framework is sound, the TBL guidelines should help to select the best of several very good options that have been generated to meet specific, local needs.

1.6 Development of the Guidelines

In March to June 2005, a draft version of these guidelines was trialled in Brisbane. The trial involved an 'intermediate level' assessment[3] that examined the relative merits (using financial, social and ecological assessment criteria) of seven alternative designs for stormwater management within medium density, greenfield residential areas of Brisbane (including the 'business as usual' case for reference purposes).

Real, local examples were used to allow an Expert Panel of 15 people to carefully assess the seven options and to enable social data to be collected from residents who lived next to different stormwater designs. Two workshops were also held involving the general public and consultation was undertaken with traditional stakeholder groups to ensure the proposed assessment criteria were sound (i.e. addressed all relevant issues) and to determine appropriate weights for each of the 14 assessment criteria. In addition, pollutant export modelling and life cycle costing work was commissioned and information was gathered from the literature (via Appendix C) to support the assessment process.

[3] Assessment levels are explained in Section 3, Step 4.

The aims of the trial project were to:

- Test and refine the draft TBL assessment guidelines.
- Use the trial to provide a forum to highlight, debate and potentially resolve specific obstacles to the adoption of common water sensitive design features in Brisbane (e.g. specific asset management and maintenance concerns with grassed swales in residential areas).
- Use the opinions and knowledge of local technical experts, the general public, traditional stakeholder groups and members of the community who live adjacent to these designs to assess the financial, ecological and social ‘pros and cons’ of the design options in order to rank them.
- Help inform policy and design decisions in Brisbane (and elsewhere) regarding preferable designs for stormwater management in medium density, greenfield residential areas.

As a result of the trial, the following modifications were made to the guidelines:

- The order of some tasks were slightly modified to increase efficiency.
- The importance of screening out options that do not comply with the guiding principles of ecologically sustainable development or are unsafe was emphasised in Step 3.
- Modifications were made to the use of the ‘risk matrix’ in Step 8.
- Significant improvements to the recommendations relating to sensitivity analysis were incorporated in Step 9.
- Recommendations relating to the use of ‘intuitive ranking’ were included in Step 9.

2. Background

2.1 The Triple-Bottom-Line Approach

The term ‘triple-bottom-line’ was first coined by John Elkington in the late 1990s (see Elkington, 1999). He described the TBL approach as: “At its narrowest, the term triple bottom line is used as a framework for measuring and reporting corporate performance against economic, social and environmental parameters ... At its broadest, the term is used to capture the whole set of values, issues and processes that companies must address in order to minimise any harm resulting from their activities and to create economic, social and environmental value. This involves being clear about the company’s purpose and taking into consideration the needs of all the company’s stakeholders” (ICLEI, 2003, p. 2).

In practice, TBL frameworks are flexible tools that can be used for corporate planning, corporate reporting, and decision making where sustainable development is the primary objective.

Note that in these guidelines, ‘TBL’ is used to refer to the trinity of financial, social and ecological elements (c.f. economic, social and environmental). This reflects the reality that:

- ‘economic’ considerations may incorporate social, ecological and/or financial elements (e.g. an economic study may seek to value social costs and benefits); and
- ‘environmental’ considerations commonly incorporate social values (e.g. aesthetics) and ecological values (e.g. waterway health).

Traditionally, decisions involving urban stormwater infrastructure in Australia have been made by technical experts using tools such as benefit-cost analysis (BCA) with little public participation. In addition, traditional benefit-cost assessments usually struggle to adequately quantify costs and benefits other than the asset’s direct costs (e.g. total acquisition cost and typical annual maintenance cost). That is, practitioners struggle to quantify in monetary terms relevant social costs / benefits, ecological costs / benefits or externalities associated with water-related infrastructure (e.g. reduced need for down-stream stormwater detention facilities and/or up-stream water supply infrastructure because of the use of estate-scale stormwater treatment and reuse facilities).

A move away from this approach and towards assessment methodologies that incorporate the TBL is occurring in more progressive organisations around the world (Environment Australia, 2003; ICLEI, 2003; and Clarke, 2001). Increasingly, these methodologies also incorporate an element of public participation (e.g. involvement of stakeholders by participating in the assessment process or by being consulted during the assessment). The importance of such public participation in the delivery of sustainable urban water management initiatives is now well recognised, especially those techniques that create an environment for deliberation and learning (Marks, 2004).

These trends are likely to be a reflection of:

- The widespread adoption of the guiding principles of ecologically sustainable development by government agencies.
- A greater acceptance of the inherent value of public participation in government decision making as an expression of a healthy democracy, a way of building human and social capital, and a way of helping to build a consensus.
- The need for rigorous, transparent and accountable decision making in natural resource management, given the intense scrutiny management agencies can receive from community groups, the media and political parties.
- The recognition that for sustainable outcomes in the area of urban water management and water sensitive urban design, a multi-disciplinary approach to decision making is essential. Multidisciplinary design teams typically include people with the skills necessary to consider the financial, ecological and social implications of major decisions.

- The widespread use of 'triple-bottom-line reporting' within organisations (Environment Australia, 2003)[4].
- The increasing number of project objectives for major infrastructure projects (e.g. water quality improvement, aesthetics, safety, research value, etc.) and availability of relevant information that creates a need for a process that can manage multiple objectives and systematically assess a wide variety of information in different forms (e.g. monetary values, qualitative information and expert opinion) and with different levels of confidence.

In addition, for modern *stormwater projects* that aim to improve waterway health, a greater need for TBL assessment tools has arisen because of:

- An increased focus on managing urban stormwater at the source (e.g. at the lot or streetscape scale), which brings the treatment and/or re-use measures closer to residents and necessitates that their design also meets social expectations (e.g. regarding aesthetics, safety, nuisance flooding, odour, etc.).
- An increased focus on integrated water management involving the total water cycle during the design of new developments which increases the complexity of decision making and the need for flexible and relatively simple decision support methodologies.

Potential benefits of taking a TBL approach to performance reporting and decision making (e.g. between design options for a stormwater project) include:

- A TBL framework can help to ensure an organisation's vision, values and actions / projects are consistent with each other (e.g. TBL assessment processes for proposed projects can use information on the organisation's values that reflect its overall strategic vision).
- A TBL assessment process can help to improve stakeholder relations through open communication channels, greater transparency and improved accountability.
- A TBL assessment process can help improve communication pathways within organisations, helping to breakdown 'silos' that may exist around functional groups or disciplines.
- TBL frameworks can help to identify and consider the tradeoffs between, or relative importance of, the different 'bottom lines' by an organisation (Ministry for the Environment, 2002).
- TBL assessment processes can encourage innovation, as it can challenge the status quo. Case studies indicate that taking a TBL approach can spark new ideas (e.g. solutions to drainage identified by Christchurch City Council in New Zealand as reported in ICLEI, 2003).
- Case study information suggests that a strong organisational commitment to TBL assessment methodologies can help to attract and retain high-calibre employees (ICLEI, 2003), possibly because such an approach is consistent with the core values of such employees.
- A TBL framework can help to improve governance by public organisations. For example, the widespread use of a TBL assessment methodology such as the one outlined in these guidelines would result in an organisation demonstrating characteristics identified by the United Nations as being reflective of good governance, namely transparency, equity, effectiveness and efficiency, accountability, strategic vision, consensus orientation and participation (ICLEI, 2003).
- TBL assessment processes that use multi criteria analysis, can manage qualitative and quantitative information and involve deliberative public participation methods to create a learning environment that can help to "bridge the gap between calculation and communication" (Holz *et al.,* 2004, p. 47). The importance of a process that

[4] For example, according to Environment Australia (2003), 45% of the world's largest 250 companies in 2003 reported on their ecological and/or social impacts as well as their financial performance (up from 35% in 1999).

accommodates participation by stakeholders is stressed by Loucks (2000) who stated that the quest for sustainable development involves multi-objective tradeoffs in a multi-disciplinary setting where "no single discipline, and certainly no single profession or interest group, has the wisdom to make these tradeoffs themselves. They can only be determined through a political process involving all interested and impacted stakeholders" (p. 3).

TBL assessment processes also have their weaknesses, although these do not appear to be hindering their popularity at present. These include:

- the resources (e.g. time and expertise) needed to undertake the assessment process, particularly if many assessment criteria and/or stakeholders are involved;
- poor acceptance of the process by stakeholders who have skills and experience in benefit-cost analysis and/or are more comfortable making decisions in isolation from non-technical stakeholders;
- some debate about the appropriateness of allocating equal weight to the three dimensions of the TBL;
- some debate about whether such processes can be used to assess the 'relative sustainability' of options (see Section 2.3); and
- no guarantee of a sustainable outcome (Donnelly and Boyle, 2004; Pope, 2003; Cobiac, 2005).

2.2 The Current Status of the TBL Approach

Since the late 1990s, the TBL approach has been used most widely in the context of corporate performance reporting. Uptake of this approach has been most rapid in the private sector (e.g. 72 of Japan's top 100 companies now produce TBL reports). Uptake in local government has been relatively slow, with a survey in 2003 indicating that only 14% of Australian Councils were active in relation to TBL reporting or decision making (ICLEI, 2003). Despite this, some Councils have made significant progress. For example the City of Melbourne (Vic), Lake Macquarie City Council (NSW) and Manningham City Council (Vic) have incorporated TBL into their annual reporting processes. In addition, the City of Melbourne has been very active in the development of an online TBL toolkit (www.melbourne.vic.gov.au) which includes a simple 'sustainability assessment' process for proposed capital projects that are valued over $20,000 (City of Melbourne, 2003).

In recent years there has been increasing interest in using a TBL framework in Australian decision making processes, such as master planning and assessing proposed capital works. Typically, multi criteria analysis is used within the context of the TBL to guide such processes. Examples where such approaches have recently been used in the context of urban water management include:

- CSIRO's Geelong Region Stormwater Reuse Project: Indented Head Pilot Study (Maheepala *et al.,* 2004), which involved a TBL multi criteria analysis to select an option that best meets a set of criteria that were based on principles of sustainable development.
- The Waterfuture project in the Pimpama Coomera region of the Gold Coast where a TBL multi criteria analysis was used to evaluate integrated water cycle management options at the master planning stage (GCCC, 2003).
- City of Melbourne's sustainability assessment process for proposed capital works. This process includes a sustainability statement to identify the extent to which the proposal would contribute to Council's identified sustainability objectives and the levels to which impacts are managed (City of Melbourne, 2003). A similar multi criteria capital works evaluation process also exists in Auckland, New Zealand (Infrastructure Auckland, 2003).
- Brisbane City Council's Rochedale Master Plan Project, which was similar in nature to the Waterfuture project (BCC, 2004).
- A trial project to evaluate the feasibility of applying a multiple objective decision support system to evaluate management options for sewage overflow abatement in the Brisbane region (CRC-CZEWM, 2003).

- A desk top TBL multi criteria analysis to screen potential management practices that could be used on the Swan Coastal Plain in Perth to minimise the discharge of nutrients in stormwater and groundwater into receiving water bodies (Parsons Brinkerhoff and Ecological Engineering, 2004).
- A TBL assessment of recycled water options in Melbourne, including the assessment and ranking of projects for the Melbourne Metropolitan Recycling Strategy (Chapman and Reichstein, 2005).
- A TBL assessment of sustainable wastewater management strategies for coastal towns in the Gippsland region by South Gippsland Water (McRae and McKaige, 2005).

In 2004, a detailed assessment guideline that considered financial, social and ecological aspects of water-related projects was released in Europe as part of the Sustainable Water industry Asset Resource Decisions (SWARD) project (Ashley *et al.,* 2004). This guideline primarily assists major decisions involving urban water supply and sewerage-related assets. An equivalent Australian assessment guideline for water and sewerage-related decisions is currently being developed by the Water Services Association of Australia (P. Donlon, pers. comm., 2004).

The CRC for Catchment Hydrology's TBL assessment guidelines for stormwater projects benefited from the findings of the much larger SWARD project. For an analysis of the similarities and differences between the two assessment guidelines, see Taylor and Fletcher (2005).

Assessment guidelines that seek to evaluate financial, ecological and social dimensions of alternative water management strategies often re-group or add to the three elements of the TBL. For example:

- in New Zealand, indigenous 'culture' is separated from the 'social' dimension to create a quadruple-bottom line;
- the European assessment guidelines resulting from the SWARD project (Ashley *et al.,* 2004) include the three dimensions of the TBL as well as a 'technical' dimension; and
- the Australian assessment guidelines for water supply and sewerage-related decisions being developed by the Water Services Association of Australia are likely to include the three dimensions of the TBL as well as a 'health' dimension (P. Donlon, pers. comm., 2004).

A significant body of literature is accumulating on possible frameworks for grouping criteria and indices during assessment processes that examine financial, social and ecological dimensions (see Cobiac, 2004). In a multi criteria analysis framework, however, how the assessment criteria are grouped (e.g. within a triple or quadruple-bottom-line framework) is of little importance compared to the *weight* that is placed on each of the criteria.

2.3 TBL Assessment Methodologies and Sustainability

Occasionally, TBL assessment systems are promoted as tools that will help to identify a 'sustainable option' for an urban water management problem. There are several flaws with this suggestion.

Firstly, there is considerable uncertainty over what a truly 'sustainable' water management solution is (Ashley *et al.,* 2002a). Consider the core objectives of Australia's National Strategy for Ecologically Sustainable Development (DEH, 1992):

- To enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations.
- To provide equity within and between generations.
- To protect biological diversity and maintain essential ecological processes and life-support systems.

Such vague objectives of sustainability result in uncertainty over the exact destination that water managers must work towards, but a relatively clear understanding of the direction that journey must take.

Consequently, urban water managers are seeking to determine 'comparative sustainability' (see Ashley *et al.*, 2002b), that is, to determine which options are furthest along the journey towards the lofty goal of sustainable development. TBL assessment methodologies are a tool that can be used to do this, but as argued by Pope (2003), Donnelly and Boyle (2004), and Cobiac (2004), they do not guarantee an outcome that is sustainable in terms of the local economy, ecology and/or social well-being.

Secondly, TBL assessments only evaluate relative sustainability if the assessment criteria are aligned with widely accepted objectives and principles for sustainable development. The TBL assessment guidelines in Section 3 recommend that two sets of objectives be defined at the start of the process: project-specific objectives (e.g. "to protect downstream platypus habitat by maintaining the current hydrologic regime and water quality"); and broad sustainability objectives (e.g. "to provide equity within and between generations"). This way, the assessment criteria can be developed to reflect specific, local stakeholder needs as well as the broader goal of sustainable development.

Finally, as explained in Section 1.5, it is incorrect to assume that a well designed TBL assessment process will always identify a good option. For example, such a process may be scoped to rank a set of poor options. Section 1.5 highlights four elements of a strategic framework that should be created in an organisation or region to create a management environment where TBL assessment guidelines can be used most productively.

2.4 Rationale for the Use of Multi Criteria Analysis

The decision support methodology adopted in these guidelines is primarily based on multi criteria analysis (MCA). Appendix A explains why this methodology was chosen in preference to methods such as benefit-cost analysis or cost-efficiency analysis. In summary, these reasons include:

- MCA has the ability to manage multiple and sometimes competing objectives.
- MCA has the ability to easily incorporate a wide variety of decision criteria that can be expressed in qualitative and/or quantitative forms.
- MCA logically and transparently structures decision making processes based on how most people normally make complex decisions.
- MCA has the ability to consider the views of more than one person and can help to build a consensus amongst a group of people (as well as build awareness, knowledge and skills).
- MCA can easily incorporate a deliberative element into the assessment process, to allow for the construction of preferences in an environment where the best available information is presented and there is opportunity for discussion and learning.
- MCA can accommodate the philosophical view that in a healthy democracy it is a right for citizens to be involved in decisions involving policies or projects that have the potential to significantly affect them.
- MCA highlights tradeoffs between criteria during the process and makes these the focus of attention and discussion.
- MCA can easily incorporate consideration of intra-generational and inter-generational equity (i.e. two principles of ecologically sustainable development).
- MCA explicitly separates facts from values.
- MCA provides an alternative to time-consuming, expensive uncertain and sometimes controversial valuation methods that seek to place a monetary value on services that do not exist in a market (e.g. traditional 'willingness to pay' studies).
- MCA can clearly highlight the uncertainty associated with information used during the assessment process, and show how this uncertainty can influence the ranking of options.
- MCA can accommodate a wide variety of methods to analyse the sensitivity of the results.

- MCA has recently been shown to be a *practical* way to consider the TBL for major decisions involving stormwater in Australia (e.g. see the projects highlighted in Section 2.2).

Multi criteria analysis does have its weaknesses. For example:

- Considerable time may be needed to undertake the analysis, especially when numerous assessment criteria and stakeholders are involved.
- The process can be, or seems to be, too complex to some stakeholders.
- Some inputs to the process may be difficult to obtain from stakeholders (e.g. subjective assessments of the relative importance of criteria).
- In a group decision making setting, stakeholders may engage in 'strategic gaming' (e.g. while putting weights on criteria).
- There is no guarantee of a clearly preferred option. In addition, the final ranking of options from the MCA may not align with the 'intuitive ranking' of the assessment body, which may undermine the credibility of the process in the eyes of some stakeholders.
- Stakeholders may not wish to participate (e.g. they may believe their input will not be considered by the ultimate decision maker).
- Where stakeholders are involved, the process relies on a good facilitator.
- Decision makers who are used to making decisions on stormwater projects in isolation (i.e. technical experts) may be uncomfortable with involving other stakeholders in the assessment process and/or incorporating elements that are subjective (e.g. decision criteria on aesthetics, inter-generational equity, etc.).
- How options score against assessment criteria can be affected by the choice of the scoring system (e.g. how a 1 to 10 scoring scale is devised for criteria such as the "life cycle cost", "safety", etc.).
- The mathematical method used to rank the options (e.g. 'aggregate value / utility function models', such as multi-attribute utility theory, the simple multiple-attribute rating technique and the analytical hierarchy process, and 'out-ranking methods' such as Electre and Promethee) may influence the ranking order of options.

Nevertheless, in the context of significant stormwater management decisions, such weaknesses are easier to address than the weaknesses associated with other methods (Holz *et al.*, 2004).

3. A Procedure for Undertaking a TBL Assessment

This section provides a 12 step procedure on how to undertake a TBL assessment for stormwater projects that aim to improve waterway health. A brief overview of the procedure is also provided in Section 1.4 and Figure 1.1.

wo worked examples are provided for each step in text boxes. These worked examples will focus on 'basic' to 'intermediate' levels of assessment, as they are likely to be the most common types of assessments done in Australia in the foreseeable future. **Note that the *same* two examples are used throughout the 12 steps in the process.**

Step 1: Define the project's objectives

Clearly define the objectives of the assessment project with reference to the outcomes that are being sought. Such objectives should address *all three* dimensions of the TBL (i.e. the financial, social and ecological dimensions).

It is recommended that a two-stage approach be used for setting objectives.

Firstly, generate a set of specific objectives to meet local needs for each dimension of the TBL. For example, "to ensure the load of phosphorus entering the downstream estuary is minimised".

Secondly, review the broad objectives and principles of 'ecologically sustainable development' (ESD) as outlined in Australia's National Strategy for ESD (DEH, 1992). These are summarised in Appendix D. Ensure that the specific, local objectives:

- Reflect the three core objectives of ESD (i.e. mirror them, or are more specific versions of them). If necessary, add some objectives to meet this requirement. For example, "to ensure costs and benefits of the project are shared fairly between the existing community as well as between the existing community and future ones" (i.e. a broad inter- and intra-generational equity objective).
- Are consistent will all of guiding principles of ESD.

The advantages of this approach are twofold. Firstly, by having assessment objectives consistent with the objectives and principles of ESD, the TBL assessment process can be used as a broad indicator of *relative* progress towards the goal of ESD. Secondly, it prompts the user to check that the specific local objectives are consistent with the high-level objectives and principles of ESD that have been endorsed by all three tiers of government in Australia (e.g. in the 'Intergovernmental Agreement on the Environment' that was signed in 1992).

With respect to setting specific *ecological objectives*, care should be taken to ensure these reflect the best available science and local policy. Significant work is currently being done on setting such objectives within regions of Australia, so consultation with local waterway health managers is recommended. For example, a recent decision support framework has been drafted for use in NSW (Walsh *et al.*, 2004) that guides users through a process to select suitable ecological objectives. According to this framework, projects that aim to protect the ecological health of wetlands, estuaries, lakes or the ocean should focus on managing average annual loads of stormwater pollutants (especially nutrients and total suspended solids). While projects that aim to protect the ecological health of streams and rivers should try to keep the effective imperviousness[5] in the catchment below thresholds that are known to be associated with rapid degradation of in-stream ecological health (such thresholds are derived from local scientific research).

[5] A glossary of technical and uncommonly used terms is provided in Section 5.0.

EXAMPLE ONE

Fletcher Park: The project's objectives are: "To select a conceptual design for a small retro-fit project involving a stormwater treatment train within the Fletcher Park precinct that:

- Minimises life cycle costs to Council over a 30 year period.
- Meets the local community's expectations in terms of aesthetics, safety, odour, recreational opportunities, flooding and impacts on the value of local property.
- Ensures the costs and benefits of the project are shared fairly between the existing community as well as between the existing community and future ones.
- Improves the ecological health of Mitchell's Creek by seeking to disconnect the upstream impervious area of the catchment from the downstream creek (e.g. through vegetated stormwater conveyance and treatment measures) so that the effective imperviousness of the catchment is minimised (the goal is ≤ 2% based on local scientific research).
- Improves the ecological health of Deletic Bay by minimising the annual average load of total nitrogen, total phosphorus and suspended sediment entering the bay to 2.2, 0.2 and 90 kg/Ha/year, respectively."

EXAMPLE TWO

Pleasantville: The project's objectives are: "To select a preferred, generic conceptual design for stormwater treatment in any new, medium density residential areas of Pleasantville that:

- Minimises life cycle costs over a 30 year period.
- Maintains the existing drainage function for removing stormwater from property.
- Meets the local community's expectations in terms of aesthetics, safety, maintenance, nuisance flooding, recreational opportunities, constraints on land use (e.g. on-street parking) and impacts on the value of local properties.
- Ensures the costs and benefits of the design are shared fairly between the existing community (e.g. ensuring designs do not discriminate against people with disabilities) as well as between the existing community and future ones.
- Protects or improves the ecological health of downstream waterways (i.e. creeks, rivers and estuaries) as a result of stormwater detention, treatment and/or reuse.
- Maximises stormwater re-use.
- Minimises environmental impacts during construction, operation and maintenance.
- Is compatible with the city's strategic vision."

Step 2: Define the 'issue(s)' to be managed

Clearly define the issue(s) being addressed by the stormwater project (e.g. the nature of waterway degradation that is to be improved by the project). This is needed to allow the people undertaking the TBL assessment to evaluate how effective each option is likely to be.

The amount and detail of information gathered and documented for this step will need to be scaled to meet the project's 'level of assessment' (see Step 4). For example, the information needs of a project undergoing a 'basic' level of assessment involving the choice between three possible types of underground gross pollutant trap would be far less than a project undergoing a 'high' level of assessment that involves choosing a design of a $2M constructed wetland with a variety of stormwater reuse and recreational features in a flood-prone, established urban area.

Accordingly, it is recommended that at *this stage*, the issues be quickly identified and documented assuming a 'basic' level of assessment. Step 2 can be revisited, if necessary, once the level of assessment has been finalised in Step 4.

For projects involving a 'high' level of assessment, where technical experts and a small number of citizens are involved in the assessment process, *detailed briefing information* will typically need to be prepared that articulates the:

- ecological issues to be managed by the project (e.g. in terms of the receiving water body's need for pollutant load reduction, stormwater flow attenuation, reduction of pollutant concentrations, etc.);
- social context in which the project must be delivered (e.g. the local social profile as well as the local community's concerns about issues such as flooding and safety);
- nature of the site's physical environment (e.g. its hydrology, ecology, geology, topography, etc.); and
- constraints on the project (e.g. financial, political, legal, etc.).

EXAMPLE ONE

Fletcher Park: The assessment manager (Project Engineer) for the Fletcher Park project talks to her colleagues in Council (e.g. the local maintenance engineer and Council ecologist) and briefly documents the key issues that she will need to consider during the assessment of options (i.e. as part of a 'basic' level of assessment). These issues include:

- The nature of ecological issues (e.g. the nature of downstream waterways, their environmental values and the key threats to these values).
- The key social issues that Council is aware of in the area (e.g. safety, the need for a crossing for pedestrians, aesthetics and the need to maintain or decrease the flood risk to properties).
- The nature of the site's physical environment (e.g. its hydrology, ecology, geology, topography, etc.).
- The nature of the downstream stormwater drainage network (e.g. drainage capacity, existence of detention basins, flood history, etc.).
- Constraints on the project (e.g. a modest maintenance budget for stormwater measures).

EXAMPLE TWO

Pleasantville: The assessment manager for the Pleasantville project chooses several real case study sites to assist in the assessment process (i.e. sites that represent different design options). He prepares background information on the nature of the key issues for a panel of experts to consider (i.e. as part of an 'intermediate' level of assessment). This background information is summarised in a PowerPoint® presentation that addresses:

- The need for the treatment of urban stormwater in the region (e.g. to protect the health of creeks, rivers and estuaries).
- Concerns over the maintenance of certain design features (e.g. swale cross-overs, vegetated treatment measures).
- Concerns over the effectiveness of some stormwater treatment measures to protect local ecological values.
- Concerns over the ability of disabled people and parents with prams to move around the streetscape when swales / bioretention systems are used along the roadside (and no footpaths).
- The uncertainty associated with community acceptance of different types of stormwater treatment measures particularly in the streetscape.
- The nature of the different design options that are currently being debated amongst technical staff in Council and why resolution of the debate is needed.

Step 3: Identify, describe and screen preliminary options

Identify and clearly describe the options that are to be assessed to manage the issues highlighted in Step 2. In most circumstances, it will be instructive to also include a 'do nothing' and/or a 'business as usual' option[6]. For example, new water sensitive stormwater design options may be assessed alongside a traditional design option (i.e. the 'business as usual' option). In assessment studies where all options clearly have a net benefit, the 'do nothing' option may be excluded, as such assessments are seeking to determine the option with the greatest net benefit on a TBL basis.

This step is a critical point in the assessment process as it is the stage with the greatest potential to generate benefits (Crown Corporation Secretariat, 1993). Techniques to generate (or reconsider) potential options include:

- brainstorming;
- critical analysis of key components of the issues being managed;
- collaboration amongst diverse groups (e.g. ecologists, town planners, landscape architects, civil engineers, academics, local residents, etc.);
- lateral thinking; and
- pragmatic design (i.e. the use of existing available knowledge and methods without innovation).

Brainstorming is a simple and widely used technique to generate options using a team of people who can offer different perspectives[7]. For stormwater projects, this is typically done by a group of technical experts in a workshop setting, or via an opportunities report prepared by a team of expert consultants.

The options generation stage should consider using source controls (as well as in-system controls) and non-structural controls (as well as structural controls) for stormwater management. It should also be kept in mind that the *National Water Quality Management Strategy - Australian Urban Stormwater Management Guidelines* (ARMCANZ & ANZECC, 2000) recommends the following hierarchy be applied when developing options to manage stormwater quality:

- *Retain and restore valuable ecosystems* [Highest management priority]: That is, protect or rehabilitate valuable elements of the stormwater system, such as watercourses, wetlands and riparian vegetation.
- *Source control - non-structural measures:* That is, apply non-structural techniques to limit adverse changes to the quantity and quality of stormwater at or near the source (e.g. the use of regulation, education and enforcement activities to minimise littering along with structural measures).
- *Source control - structural measures:* That is, install constructed measures at or near the source to manage stormwater quantity and quality (e.g. porous paving, rain gardens, rainwater tanks, etc.).
- *In-system control - structural measures* [Lowest management priority]: That is, install constructed measures within, or at the end of stormwater systems (e.g. constructed wetlands and ponds) to manage stormwater quantity and quality before it is discharged into receiving waters.

Note that subsequent involvement by stakeholders in the assessment process (e.g. during Step 5) may alter the list of options undergoing assessment. The assessment process should always be run in a flexible manner so that new or modified options with potential merit can be included at any stage. This may mean revisiting steps in the process.

A screening stage is recommended as part of this step to:

- reduce the number of potential options down to a manageable size, particularly if modelling is envisaged as part of the assessment process (e.g. pollutant export modelling); and

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[6] 'Business as usual' refers to the scenario that is traditionally used (e.g. traditional kerb, channel and piped drainage on residential subdivisions as opposed to 'water sensitive' alternatives).

[7] For more information on how to undertake the brainstorming technique, see the Citizen Science Toolbox at www.coastal.crc.org.au/toolbox/index.asp.

- remove options from the assessment process that clearly fail to meet critical objectives (e.g. safety, protection of ecosystem health, inter-generational equity).

For the sake of practicality, it is recommended that the number of options be kept below 10, and preferably below five where possible.

To screen a list of preliminary options, two alternatives are available.

The first alternative is a formal approach, where a small set of 'Mandatory Project Outcomes' (MPOs) are defined that potential projects must have a reasonable probability of meeting for them to be considered in the assessment process. A list of typical TBL assessment criteria is provided in Table 3.1 (with more detail provided in Table C.1 in Appendix C). This list, along with knowledge generated from Step 2, can be used to generate a set of MPOs that are relevant to the project.

The assessment manager or a group of technical experts (for more complex projects) should screen the preliminary options against each of these MPOs using a simple 'yes' / 'no' assessment process. Only those options that are likely to meet all of the MPOs should be assessed in the following steps. Note that for many stormwater projects this process will eliminate the 'business as usual' option as it typically fails to meet MPOs relating to protection of ecological health and/or inter-generational equity (as options that degrade ecosystem services disadvantage future generations).

The alternative screening approach is a simple, informal approach, where the assessment manager or a group of technical experts (for more complex projects) discuss the options and reduce them to a smaller set that *intuitively* appear to:

- have the best chance of providing the greatest net benefit given the project's objectives (determined in Step 1); and
- provide an acceptable level of performance against all of the non-negotiable project objectives (e.g. those relating to safety and protection of ecosystem health).

EXAMPLE ONE

Fletcher Park: As an illustration of the formal, MPO approach, consider the Fletcher Park example. In this example, the funding for the project originates from a grants program with specific conditions (e.g. an upper limit on cost). Given this context, the assessment manager defines the following four MPOs:

Financial

1. The project's capital cost must not exceed $250,000 (in 2005 dollars).

Social

1. The project must not reduce the flood immunity of residential properties in the area.
2. The project must not increase the risk that someone may drown in the stormwater drainage network.

Ecological

1. The project must reduce the average annual loads of total nitrogen, total phosphorus and suspended sediment entering the Deletic Bay to at least 2.2, 0.2 and 90 kg/ha/year, respectively).

The assessment manager uses these MPOs to screen 10 preliminary design options that were developed by herself with input from her colleagues in Council with skills and experience in civil engineering, ecology, stormwater maintenance, hydrology, stormwater quality management and landscape design. Screening produces a shortlist of three options. The assessment manager believes that all three will clearly have a net benefit, so a 'do nothing' option is not included in the set of preliminary options to be assessed against the triple-bottom-line.

EXAMPLE TWO

Pleasantville: As an illustration of the informal approach, consider the Pleasantville example. In this example, 15 possible stormwater designs are discussed amongst a group of technical experts. They are asked by the project manager to consider how they will perform given the objective of the design (as outlined in Step 1). The group conclude that:

1. Some of the options are redundant (as there are other options that are clearly superior).
2. Some options could not be entertained on road-related safety grounds alone.
3. The 'business as usual' scenario should be excluded from the assessment, as it fails to meet the objectives relating to ecological health and inter-generational equity.

As a result, the preliminary options were narrowed down to six (all of which include rainwater tanks on residential lots):

1. Traditional kerb and channel drainage with enclosed drainage leading to a small, local constructed wetland.
2. Traditional kerb and channel drainage with enclosed drainage leading to a large, regional constructed wetland.
3. Roadside bioretention swales.
4. Bioretention systems within the centre of the road (median strip).
5. Bioretention 'pods', located on both sides of the road at a spacing of 30 metres.
6. Street tree bioretention systems, located on both sides of the road at a spacing of 7.5 metres.

Table 3.1 Possible TBL Assessment Criteria for Typical Urban Stormwater Projects to Improve Waterway Health

Category	Possible TBL Assessment Criteria to Assess the Project's Performance Against Objectives *(Note: these criteria can be assessed in a qualitative or quantitative manner)*
Financial (i.e. project costs and values that are relatively easy to express in financial terms)	The life cycle cost of the project over a given life cycle / span (note that to properly compare alternative stormwater projects, the time period over which the life cycle costing analysis is undertaken needs to be the same). For details on how to calculate a life cycle cost for stormwater projects, see Taylor (2003).
	The equivalent annual payment cost (i.e. the life cycle cost divided by the life cycle / span).
	The total acquisition cost (i.e. the initial capital cost including all costs associated with feasibility studies, design and construction).
	The typical annual maintenance cost (this may include an energy cost component for stormwater reuse projects).
	The cost of land occupied by the stormwater management measure (may include the cost of the land and the cost of not being able to use the land for another purpose).
	Savings associated with a reduced need for reticulated potable water (may include the avoided cost of using mains water as well as avoided costs associated with water supply infrastructure).
	Changes to the value of nearby properties as a result of the project.
	The ability to fund / resource the asset's costs over the whole life cycle.
	Savings associated with a reduced need for downstream stormwater detention (typically only relevant to large stormwater reuse projects that detain stormwater on-site during large storm events).
	Savings associated with a reduced need for maintenance of downstream stormwater infrastructure and waterways (e.g. due to reduced downstream erosion associated with small, frequent storm events).
	Hidden costs (e.g. costs associated with taxes, delays in gaining a development approval, environmental permits, environmental monitoring, environmental management during construction, insurance, etc.).
	Contingent costs (e.g. possible additional costs relating to construction, environmental fines, property damage, legal expenses, etc.).
	Changes to annual property rates of nearby properties due to changes in their value.
	The impact on the rate of sales for lots / houses on new estates.
	The organisation's exposure to financial risk.
Social (i.e. 'use values' that relate to people's quality of life)	The impact on the area's general amenity / liveability (a broad social criterion that reflects many of the more specific criteria in this table).
	The impact on the safety of people using the area (e.g. the risk of drowning).
	The impact on the health and well-being of nearby residents who may be affected by disease vectors (e.g. mosquitoes), pests and odours.
	The impact on the area's aesthetic values.
	The intra-generational equity associated with the project. That is, ensuring the benefits and costs of the project to the community are equally shared rather than one part of the community experiencing substantial costs / benefits compared to the broader community (e.g. substantially elevated property values in the immediate vicinity of a public project or disadvantaged disabled citizens as a result of a new design).
	The inter-generational equity associated with the project. That is, ensuring the project produces costs and benefits that are equally shared by current and future generations. For example, ensuring an option does not degrade ecosystems services within a local estuary, so that future generations are unable to enjoy these services.
	The impact on passive and active recreation around the stormwater asset (e.g. walking, jogging, cycling, bird-watching, etc.).
	The impact on individual and community well-being and welfare (e.g. social cohesion and economic prosperity).
	The impact on research and/or educational opportunities (e.g. in association with a constructed wetland).
	The maintenance burden for local residents (e.g. maintaining grassed swales in the road reserve).
	The inconvenience associated with nuisance flooding (e.g. temporarily ponding in swales outside of residential premises).
	The inconvenience to people using the road reserve (e.g. car parking may be restricted due to the presence of stormwater treatment measures).
	The impact on transport opportunities along and/or through the waterway / drainage corridor (e.g. walkways, cycle paths and bridges).
	The acceptability to stakeholders of the project.

Table 3.1 Possible TBL Assessment Criteria for Typical Urban Stormwater Projects to Improve Waterway Health (Cont...)

Category	Possible TBL Assessment Criteria to Assess the Project's Performance Against Objectives *(Note: these criteria can be assessed in a qualitative or quantitative manner)*
	The impact on the area's cultural and spiritual values (indigenous or otherwise).
	Likelihood of associated behavioural change and/or participation by local stakeholders.
	Flexibility of the project to accommodate changing social expectations over its life cycle.
	The impact on commercial fishing, aquaculture and/or recreational fishing in affected receiving waters.
	The impact on swimming and/or boating in affected receiving waters.
	The impact on tourism and/or water-based transport in affected receiving waters.
	The risk of vandalism and/or theft in association with the stormwater infrastructure (e.g. theft of release nets).
	Impact on the availability of shallow groundwater for local reuse.
	Shading / cooling, air quality improvement and carbon sequestration benefits from the use of *vegetated* stormwater treatment measures (e.g. wetlands, street trees that filter road runoff, etc.).
	The magnitude of greenhouse gas emissions associated with the project's power use (potentially relevant to stormwater reuse projects with electric pumps).
Ecological (i.e. 'intrinsic values' that do not relate to the current use of ecosystem services by people)	The impact on the ecological health of affected local and/or regional ecosystems (i.e. the impact on the "existence value" of these ecosystems). Several *secondary* criteria and indicators may be developed to assess the likely impact on ecological health. For example, the loads of nutrients entering downstream wetlands could be used as a secondary criterion. In this case the indicator could be kilograms of nitrogen and/or phosphorus per hectare per year, as estimated by modelling. For examples of typical ecosystem health indicators of fresh water, estuarine and marine systems, see the 'Ecological Health Monitoring Program for South East Queensland' (EHMP, 2004).
	The impact on the value of having healthy aquatic and riparian ecosystems for potential use in the future (i.e. the impact on the "option value" of these ecosystems).
	The impact on the value of providing future generations with healthy aquatic and riparian ecosystems (i.e. the impact on the "bequest value" of these ecosystems).
	Ecological impacts associated with the project's materials, wastes and/or energy use during construction, operation, maintenance and/or decommissioning.

Notes:

- This list is not exhaustive, it has been provided to assist the assessment body to develop a manageable set of the most relevant and potentially significant assessment criteria for a given project.
- Care must be taken to avoid 'double counting' values which results from using overlapping criteria (e.g. aesthetic values and changes in nearby property values). If this is unavoidable, the weight placed on the criteria in the TBL assessment process (see Step 7) should reflect the degree of overlap.
- Table C.1 in Appendix C lists typical values that are affected by urban stormwater projects that aim to improve waterway health (such as those given above) and also indicates whether they are likely to be a benefit or a cost, whether they are usually considered an 'externality', and where they occur (i.e. upstream of the asset, within and immediately around the asset, and/or downstream of the asset). Reviewing Table C.1 may also be of assistance when first generating a list of possible assessment criteria.

Step 4: Determine an appropriate 'level of assessment'

Using the guidelines in Table 3.2, determine which of the three levels of assessment best suits the nature of the project. This choice will have major ramifications in terms of the resources needed to run the assessment process, the degree of rigor involved in the assessment, and the extent of involvement by stakeholders.

The three choices are: 'basic', 'intermediate' or 'high' levels of assessment. These levels have been defined so that the guidelines are practical for projects of all scales.

When using the guidelines in Table 3.2 it is likely that a project will meet some of the criteria for more than one level. The key is to choose a level that <u>best</u> matches the project.

Experienced stormwater managers who are comfortable with using these assessment guidelines may wish to adopt a process that borrows elements from more than one level and/or modify the elements from one level (e.g. use alternative public participation techniques). For most users however, it is recommended that just one level be chosen and the guidelines for that level be followed.

Feedback from the urban stormwater industry in Australia has stressed the need for the TBL assessment process to be as simple as possible; otherwise it is likely that it will not be used in the long term. Accordingly, if a proposed project is equally suited to two assessment levels, it is recommended that the *less rigorous level* of assessment be undertaken at least until users are familiar with the assessment process. Similarly, if users are concerned about limited resources to run the assessment process (e.g. time, money, people and available skills), they should ensure that they choose a level of assessment that they are *confident they can complete* given available resources.

EXAMPLE ONE

Fletcher Park: For the Fletcher Park scenario, the assessment manager consults with her colleagues in Council, reviews the aspects listed in Table 3.2 and concludes:

- The maximum capital cost of the project has been set at $250,000 (i.e. on the border of the 'basic' and 'intermediate' levels of assessment).
- The project best suits an 'intermediate' level of assessment for the aspects of: potential maintenance concerns, potential political impact, likely impact on the local community (and likely level of concern) and potential impact on ecosystems.
- The project best suits a 'basic' level of assessment for the aspects of: impact on the wider community, impact on the urban water cycle, organisational culture and available resources for the assessment.

Given the project appears to suit either a 'basic' or 'intermediate' level of assessment, but resources (i.e. time and human resources) are only available for a 'basic' level of assessment, a 'basic' level is chosen.

EXAMPLE TWO

Pleasantville: For the Pleasantville example involving a policy decision, the assessment manager reviews Table 3.2 and concludes:

- The capital cost of the project has the potential to be greater than $1,000,000 (i.e. consistent with a ‘high’ level of assessment), as the policy decision has the potential to influence numerous stormwater designs across the city in the future.
- The project also best suits a ‘high’ level of assessment for the aspect of potential maintenance concerns.
- The project best suits an ‘intermediate’ level of assessment for the aspects of: potential political impact, likely impact on the local community (and likely level of concern), impact on the wider community, potential impact on ecosystems and impact on the urban water cycle.
- In terms of the organisation’s culture and how supportive it is of involving technical experts, traditional stakeholders and affected citizens in the assessment process, influential staff members within the organisation would currently be more comfortable with a level of assessment that involves high levels of consultation (e.g. an ‘intermediate’ level of assessment), rather than participation of non-government stakeholders in the assessment team (i.e. a ‘high’ level of assessment).
- In terms of available resources from the assessment, the assessment needs to be done in two months (i.e. consistent with an ‘intermediate’ level of assessment), but $30,000 has been allocated to support the assessment process given the significance of its outcome (i.e. consistent with a ‘high’ level of assessment). This funding could be used for facilitation of expert panel meetings, engaging specialist consultants to help with the expert panel, gathering local data to support decision making (e.g. social data, results from pollutant export modelling, life cycle costing analyses, etc.).

After careful deliberation, the assessment manager concludes that the ‘intermediate’ level of assessment would best suit the project. In particular, it would be more compatible with his organisation’s culture and timeframe for the assessment.

Table 3.2 Guidelines to Help Determine the Most Suitable Level of Assessment

Aspects to Consider *(in no particular order)*	**Level of Assessment for Urban Stormwater Projects That Aim to Improve Waterway Health**		
	'Basic' level of assessment	**'Intermediate' level of assessment**	**'High' level of assessment**
Capital cost of the project	< $250,000.	$250,000 to $1,000,000.	>$1,000,000.
Potential maintenance concerns	Minor. The options being assessed involve maintenance practices that are well accepted and/or minor in nature.	Moderate. The options being assessed involve maintenance practices that are relatively new and/or a source of concern to some stakeholders.	Major. The options being assessed involve maintenance practices that are a major concern to stakeholders because they are controversial, poorly understood, not costed, relatively expensive and/or potentially dangerous.
Potential political impact (most relevant to government funded projects)	Minor. Positive or negative political impacts are very unlikely and would be minor in nature.	Moderate. Local Councillor(s) would want to be consulted. There is potential for moderate political impact (positive and/or negative).	Major. The project is likely to be of acute interest to local Councillor(s) and they will want to have a close involvement with the project through its design and delivery.
Impact on the local community and likely level of concern	Minor. It is unlikely that any member of the community would demonstrate a strong preference for any of the options (including the "do nothing" option).	Moderate. Local residents are likely to be affected and would want the opportunity to participate in the assessment process. The project is however, unlikely to generate strong opinions, emotions and/or conflict.	Major. The project has the potential to: significantly advantage or disadvantage local residents (e.g. by affecting safety, aesthetics, property values, etc.); and generate strong opinions, emotions and/or conflict amongst local stakeholders.
Impact on the wider community	Minor to negligible. The broader community would most likely show no interest in the project.	Moderate. Members of the broader community are likely to have a low to moderate level of interest in terms of the project's impact on their property rates, recreational opportunities, flooding, aesthetics, educational opportunities, ecosystem health, etc.	Major. Members of the broader community are likely to have a high level of interest in terms of the project's impact on their property rates, recreational opportunities, flooding, aesthetics, educational opportunities, ecosystem health, etc.
Potential impact on ecosystems	Overwhelmingly positive. The project seeks to improve the health of environmental assets, and adverse impacts (such as those caused during construction) are considered to be minor.	Generally positive. The project seeks to improve the health of environmental assets, but some adverse impacts of low to moderate significance are likely to occur (e.g. elevated temperatures in the discharge from constructed wetlands during low flow periods).	Positive and negative. The project seeks to improve the health of environmental assets, but some highly significant adverse impacts may occur and be of concern to some stakeholders (e.g. disturbance of acid sulfate soils, altering the groundwater regime near natural wetlands, and providing a mechanism to release nutrients in a form and at a time that is hazardous to ecosystems in receiving water bodies).
Impact on the urban water cycle	Negligible. The project has negligible impact on aspects of the water cycle other than stormwater (e.g. water supply and conservation, sewage treatment and reuse, greywater treatment and reuse, as well as groundwater quality and hydrology).	Moderate. The project has low to moderate impacts on aspects of the water cycle other than stormwater. For example, the project involves the use of rainwater tanks.	Major. The project has major impacts on aspects of the water cycle other than stormwater quality. For example, the project involves large scale aquifer storage and recovery.
The culture within the organisation that will manage the TBL assessment process (note that TBL assessment processes may be used as a capacity building mechanism to change such cultures)	The organisational culture best supports assessment by a technical staff member with limited input from other technical experts or representatives from traditional stakeholder groups (e.g. local catchment management groups).	The organisational culture best supports assessment by a group of technical experts with a strong commitment to *consultation* with stakeholders from the community (i.e. traditional stakeholder groups and directly affected local citizens).	The organisational culture best supports assessment by a facilitated group of representative citizens, supported by a group of technical experts and traditional stakeholder groups.
Available resources for the assessment (this aspect is likely to dictate the choice of level for many projects)	Minor. The assessment needs to be done in 1 to 4 weeks and cost <$2,000 (including on-costs / over-heads).	Moderate. The assessment needs to be done in 1 to 3 months and cost between $2,000 and $10,000 (including on-costs / over-heads).	High. The assessment needs to be done in 3 to 6 months and cost between $10,000 and $50,000 (including on-costs / over-heads).

Note: These guidelines are intended to be used in a flexible manner to prompt thought about the significance of the assessment process.

Step 5: Arrange the TBL assessment body

Arrange an 'assessment body' that is appropriate for the level of assessment. It is recommended that:

- A suitably experienced and qualified stormwater manager (e.g. senior engineer or scientist) who is committed to consulting with technical experts, community groups and members of the public (as needed) be the 'assessment body' that uses multi criteria analysis for the '*basic*' level of assessment.
- An Expert Panel (involving strong consultation with other stakeholders - both traditional stakeholder groups and affected citizens) be used as an assessment body to support multi criteria analysis for the '*intermediate*' level of assessment.
- A Small Deliberative Panel (equivalent to a scaled-down Citizens' Jury) be used as an assessment body to undertake multi criteria analysis for the '*high*' level of assessment. This panel would be supported by a group of technical experts and traditional stakeholders (i.e. an advisory group).[8]

Guidance for 'basic' level assessments:

The 'basic' level of assessment should be undertaken by an experienced stormwater manager who is committed to consulting (as needed) with:

- technical experts (e.g. experts in various disciplines from within and outside the hosting organisation);
- representatives from traditional stakeholder groups (e.g. industry groups and local catchment groups); and/or
- directly affected citizens (e.g. residents who live adjacent to the project).

Stakeholders (i.e. people whose interests are potentially affected by the decision) who will be consulted need to be identified at this point in the process. Where the identification of stakeholders is not straightforward, 'stakeholder analysis' may need to be undertaken. For advice on how to conduct this technique, see the Citizen Science Toolbox at www.coastal.crc.org.au/ toolbox/index.asp.

When stakeholders are first invited to participate in the assessment process, it should be made clear how they will be involved, who will make the final decision, how their input will be used to make the final decision, and whether they will be paid for their time. For 'basic' level assessments, typically only experts that are engaged as consultants to perform specific tasks would be paid for their time.

EXAMPLE ONE

Fletcher Park - 'basic' level of assessment: For the Fletcher Park scenario, the assessment manager is a senior engineer with experience in stormwater design and strong skills in hydrology. She identifies people within her organisation with whom she can consult during the assessment process (and during the subsequent design phase) who have complementary skills in ecology, landscape design, stormwater maintenance, stormwater quality management (including pollutant export modelling) and life cycle costing. She also identifies stakeholders external to the organisation who will need to be consulted for the project to be successful (i.e. the president of the local catchment care group, a small group of citizens who live next to the park, and the local Councillor).

[8] See Appendix B for details of relevant public participation techniques such as Citizens' Juries / Small Deliberative Panels, Expert Panels, Workshops, Delphi Studies, Fish Bowls, Consensus Conferences, Public Conversations, etc. as well as a discussion on why certain techniques have been recommended in these guidelines. Appendix B also provides guidance on how to use nine common types of public participation methods that are potentially applicable to the TBL assessment process.

Guidance for 'intermediate' level assessments:

Form two groups to help with the assessment:

- an Expert Panel consisting of relevant technical experts (e.g. in-house experts, consultants and/or academics); and
- a consultative group[9] consisting of representatives from traditional stakeholder groups and directly affected citizens who wish to be involved[10].

For the sake of practicality it is recommended that the Expert Panel be kept at or below 15 people. The participants should be chosen so that they provide the technical skills that are necessary as well as a range of possible opinions (e.g. people with concerns over 'water sensitive' design options, as well as those who are advocates for such options).

Where there are strong differences of opinions (e.g. over the merits of 'water sensitive' designs), it is recommended that the panel consist of people who have shown the capacity to clearly explain their perspective, listen to others, reason and negotiate. In addition, the relative proportion of people on the panel with a particular view (e.g. strong concerns over maintenance issues) should broadly represent the extent to which the hosting organisation holds these views.

Appointing a skilled facilitator to run the Expert Panel meetings is very important. Ideally, the facilitator would have a basic technical understanding as well as excellent communication, facilitation and conflict resolution skills. It is not recommended that the assessment manager undertake the facilitation role, as it limits the extent to which they can be actively involved in the panel's technical discussions.

EXAMPLE TWO

Pleasantville - 'intermediate' level of assessment: The assessment manager for this project organises an Expert Panel consisting of:

- a senior stormwater drainage engineer with skills in both stormwater quality and quantity management (including modern 'water sensitive urban design');
- an ecologist with a sound understanding of urban aquatic ecology, modern research findings and local ecosystems;
- a town planner with an understanding of the local community's wants and needs concerning stormwater management features in the streetscape and within areas of public open space;
- a senior maintenance engineer who has experience in maintaining stormwater assets that help to improve the health of urban waterways (e.g. swales, bioretention systems, etc.);
- a town planner and social planner;
- a senior asset management engineer who has concerns over the uncertainty associated with the performance, life span and cost of several stormwater treatment options;
- a landscape architect who has experience working with local developers, communities and development assessment officers to design appealing and functional urban environments; and
- a local consultant who specialises in water sensitive urban design.

The assessment manager also identifies external stakeholders to consult during the assessment process. These consist of:

- residents who live adjacent to examples of each of the six design options (consultation to occur in the form of a door-to-door survey);
- citizens that are broadly representative of the city's population (consultation to occur in the form of two workshops);
- representatives from the Urban Development Industry of Australia and the Stormwater Industry Association; and
- local government councillors who have expressed an interest in the issue.

The assessment manager also engages a facilitator (with a sound understanding of the technical issues) to assist with organising, running, and documenting the findings of the Expert Panel.

[9] The term 'group' is used loosely here, as the stakeholders may not need to physically meet during the project.

[10] It is acknowledged that some projects may have few, if any, community-based stakeholders to consult with. For example, stormwater projects involving large greenfield developments may have no 'affected residents' (i.e. they have not yet moved into the estate) or catchment care group (i.e. such a group may take several years to emerge).

Guidance for 'high' level assessments:

Form two groups to help with this level of assessment:

- a *Small Deliberative Panel* consisting of people that are randomly selected to be broadly representative of the affected population (i.e. citizens, not representatives from traditional stakeholder groups) and are likely to act in the *broader public good*; and
- an *advisory group* consisting of relevant technical experts (e.g. civil engineers, ecologists, town planners, landscape architects, etc.) and representatives from traditional stakeholder groups (e.g. the local catchment group and local residents group).

For the sake of practicality it is recommended that both groups be kept at or below 12 people (e.g. 8 to 12 people) and the Panel meet for less than two days (e.g. one day if possible).

To form the advisory group, determine the necessary *technical skills* that will probably be needed during the project (in the same way that the Expert Panel was constructed for the 'intermediate' level of assessment), as well as the *views* of traditional stakeholder groups and citizens with a strong vested interest that need to be understood and addressed. Identify individuals who can speak knowledgeably on their area of expertise / interest and invite them to participate in the advisory group.

The method of selecting a Small Deliberative Panel (equivalent to a Citizens' Jury where the number of people on the jury and the time commitment have been reduced) is more complex. Appendix B provides an overview of this public participation technique, while the publication titled "Consult Your Community - A Handbook: A Guide to Using Citizens' Juries" (Carson, 2003)[11] provides a more comprehensive guideline on how to establish and run a jury / panel. The key points are that the jury / panel should:

- be representative of the affected population (in general terms);
- not be told what the jury / panel is working on *during* the process of recruiting and selecting panel members (to minimise the risk of selecting a group of people whose views are substantially different from the broader community);
- not involve members of traditional stakeholder groups who represent sectional interests (they can be called on to address the jury / panel as 'expert witnesses');
- not involve people that have a *strong* self-interest in the issue, such as someone whose land may be purchased as a result of the project (they can also be 'expert witnesses'); and
- be reimbursed for their time and expenses (i.e. paid at the end of the process if they have been fully involved in the process).

For participatory techniques such as Small Deliberative Panels, it is recommended that the assessment manager prepare a plain English document that explains the process and articulates the commitments of the hosting organisation with respect to the assessment process (e.g. as part of a 'terms of reference' for the panel).[12] Financial remuneration should also be discussed and agreed at this point.

Note that Citizens' Juries, as typically used for natural resource management decisions, can be very productive but resource intensive. Consequently, for most stormwater assessment projects it will be necessary to scale-down the process set out in guidelines such as the one developed by Carson (2003). Aspects such as group size, the extent of pre-jury training, the jury's sitting time and the number of expert witness presentations can all be reduced to ensure that the technique does not become too cumbersome for the scale of the project. Commonsense and pragmatism is needed during the design of the panel / jury.

[11] Available at: www.iplan.nsw.gov.au/engagement/stories/docs/cj_handbook.pdf (June 2005).
[12] For an example see Carson (2003).

Step 6: Identify the TBL assessment criteria and indicators

Define the financial, ecological and social criteria that will allow the significant benefits and drawbacks of each option to be assessed. Such criteria should relate to the objectives of the project (see Step 1) as well as all significant stakeholder concerns and values. For example, local maintenance personnel may have concerns about possible maintenance costs and safety during maintenance. Assessment criteria can then be developed to address these concerns (e.g. "typical annual maintenance cost" and "risks to the safety of maintenance staff").

A list of possible assessment criteria that are potentially relevant to typical urban stormwater projects that aim to improve waterway health is provided in Table 3.1. This list can be used as a checklist to help the assessment body ensure that no major issues have been over-looked when assessment criteria are being generated.

Renn *et al.* (1993) recommend that 'value-tree analysis' be used for this step in the process. This technique would be most suitable for 'intermediate' and 'high' level assessments. It involves three tasks:

1. The assessment manager conducts personal interviews[13] with traditional stakeholder groups (e.g. the local catchment group, the local councillor, maintenance staff, etc.) and technical experts to identify *values* that need to be protected (e.g. aesthetics, public safety, ecological health, etc.) and possible *assessment criteria* for all three elements of the TBL. Note that the objectives of the project (see Step 1) should be aligned with these values.
2. The assessment manager structures the values and possible assessment criteria into a *hierarchy*. For example, the high level value relating to the need for "safety" may have three key assessment criteria relating to it: "risk of increased mosquitoes", "risk of accidental drowning" and "risks to maintenance staff".
3. The assessment manager consults with traditional stakeholder groups in an iterative manner until a single 'value tree' is produced that includes all *significant* values at the top and their possible assessment criteria below. It is recommended that the financial, ecological and social 'branches' of this tree be kept separate to assist the weighting process which is explained later in these guidelines.

A very simple 'value tree' for an assessment project involving several possible designs of a stormwater treatment train is provided in Figure 3.1. In this example, the treated stormwater flows into a high value stream and into an estuary.

For a 'basic' level of assessment, the identification of relevant values and assessment criteria is likely to be straightforward and may be done solely by the assessment manager. Personal judgement is needed by the assessment manager to determine how much consultation is required at this stage and who to include. If consultation is necessary, the simple one-to-one Public Conversation technique is recommended (see Appendix B for details).

For an 'intermediate' level of assessment the identification of relevant values and assessment criteria should be done initially by the assessment manager and finalised by the Expert Panel in consultation with the consultative group.

For a 'high' level of assessment the identification of relevant values and assessment criteria should be done initially by the assessment manager and finalised by the Small Deliberative Panel in consultation with its advisory group and any other key stakeholders not represented on the advisory group.

It is recommended that the number of assessment criteria be kept down to less than 15 where possible, to simplify the assessment process. The chosen assessment criteria should relate to the most significant values and concerns, but should also highlight *significant differences* between the options.

[13] See Appendix B for a description of a simple public consultation technique called Public Conversations that would be most suited to this step. Alternatively, the assessment manager could use other forms of public participation (e.g. Workshops and Delphi Studies).

Once assessment criteria are chosen, indicators can be developed for each criterion and is usually a straightforward process. For example, if a criterion is "to minimise the typical annual maintenance cost" of a constructed wetland, then a suitable indicator would be "2005 Australian dollars ($) per year". Estimates for this indicator can be easily generated using the recently developed life cycle costing module in the CRC for Catchment Hydrology's MUSIC model[14].

EXAMPLE ONE

Fletcher Park - 'basic' level of assessment: For the Fletcher Park scenario, three possible stormwater treatment train designs are to be assessed. The options involve a constructed wetland, a pond and a bioretention basin.

The assessment manager prepares a *draft* 'value tree'. This tree has three initial branches like the one in Figure 3.1 for each element of the TBL. Under each of these branches the assessment values and criteria are briefly summarised. For example, under the *financial* branch of the 'value tree', there is one high level value / concern:

- "Cost of the project to Council".

Under the "Cost of the project to Council" value / concern, the proposed assessment criteria are:

- "life cycle cost of the project (over a 30 year timeframe)";
- "total acquisition cost of the project"; and
- "typical annual maintenance cost of the project".[15]

To finalise the 'value tree', the assessment manager:

- uses Table 3.1 as a checklist to double-check that no critical values or assessment criteria have been over-looked in the draft 'value tree';
- checks that the final assessment criteria reflect the project's objectives (from Step 1) and key issues that need to be managed by the project (from Step 2); and
- talks to key stakeholders for the project (e.g. in-house technical experts, the local catchment care group and directly affected citizens near Fletcher Park) about the draft 'value tree' and makes amendments until the assessment criteria address all significant values and concerns.

[14] See www.toolkit.net.au/music for more details on the 'Model for Urban Stormwater Improvement Conceptualisation' (MUSIC).

[15] This is an example where there is some overlap between the financial criteria. The weights placed on these criteria during Step 7 should reflect this situation.

EXAMPLE TWO

Pleasantville - 'intermediate' level of assessment: The assessment manager for this project drafts a 'value tree'. To draft the 'value tree' he reviews the project's objectives (from Step 1) and key issues that need to be managed by the project (from Step 2).

He then works with the Expert Panel to refine the 'value tree' until the panel is satisfied that the assessment criteria address all of their significant values and concerns.

During this process, the assessment manager stresses to all involved that weights (or rankings) will be used to highlight the *relative importance* of these criteria during subsequent stages of the assessment process, so they need not be concerned at this stage if they believe some of the assessment criteria are trivial in nature.

An example of *one* of the values / concerns, assessment criteria and indicators is given below for the 'social' dimension of the TBL. In all, 12 assessment criteria are developed by the panel.

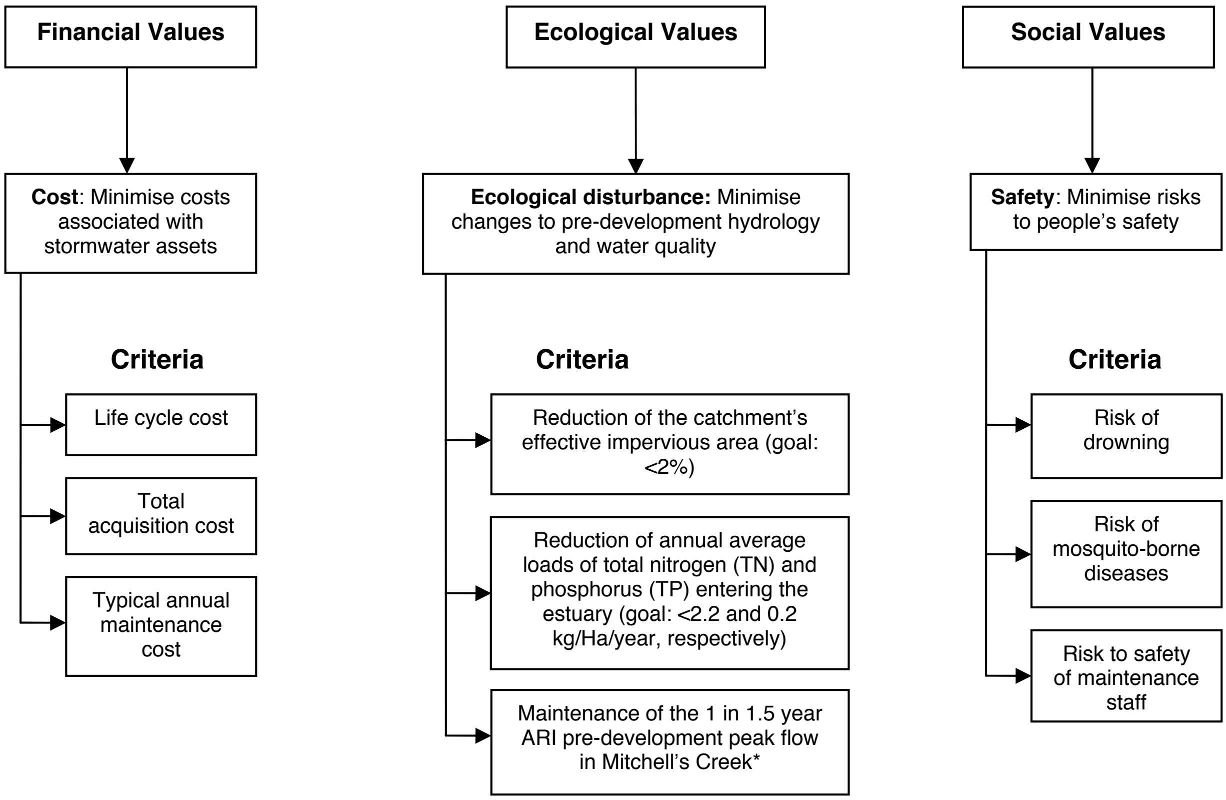
Element of the triple-bottom-line: Social.

Value / concern: Community acceptance of designs.

Assessment criteria: Over-all degree of acceptance of the design by the community in terms of aesthetics, safety, need for home-owner maintenance (e.g. a road-side swale), nuisance flooding, recreational opportunities, pests, constraints on land use (e.g. on-street parking, pedestrian access), providing habitat for animals, protecting downstream waterways and impacts on the value of local properties.

Indicator: A 1 to 5 'acceptance score' using a scoring key developed by the assessment manager. (Scoring will be done by the Expert Panel, after reviewing social data collected from a door-to-door survey of people who live next to an example of each design option. The design of the survey will generate data that allows the Expert Panel to easily score this assessment criteria.)

The panel consults with key stakeholders and the public (via two workshops) on whether the proposed assessment criteria are adequate to address all values, issues and concerns. This is done in parallel with consultation undertaken during Step 7. As a result, minor amendments are made to the wording of the 12 criteria and two more criteria are added.



Notes:

- The values and criteria in this simple example are not exhaustive, but capture the most significant aspects of the project that need to be assessed.
- * ARI = average recurrence interval.
- This example assumes the downstream environment is a high value stream that enters an estuary.
- It is important to check with leading local waterway managers to determine suitable ecological objectives, as these vary around Australia and are being revised in many regions. For more details, see the notes in Step 1.

Figure 3.1 An Example of a Simple 'Value Tree' for an Assessment Project Involving a Stormwater Treatment Train in an Established Park

Step 7: Determine the relative importance of the assessment criteria

In Step 6 assessment criteria were identified for each element of the TBL. Step 7 involves assessing the relative importance that should be placed on each assessment criterion. For example, a given stakeholder may believe that a "risk to public safety" assessment criterion is of far greater significance than a "aesthetic impact" criterion.

Guidelines for 'basic' level assessments:

For this level of assessment the assessment manager undertakes the role of assigning weights to each of the assessment criteria. He or she may choose to consult with technical experts, members of traditional stakeholder groups and/or directly affected citizens when undertaking this process.

Who is consulted and the degree of consultation is determined by the assessment manager on a case-by-case basis. This decision will typically be based on:

- the confidence the assessment manager has in his / her understanding of the issues of concern to stakeholders;
- the likely value of feedback obtained by consultation regarding the relative importance of the assessment criteria; and
- the resources required to undertake consultation (e.g. the assessment manager's time).

If further consultation is needed at this stage, recommended methods include Delphi Studies and/or Public (one-to-one) Conversations (see Appendix B for a summary of these methods).

There are many ways to assign weights to each of the assessment criteria or place the criteria in order of relative importance (e.g. see Hajkowicz *et al.* [2000b] and/or d'Angelo *et al.* [1998] for a discussion of common weighting methods). Researchers have found that decision makers typically assign similar weights to assessment criteria using different methods, but they suggest it is desirable to use more than one weighting technique, where practicable, to minimise the effect of any bias associated with a particular technique (Hajkowicz *et al.*, 2000a). A range of decision support software[16] is also available that guides people through the weighting process, provides several options for allocating weights / rankings and assists with the subsequent calculations. Guidance is given below on how to undertake a very simple weighting technique without the use of decision support software.

EXAMPLE ONE

Fletcher Park - 'basic' level of assessment: For the Fletcher Park scenario, the assessment manager uses the 'counter technique', as described in the guidelines, to allocate weights to each assessment criteria. When allocating weights she considers the views previously expressed to her by technical experts, traditional stakeholder groups (e.g. the President of the local catchment care group) and several of the directly affected citizens.

Before finalising the weights, she consults several respected in-house experts who are familiar with the project by showing them a set of draft weights. These experts ask several questions about specific weights that result in discussion, new knowledge being generated and a slight adjustment of the weights.

[16] Examples include: 'Logical Decisions', 'Logical Decisions for Groups' 'Criterium DecisionPlus', 'Expert Choice', 'Definate2'', 'Promethee' and 'Facilitator'. Note that 'Facilitator' is freeware developed by the CRC for Coastal Zone, Estuary and Waterway Management and has a user's manual (see www.coastal.crc.org.au/modss/index.html). Facilitator prompts the user to rank the criteria to assign approximate relative importance rather than prompting the user to assign a specific weighting score.

A simple method for one person to determine weights is to use 99 counters (e.g. toothpicks or plastic beads) and a sheet of paper that lists all the assessment criteria. Thirty-three (33) of these counters are then allocated to the *financial* assessment criteria in a way that reflects their relative importance to the assessment manager (i.e. important criteria attract more counters). Then, 33 counters are allocated to the social assessment criteria, and the remaining 33 counters are allocated to the ecological assessment criteria. This process ensures that the three elements of the TBL are assigned equal importance[17], but the assessment criteria within each element of the TBL are assigned weights that reflects the view of the assessment manager.

Guidelines for 'intermediate' level assessments:

For this level of assessment an Expert Panel is used to generate a set of weights for each of the assessment criteria (or alternatively, a ranking of the assessment criteria in order of perceived importance) that best reflects the *broader public good* (rather than sectional interests).

Prior to assigning weights, the panel should seek feedback from stakeholders on the relative importance of the proposed assessment criteria. It is recommended that consultation involve members of the public without a strong vested interest (e.g. via short workshops) as well as traditional stakeholder groups.

As with the method for 'basic' level assessments, the Expert Panel may choose to use decision support software to assist with the calculation of weights or simple manual alternatives (e.g. the previously described 'counter technique'). Weights are normally assigned individually within the group, given people's views on the relative importance of criteria are often quite different. Alternatively, the panel may wish to use a 'consensus rating' method (i.e. generate a consensus on the weights via discussion and debate), if a consensus amongst the panel members is likely to be easily achievable.

Guidance is given below on how to the simple 'counter technique' for allocating weights *within a group* without the use of decision support software.

A simple method to determine weights is to allocate 99 counters (e.g. toothpicks or plastic beads) to each member of the panel along with a sheet of paper that lists all the assessment criteria, and ask them to individually allocate 33 of these counters across all of the *financial* assessment criteria in a way that reflects the importance of the criteria to them as a representative of the *broader community* (i.e. important criteria attract more counters). Then, ask them to allocate 33 counters to the social assessment criteria, and the remaining 33 counters allocated to the ecological assessment criteria. Once every panel member has done this task, the weighting data are collected and analysed. The median values for weights attributed to each assessment criteria are usually used to express a 'group result'.

The opportunity should be provided throughout this process for participants to explain the reasoning behind their allocations of weights and to discuss the issues that emerge. The participants should also be allowed to repeat the weighting exercise if this discussion has led to a change in anyone's perspective.

Where weights have been individually assigned by panel members, the minimum, mode, mean and maximum weights for each assessment criterion should also be recorded (along with the median value) to enable sensitivity analysis to be undertaken later in the process.

The Expert Panel should be familiar with the project given their earlier involvement in the assessment process and therefore should require little background information (other than feedback from the consultation) or process-related training. However, they may wish to receive brief presentations (either written or verbal) from representatives of the consultative group prior to the final allocation of weights to each of the assessment criteria (e.g. where polarised views exist amongst stakeholders).

[17] This methodology is typical of modern TBL assessments that involve multi criteria analysis (e.g. GCCC, 2003 and Maheepala *et al.*, 2004) and reflects a policy position which is implicit in Australia's National Strategy for Ecologically Sustainable Development (ESD). That is, in terms of the three core objectives of ESD that address economic welfare, social welfare and ecological health, "no objective … should predominate over the others" (DEH, 1992). It is therefore recommended that this methodology be used if it is intended that the project be consistent with the objectives and principles of ESD, as articulated in Australia's National Strategy for ESD (see Appendix D).

EXAMPLE TWO

Pleasantville - 'intermediate' level of assessment: The assessment manager for this project gathers feedback from:

- people who are representative of the city's broader community (via two short workshops that are organised by a market research company); and
- representatives from traditional stakeholder groups (i.e. local councillors, the Stormwater Industry Association and the Urban Development Institute of Australia).

This consultation step undertakes two functions: it checks that the proposed assessment criteria are adequate to address stakeholder values and concerns (part of Step 6); and determines the relative importance of each criterion to each stakeholder. Consulted stakeholders are asked to give each assessment criteria a score from 0 (not important at all) to 10 (extremely important).

The Expert Panel reconvenes to finalise the assessment criteria and weights on each of the criteria. After reviewing and discussing feedback from stakeholders, the panel agree to slightly modify some criteria and add two new criteria. The panel members then individually allocate weights to each of the assessment criteria by using the 'counter technique' to assign 99 points over each of the finalised assessment criteria, with 33 points being distributed within each of the three elements of the TBL. A median value is then calculated for each criteria based on data gathered from each panel member.

The form that records each panel member's individual weights is kept available during subsequent steps in the process to allow it to be revised, should panel members change their views as a result of new information that emerges during the assessment process.

Guidelines for 'high' level assessments:

Convene a meeting of the Small Deliberative Panel (i.e. a scaled down Citizens' Jury) using a skilled, independent facilitator. Undertake the following tasks to determine the relative importance of the assessment criteria:

- Assuming the panel is meeting for the first time, briefly introduce the panel to the project and decision being made, clearly explaining their role and how their advice will influence the ultimate decision. Clearly defined 'rules' of constructive group discussion also need to be communicated. Note that depending on the panel and complexity of the issue, background training may be needed on aspects such as note taking, questioning of expert witnesses, etc. To simplify such training, written education material can be provided to participants before the event.
- Provide participants with background information on the problem being addressed, potential options, *suggested* values and assessment criteria. This may be done in written form, supported by presentations from stakeholders such as technical experts and representatives from traditional stakeholder groups. The panel should be able to request presentations from specific 'expert witnesses' if they feel they need to get another perspective. Where there is potential for controversy, the expert witnesses should represent all sides of the debate.
- Explore whether the panel can think of any more options that should be considered and include these if necessary. That is, the assessment process should be flexible to accommodate good ideas, regardless of when they emerge in the decision making process. If new options emerge, it will be necessary to briefly discuss them (within the panel and with technical experts from the panel's advisory group), determine whether these options are likely to meet the Mandatory Project Outcomes (see Step 3) and determine whether they have a realistic chance of being favoured over existing options. If the options still have merit, it will be necessary to revisit some earlier steps in the assessment process (e.g. ensure that the assessment criteria address any new concerns / values that are associated with the new options). Pragmatism is needed here, as revisiting steps in the assessment process may consume significant resources.
- Finalise the values and assessment criteria that were drafted by the assessment manager during Step 6. The panel may add new values and/or criteria. The panel may also wish to call technical experts and/or representatives from traditional stakeholder groups as 'expert witnesses' at this point. The exchange of views and constructive discussion amongst the panel should be encouraged at all times.
- Request the panel to assign weights to each of the finalised assessment criteria or place the criteria in order of relative importance. Advice on how this can be done in a *group* setting (including how to consult with traditional stakeholder groups) has been provided in the guidelines for this step involving an 'intermediate' level of assessment.

If the assessment manager wishes to use decision support software (rather than simple methods like the previously described 'counter technique'), it is recommended that a specialist be engaged purely to manage the technology during the panel's work. This way, the panel's facilitator can focus on group processes, communication and the content of the discussion.

Step 8: Develop an impact matrix

Using advice from technical experts, construct an impact matrix that summarises how each option will probably perform against each of the finalised assessment criteria. The impact matrix is a table with the options listed on one side and the assessment criteria on another. 'Impact scores' are contained within the matrix which indicate the relative performance of each option.

Four steps are recommended to develop an impact matrix:

1. Use the best available indicator and unit of measurement for each assessment criteria to initially assess each option's performance (i.e. its most likely impact or consequence). For example, the assessment criteria "life cycle cost" should use Australian dollars (with reference to a base date) and use a calculation methodology defined by the

Australian Standard for life cycle costing (AS/NZS 4536:1999). For less tangible criteria such as "aesthetic appeal", an indicator and unit of measurement will need to be devised, such as a subjective five point scale with a supporting explanatory key.

2. Convert all of the descriptions of performance generated in the preceding step to 'performance scores' with a similar unit of measurement (i.e. a 1 to 5 rating scale). For example, for a given project, an option with the life cycle cost (LCC): ≥ $1,000,000 scores 1; $750,000 ≤ LCC < $1,000,000 scores 2; $500,000 ≤ LCC < $750,000 scores 3; $250,000 ≤ LCC < $500,000 scores 4; and LCC < $250,000 scores 5. Each scoring system (called a 'scoring key') should be structured so a desirable result scores highly (e.g. 5). Care is needed here to minimise a source of bias. That is, the scoring system should be designed so that for a given project, the best possible performance for the assessment criteria scores a 5 and the worst possible performance scores a 1. As such, these scoring keys will be site-specific.

   When developing scoring keys, the inclusion of a base case (as one of the options) can often be helpful, as the scores for the remaining options can represent a change from this baseline (e.g. a simple 1 to 5 scoring system could be: performance is the same as the base case [3]; performance is *slightly* better [4] or worse [2] than the base case; and performance is greatly better [5] or worse [1] than the base case).

3. Using a 1 to 5 rating scale, generate a 'likelihood score' along with each 'performance score'. The likelihood score indicates how likely it is that the option will perform to the extent indicated by the 'performance score'. For example, a bioretention system may have a high 'performance score' for its potential ability to reduce loads of nitrogen in stormwater but uncertainty about how well the proposed system will be maintained in the long-term in a given geographic setting may result in only a moderate 'likelihood score'. Likelihood scores should reflect:

   - the uncertainty associated with performance estimates (e.g. estimates of stormwater treatment performance from pollutant export models); and
   - the risk of failure associated with the stormwater treatment measure (e.g. due to relatively new technology or the likelihood of poor maintenance).

Note that new technology / options will typically have lower 'likelihood scores' than well known alternatives. This can be a *significant* disadvantage to promising new technology in the assessment process. Where this issue is of concern, the effect of the 'likelihood scores' on the final ranking of options will need to be examined during the sensitivity analysis stage (see Step 9). In some cases, the assessment body may choose to assume all options have the same 'likelihood score' to create a 'level playing field' where promising new options are not disadvantaged. It could be argued that such an approach is consistent with the adaptive management philosophy.

4. Combine each 'likelihood score' with its corresponding 'performance score' to generate an 'impact score' using the risk analysis matrix in Table 3.6. Using this matrix, the 'impact score' is simply the product of the 'likelihood score' and its corresponding 'performance score'. The impact scores will therefore range from 1 to 25.

Table 3.3 provides a simple example of an impact matrix, while explanatory keys for the 'performance scores' and 'likelihood scores' are provided in Tables 3.4 and 3.5, respectively.

The development of an impact matrix for proposed stormwater management measures that aim to improve waterway health will typically draw on:

- Pollutant export modelling results (e.g. MUSIC[18] modelling that estimates the average annual load of sediment, nitrogen, phosphorus and/or gross pollutants removed by each option).

[18] 'Model for Urban Stormwater Improvement Conceptualisation'. A model developed by the CRC for Catchment Hydrology which is widely used across Australia to develop stormwater management plans involving structural management measures to improve the management of stormwater quality and quantity. For more information see: www.toolkit.net.au.

- Life cycle costing results (e.g. using the methodology described in Taylor [2003] or by using the life cycle costing module in MUSIC[19]).
- Information from the literature on the significance / value of costs and benefits associated with stormwater management measures (e.g. impacts on adjacent property values, ecosystem services, aesthetics, safety, community acceptance, etc.).
- Locally derived social survey data (e.g. community views on the pros and cons of various stormwater designs and the values such designs are seeking to protect).
- Local expert opinion and experience.

Various data collection methods that can be used at this stage in the assessment process are summarised in Ashley *et al.* (2004). They include:

- Social analysis tools.
- Economic analysis tools (e.g. traditional cost-benefit analysis can be one input to a TBL process).
- Environmental analysis tools (e.g. life cycle assessment[20]).
- Water modelling tools (e.g. for examining the water re-use benefits of stormwater projects as well as pollutant export modelling).
- Analysis of records.
- Direct measurement.

To assist experts to develop an impact matrix involving externalities in the absence of local data, relevant information from the literature has been summarised and referenced in Appendix C. Much of this originates from environmental valuation studies (i.e. attempts to place an approximate monetary value on relevant values such as waterway health). This information could be used by experts developing an impact matrix as a *qualitative* guide to potential impacts (given the high degree of uncertainty associated with such data). For example, there are numerous case studies reported in the literature (and in Appendix C) that have quantified changes to residential property values as a result of proximity to water bodies (e.g. ponds, lakes, creeks, rivers and wetlands), changes to the quality of water in nearby water bodies and proximity to 'green space'. These quantitative studies can be used to *broadly estimate* whether a proposed stormwater improvement project will enhance or degrade local property values, and if so to what extent (e.g. a minor, moderate or great extent).

It is likely that the creation of an impact matrix will involve subjective expert opinion for several assessment criteria, given current gaps in our knowledge concerning how stormwater management measures affect many social and ecological values. Where expert opinion is used, it may be associated with high levels of uncertainty. To alert stakeholders to high levels of uncertainty associated with entries in the impact matrix, it is recommended that footnotes be added to the matrix. Examples of such footnotes are given in Table 3.3.

In addition, an impact matrix should include a clear statement concerning all *assumptions* made by those involved with its creation. For example, if life cycle costs are provided in a matrix, it should reference the methodology that was used to calculate these costs, the discount rate that was used, the base date, the time-frame of the analysis, whether decommissioning costs were included and whether land acquisition costs were included. Ideally a histogram showing the distribution of all costs (both real and discounted real costs) over the life cycle should also be provided for each option to expose any significant costs that occur late in the life cycle that may be masked by the process of discounting future costs to produce a 'life cycle cost'.[21]

[19] This module is incorporated into version 3 of MUSIC.

[20] Care is needed before embarking on a full life cycle analysis as an input to a TBL assessment process. Such analyses seek to quantify all environmental impacts associated with a product / asset from cradle to grave (Standards Australia, 1998). Software and several databases are available to assist this process (see Gouda *et al.*, 2001). However the process is typically very resource intensive and the end results are associated with large degrees of uncertainty. For the vast majority of urban stormwater projects involving several options, this methodology will be too resource intensive to be practical.

[21] For example, consider two options involving constructed measures to improve stormwater quality. Say Options A and B have the same life cycle length (i.e. 30 years) and 'lifecycle cost', with the life cycle cost being the sum of all costs over the life cycle of the asset after they have been adjusted for inflation and discounted. Despite having the same life cycle cost, Option A incurs small costs early in its life cycle (which are not heavily discounted), while Option B incurs huge costs very late in its life cycle (which are heavily discounted). Decision makers who wish to comply with the ecologically sustainable development principle of 'inter-generational equity' (see Appendix D) would normally want to consider this important difference in the assessment process.

The use of an Expert Panel or a Delphi Study (e.g. a group that provides several waves of input by e-mail) are recommended as participation techniques to involve experts in the process of generating an impact matrix (see Appendix B for an explanation of these techniques). To simplify the process, the assessment manager may choose to firstly develop a draft version to circulate for comment.

For 'basic' level of assessments, the assessment manager prepares the impact matrix, consulting with experts as needed (e.g. using one-to-one discussions or the Delphi Study method of participation).

For 'intermediate' level assessments, the assessment manager drafts scoring keys for each assessment criterion and works with the Expert Panel to finalise the impact matrix.

For 'high' level assessments, the assessment manager drafts scoring keys for each assessment criterion and works with experts in the Citizens' Jury's advisory group to draft the impact matrix. The assessment manager then explains the draft impact matrix to the Citizens' Jury (with the advisory group being present). Following discussion and revision (if necessary), the matrix is finalised by the jury.

EXAMPLE ONE

Fletcher Park - 'basic' level of assessment: For the Fletcher Park scenario, the assessment manager drafts a simple impact matrix (with scoring keys) to assess three options: a constructed wetland (with a gross pollutant trap); pond; and bioretention system. The draft impact matrix is refined using one-to-one conversations with several in-house technical experts.

The assessment manager uses outputs from MUSIC modelling, local experience and findings from the literature to construct the matrix.

Three of the 14 assessment criteria and two of the three options from the impact matrix are given in Table 3.3. The scoring keys used for the 'performance scores' and 'likelihood scores' are explained in Tables 3.4 and 3.5, respectively.

EXAMPLE TWO

Pleasantville - 'intermediate' level of assessment: For the Pleasantville scenario, the only differences to the example given above for the 'basic' level of assessment are:

- The Expert Panel develops and finalises the impact matrix. A *single* set of performance and likelihood scores are generated by consensus within the panel following a review of available information, discussion and debate.
- Data from the following sources is collected to inform the panel's work: the door-to-door surveys of residents who live adjacent to examples of each design option; pollutant export and hydrologic modelling; life cycle costing analyses; analyses of stormwater reuse potential; analyses of the extent to which each option reduces the catchment's proportion of directly connected impervious area; photographs of alternative design options (to aid group discussion); and the literature (e.g. for issues such as the impact of various stormwater designs on residential property values, safety, amenity, etc.).

Table 3.3 Hypothetical 'Impact Matrix' for a TBL Assessment of Two Stormwater Management Options

Assessment Criteria *(note: only some are provided in this example)*	**Option A** Bioretention system	**Option B** Constructed wetland (with a gross pollutant trap)
Financial Criteria		
Life cycle cost for the asset in 2005 Australian dollars calculated over a 30 year life span using methodology described in Taylor (2003), a real discount rate of 5.5% and no decommissioning costs[1]	Likely performance: $150,000 (MUSIC estimate) Performance score: 4 (see Table 3.4 for an explanation of these 1 to 5 ratings) Likelihood score: 4[2] (see Table 3.5 for an explanation of these 1 to 5 ratings) **Impact score: 16 (High)** (i.e. 4 x 4, as shown in Table 3.6)	Likely performance: $350,000 (MUSIC estimate) Performance score: 2 Likelihood score: 5 **Impact score: 10 (Medium)**
Social Criteria		
Safety risks to residents (e.g. drowning)	Likely performance: A very small risk of drowning exists (only during major storm events) Performance score: 3[3] Likelihood score (i.e. likelihood that the expected performance will be delivered): 4[3] **Impact score: 12 (Medium)**	Likely performance: A moderate risk of drowning exists, even with modern design features Performance score: 1[3] Likelihood score (i.e. likelihood that the expected performance will be delivered): 4[3] **Impact score: 4 (Low)**
Ecological Criteria		
Load of nitrogen (TN) removed from stormwater	Likely performance: 782 kg in an average year (MUSIC estimate). Equivalent to a 55% reduction in the total load of TN draining from the catchment in a typical year. Performance score: 3 Likelihood score: 4[4] **Impact score: 12 (Medium)**	Likely performance: 850 kg in an average year (MUSIC estimate). Equivalent to a 60% reduction in the total load of TN draining from the catchment in a typical year. Performance score: 4 Likelihood score: 5[4] **Impact score: 20 (Very high)**

Notes:

- The criteria and options in this table are not meant to be exhaustive. This table is based on the Fletcher Park example, which involves 14 assessment criteria and three options.
- Simple scoring keys would be provided for all 1-5 rating scales like those in Table 3.4 and 3.5.
- The term "performance" in this table is relevant to all assessment criteria, not just those that relate to a stormwater treatment train's pollutant removal performance.
- A base case was not included for this example, as it was determined in Step 3 that all options would have a net benefit compared to a 'do nothing' / 'business as usual' scenario (e.g. no stormwater treatment).
- 1. Land acquisition costs (or 'opportunity costs') were not included in the life cycle costing analysis. Also, a sensitivity analysis was undertaken regarding the choice of real discount rate (±1% and ±2%). Little relative difference in the resulting life cycle costs of options was observed.
- 2. There is a moderate degree of uncertainty associated with costing estimates for these types of treatment measure due to the limited availability of high-quality costing data, especially for maintenance costs.
- 3. Based on expert judgement as well as information from overseas and New South Wales case studies where a small number of adults and children have drowned in stormwater infrastructure (e.g. ponds and basins). Limited local data is available to undertake a meaningful risk assessment for this criterion.
- 4. These scores reflect the level of certainty currently associated with the long term pollutant removal performance of these measures in the context they are proposed to be used.

Table 3.4 Performance Scoring Keys for the Impact Matrix in Table 3.3

Rating	Categorisation	Example of Descriptions for Each of the Assessment Criteria (from Table 3.3)*		
		Life cycle cost (X) ($2005)	Child safety	Percentage of the load of TN removed (Y)
5	Outstanding benefits / Little costs	X < $100,000	The risk of drowning is much lower than traditional stormwater drainage	Y ≥ 80% of existing annual TN load
4	Major benefits / Minor costs	$100,000 ≤ X < $200,000	The risk of drowning is slightly lower than traditional stormwater drainage	80% > Y ≥ 60% of existing annual TN load
3	Moderate benefits / Moderate costs	$200,000 ≤ X < $300,000	The risk of drowning is equivalent to traditional stormwater drainage	60% > Y ≥ 40% of existing annual TN load
2	Minor benefits / Major costs	$300,000 ≤ X < $400,000	The risk of drowning is higher than traditional stormwater drainage	40% > Y ≥ 20% of existing annual TN load
1	Little or no benefits / Outstandingly high costs	X ≥ $400,000	The risk of drowning is much higher than traditional stormwater drainage	Y < 20% of existing annual TN load

Notes:

- * These descriptions need to be developed for each assessment criterion during the project. That is, they are project-specific. The range of ratings should be broad enough to cover all possible options. "All possible options" may be a greater set than the options being assessed (e.g. as some options may have been culled in Step 3). A score of 5 should represent the highest possible score given the nature of the project and range of all possible options, while a score of 1 should represent the lowest possible score.
- The relationship between the 1 to 5 scores and the units of measurement (e.g. dollars, percentage reduction of the annual load of TN) does not have to be linear.

Table 3.5 Likelihood Scoring Key for the Impact Matrix in Table 3.3

Rating	Categorisation	Description
5	Almost certain	Outcome is expected to occur in most circumstances
4	Likely	Outcome will probably occur in most circumstances
3	Possible	Outcome could occur
2	Unlikely	Outcome could occur but is not expected
1	Rare	Outcome is expected to occur only in exceptional circumstances

Source: Modified from Standards Australia (2004)

Table 3.6 Risk Analysis Matrix to Determine the 'Impact Scores'

		PERFORMANCE SCORE				
		Very High (5)	**High (4)**	**Medium (3)**	**Low (2)**	**Very Low (1)**
LIKELIHOOD SCORE	**Almost Certain (5)**	Extreme impact (25)	Very high impact (20)	High impact (15)	Medium impact (10)	Low impact (5)
	Likely (4)	Very high impact (20)	High impact (16)	Medium impact (12)	Medium impact (8)	Low impact (4)
	Possible (3)	High impact (15)	Medium impact (12)	Medium impact (9)	Low impact (6)	Negligible impact (3)
	Unlikely (2)	Medium impact (10)	Medium impact (8)	Low impact (6)	Low impact (4)	Negligible impact (2)
	Rare (1)	Low impact (5)	Low impact (4)	Negligible impact (3)	Negligible impact (2)	Negligible impact (1)

Source: Modified from Australian Standard for Risk Management - AS/NZS 4360:2004 (Standards Australia, 2004) and Wildriver (2004).

Note:

- During a major trial to test the validity of these guidelines in 2005, a 1 to 25 linear risk analysis matrix (i.e. the one above) was used as well as a 0 to 128 non-linear risk analysis matrix (see Wildriver, 2004) to rank options during the sensitivity analysis (Step 9). It was found that the ranking obtained from using the linear risk analysis matrix correlated better with the intuitive ranking of the Expert Panel. Consequently, the linear risk analysis matrix has been included in these guidelines.

Step 9: Identify the preferred option

It is recommended that the assessment body try to rank the options in order of preference using only intuition *immediately after* the likelihood and performance scores have been allocated (see Step 8). This 'intuitive ranking' provides a useful comparison when undertaking multi criteria analysis (e.g. it can be used to check whether the multi criteria analysis produces similar results to that expected by decision makers). If the results of two methods are very different, the 'intuitive ranking' step can be revisited after the results from the multi criteria analysis are available and people have had time to think about and discuss why the results are so different.

Once the assessment criteria, the impact matrix and the criteria weights are finalised, multi criteria analysis can be used to *assist* with the selection of the preferred option. Typically, options are ranked to reflect their overall performance when assessed against TBL objectives. This can be done using decision support software or simple manual calculations. Note however that this process should only be used to assist decision making, not replace it.

For example, it is quite legitimate for an assessment body to select an option that has not been ranked the highest by the multi criteria analysis if:

- using the multi criteria analysis process has caused the decision makers to change their views on issues such as the importance of certain weights and/or assessment criteria; and/or
- the decision makers simply do not feel comfortable with the rankings from the multi criteria analysis

(e.g. a decision making body may have had poor experiences with the highest ranked option and are reluctant to use it again, despite evidence suggesting it should provide the greatest net benefit).

There are several multi criteria analysis methods that can be used to rank options. Table 3.7 provides a summary of five of the more common methods as summarised in Ashley *et al,* (2004). The first three of these methods involve complex mathematical procedures and therefore require specialist decision support software and expert assistance. Note that a decision to use any of these methods needs to be made *early* in the assessment process as they use different methodologies to generate weights on assessment criteria and determine the preferred option. The final two methods are simpler, requiring less specialist knowledge and can be applied through manual calculations (especially the SMART method). The approach adopted in these guidelines is similar to the SMART method.

Revisiting some of the earlier steps in the assessment process may be necessary during the ranking process. For example, an assessment body may wish to adjust some of the weights on assessment criteria and re-run the ranking process (e.g. examine what would happen to the order of ranked options if all options had the same 'likelihood scores'). This can be done to respond to a change of view or to undertake sensitivity analysis. Depending on the method used, decision support software packages may be available to allow this to be done quickly and easily without the need for an assessment body to reconvene at a later date.

If the order of ranked options from the multi criteria analysis is unexpected (i.e. it is substantially different from the intuitive ranking that was done immediately after Step 8) it is recommended that the assessment body:

- seek to identify the cause of the unexpected result by reviewing the likelihood scores, performance scores, impact scores and weights on the assessment criteria, as well as undertaking sensitivity analysis;
- discuss why decision makers found the results from the multi criteria analysis to be unexpected and why specific options performed better or worse than expected;
- revise inputs to the multi criteria analysis process if necessary (being careful to minimise or avoid strategic gaming behaviour by members of the assessment body) or repeat the intuitive ranking process once the results of the multi criteria analysis have been examined, explained and discussed; and
- use the services of an independent, skilled facilitator to assist this process.

Several forms of sensitivity analysis can be undertaken. For example, the assessment body may examine the effect on the order of ranked options of:

- Using the minimum, maximum, mode or mean weights on assessment criteria that were generated by a group, rather than the median value.
- Using equal weights on all the assessment criteria.
- Setting all the 'likelihood scores' (see Step 8) for a given assessment criteria to equal the score given to the option that is most well known. This ensures that new, innovative options that are not as well known are not significantly disadvantaged.
- Monte Carlo analysis (an advanced technique, see Ashley *et al.* [2004] for more details).
- Using alternative multi criteria analysis techniques (e.g. those in Table 3.7). Note however that some techniques cannot be used retrospectively.

The following guidelines incorporate a 'weighted summation' style of aggregation to combine impact scores and the weights on assessment criteria to rank options. It is used by the simplest multi criteria analysis techniques, such as the SMART method. This approach can be used without specialist software and expertise.

When using this simple approach to rank options, a decision needs to be made on whether to include *all* of the assessment criteria in the ranking process, or whether to isolate the financial criteria. These two options are described below:

- Firstly, it is possible to use all of the financial, social and ecological assessment criteria in the same way to generate an 'over-all value score' for each option using multi attribute utility theory. The resulting value score represents how well the option performed against each of the assessment criteria (as defined by the 'impact scores' in the impact matrix) and the weight on each of these criteria. The simplest and most widely used method of aggregation is the weighted summation method, where:

  Value Score = Σ Impact Score for Each Criterion × Weight on Each Criterion

  The example given in Table 3.8 uses this approach.

- An alternative however, is to use multi criteria analysis to generate an 'over-all benefit score' (OBS) for each option using the 'weighted summation method' that includes only the ecological and social elements of the TBL. Financial elements such as the life cycle cost (LCC), Equivalent Annual Payment (EAP)[22], Total Acquisition Cost (TAC)[23] and/or Typical Annual Maintenance Cost (TAM) are used as indicators of cost. Using this method, options can be ranked and reviewed based on any of the following four 'indices of value':
  - OBS ÷ LCC;
  - OBS ÷ EAP;
  - OBS ÷ TAC; and/or
  - OBS ÷ TAM.

Alternatively, a graphical approach can be used, where the over-all benefit score of each option is plotted on a two-dimensional graph against either of the four financial elements given above (with most emphasis typically being given to the life cycle cost). See Sinawi *et al.* (2005) for an example of the graphical approach.

This approach provides an insight into the *relative* benefit to cost ratio of each option. To identify a preferred option using this method, the assessment body reviews the indices of value (which are usually presented in one table) or alternatively, reviews the plots of the over-all benefit scores vs. financial elements. An option is then chosen that represents the greatest value *to the assessment* body. For example, an assessment body that is focused on minimising life cycle costs may choose the option with the highest 'OBS ÷ LCC' index of value.

There is a drawback however in using this second method, in that it inherently gives more importance to the financial elements than the social or ecological elements of the TBL. This contravenes a fundamental and widely endorsed principle of sustainable development in that the three elements of the TBL should be given equal weight (see Appendix D).

EXAMPLE ONE

Fletcher Park - 'basic' level of assessment: For the Fletcher Park scenario, the assessment manager uses the SMART multi criteria analysis technique to combine the impact scores from the impact matrix (from Step 8) with the weights on each criteria (from Step 7) to generate an over-all value score for each option. The over-all value scores are used to rank the three options (i.e. the option with the highest score is preferred).

Table 3.8 is a simplified example of the calculations for this analysis. That is, it only includes two of the options and three of the assessment criteria.

[22] The EAP is the life cycle cost ($) of the asset / project divided by its life cycle or life-span (in years).
[23] The TAC is usually defined as the sum of the costs to define the need for the asset (e.g. feasibility studies), design costs and construction costs, where all costs include over-heads, but not tax. Land acquisition costs may also be added if this is clearly indicated in the analysis.

EXAMPLE TWO

Pleasantville - 'intermediate' level of assessment: For the Pleasantville scenario, the Expert Panel also uses the SMART multi criteria analysis technique to combine the impact scores from the impact matrix (from Step 8) with the weights on each criteria (from Step 7) to generate an over-all value score for each option. The over-all value scores are used to rank the six options (i.e. the option with the highest score is preferred).

The order of ranked options from the multi criteria analysis is however significantly different from the panel's 'intuitive ranking' that was done immediately after likelihood and performance scores were assigned to each option (i.e. Step 8). This 'intuitive ranking' was determined by each panel member scoring the six options from 1 (preferred) to 6 (least preferred), then adding all of these scores to rank the options.

The panel reviews why the multi criteria analysis ranked some options higher than expected, while others performed worse than expected, by reviewing the likelihood scores, performance scores, impact scores and weights on the assessment criteria, as well as undertaking sensitivity analysis.

The panel concludes that the performance scores and weights on the assessment criteria are sound, but new, untested, innovative options are being significantly disadvantaged by having lower likelihood scores compared to other options. The panel agrees to set all the likelihood scores for a given assessment criteria to equal the score given to the option that is most well known to provide a 'level playing field' for new options that show promise.

The multi criteria analysis is repeated and produces a ranking that is similar to the panel's 'intuitive ranking'. The differences are thought to be due to psychological influences that are not addressed by the assessment criteria. For example, some of the panel members were not supportive of the highest ranked option from the revised multi criteria analysis due to a poor personal experience with that design option and the significant professional risks associated with the option should it fail. Others were keen to try new, relatively untested options (even though they did not rank highly in the multi criteria analysis) as they would enjoy the process of designing and trialling them.

After further discussion of the results from the revised multi criteria analysis, the panel revises its 'intuitive ranking' and agrees that the top ranked option that results from this process should be the preferred option (i.e. the panel uses the multi criteria analysis to *support* its decision making, not replace it).

Table 3.7 Common Multi Criteria Analysis Methods

Method	Description
AHP - Analytical Hierarchy Process.	The essential idea is to find the criteria trade-off weights through pair-wise comparisons of criteria and, in addition, to find the value of each option for each given criteria through pair-wise comparisons of options on that criteria.
Promethee - Preference Ranking Organisation Method for Enrichment Evaluation.	An outranking method, based on the Electre procedure (see below), which utilises the decision maker's preferences.
Electre - Elimination et Choix Traduisant la Réalité.	An outranking method where the predominant idea is that an option can be eliminated if it is dominated by other options. The various versions of Electre differ in their use of thresholds, weights, outranking relations and a credibility index.
MAUT - Multi Attribute Utility Theory.	Based on the construction of a decision maker's utility function in order to represent his / her preferred structure.
SMART - Simple Multiple Attribute Rating Technique.	A simple version of the MAUT procedure. A weighted summation technique where internally consistent performance scores (e.g. 1 to 5 scores) are multiplied by relevant weights before being added to produce a cumulative performance score. Note that this technique assumes you can trade-off between all assessment criteria.

Source: Modified from Ashley *et al.* (2004).

Table 3.8 Hypothetical Calculation of an Over-all Value Score

Criteria[1]	**Options**	
	A: Bioretention system	**B: Constructed wetland with gross pollutant trap**
Financial: Life cycle cost	Impact score[2]: 16 Weight on criterion[3]: 8 *Weighted impact score: 128 (i.e. 16 x 8)*	Impact score: 10 Weight on criterion: 8 *Weighted impact score: 80*
Social: Safety risk to residents (e.g. drowning)	Impact score: 12 Weight on criterion: 9 *Weighted impact score: 108*	Impact score: 4 Weight on criterion: 9 *Weighted impact score: 36*
Ecological: Load of nitrogen removed from stormwater in an average year	Impact score: 12 Weight on criterion: 7 *Weighted impact score: 84*	Impact score: 20 Weight on criterion: 7 *Weighted impact score: 140*
Over-all Value Score (sum of all weighted impact scores)	320	256
Rank	**1 (preferred)**	**2**

Notes:

1. For more details on these criteria, see Table 3.3 and Figure 3.1.
2. From Table 3.3.
3. Normalised to a score out of 10 to aid interpretation (i.e. the highest weight from Step 7 is assigned '10/10' and the other weights are scaled accordingly. This step is not essential to the ranking process.

Step 10: Recommend the preferred option

Regardless of the level of assessment, the assessment body should make a formal recommendation to the ultimate decision making body. This recommendation should include a justification for the choice, describe the assessment process that was used, indicate the extent to which stakeholders have been involved in the process, and the extent to which consensus was achieved during group decision making (where relevant).

EXAMPLE ONE

Fletcher Park - 'basic' level of assessment: For the Fletcher Park scenario, the assessment manager prepared a PowerPoint presentation summarising the assessment process that has been followed. She then presents the findings of the assessment process to senior staff within the organisation.

EXAMPLE TWO

Pleasantville - 'intermediate' level of assessment: For the Pleasantville scenario, the assessment manager drafts a five page executive summary report for senior managers within the local government authority to consider.

The report describes why an assessment was undertaken, the options considered and the assessment methodology. It primarily makes a recommendation on which stormwater design option was favoured based on the TBL assessment process. Minor recommendations are also made about how similar assessment processes can be improved in future and how stakeholders should be keep up-to-date on the project's outcome.

Before finalising the report, the assessment manager ensures that all of the Expert Panel members have had the chance to comment and agree that it represents their collective views.

Step 11: Make the final decision and provide feedback

The ultimate decision making body should consider the recommendation(s) from the assessment process along with other factors such as:

- the organisation's current budget situation;
- political requirements and considerations;
- timing issues that may affect when the project could be delivered;
- regulatory constraints; and
- the risk tolerance of the decision maker (i.e. this may be different to the assessment body).

The ultimate decision making body needs to understand the assessment process that has been followed and the involvement of stakeholders. Where citizens and/or community-based stakeholder groups have been involved in the assessment process, the decision making body should be aware of the risk that stakeholder discontent and distrust may be generated if their recommendations are not adopted and a satisfactory explanation is not provided. This step needs to be managed with much thought, care and diplomacy.

Once the decision is made, feedback should be provided to every member of the assessment body on the decision and why the decision was made. This is particularly important when citizens and/or community-based stakeholder groups have been involved in the assessment process.

It is also recommended that the members of the assessment body who are not staff of the host organisation and have not been paid to participate, be officially thanked for their input.

EXAMPLE ONE

Fletcher Park - 'basic' level of assessment: For the Fletcher Park scenario, once the assessment manager verbally explains the assessment process that has been followed and provides her recommendation on the preferred design option to senior management, she is requested to begin the preliminary design work for the recommended option.

At this forum, senior managers briefly discuss the organisation's budgetary situation, potential political issues and key issues that have emerged during the assessment process. They conclude that there are no significant barriers to the implementation of the recommended option, however they note that the design phase of the project will need to involve maintenance staff and citizens who live next to the park.

In closing the meeting, senior managers thank the assessment manager for her work as well as those technical experts who provided input during the assessment process.

EXAMPLE TWO

Pleasantville - 'intermediate' level of assessment: For the Pleasantville scenario, the managers responsible for stormwater infrastructure, water-related policy and 'urban management' within the local government authority review the assessment report. After discussion, they agree that the recommended design option should be the option Council promotes through its training programs, guidelines and development assessment system.

The most senior manager requests that the assessment manager run several short seminars within the organisation and in the development community to alert staff and consultants to the project and the preferred design option for residential stormwater design in greenfield estates. In addition, the assessment manager is asked to review the town plan and supporting design guidelines to ensure that the preferred design option is explicitly promoted. Finally, the assessment manager is thanked for his work and asked to write to members of the Expert Panel on Council's behalf, thanking them for their input.

Step 12: Post-project evaluation and feedback

Once the chosen option has been implemented, it is important to evaluate its performance against key financial, social and ecological criteria. For example, to determine whether the *anticipated* cost of the project was realistic. In essence this step involves checking whether the impact matrix (see Step 8) was realistic for the chosen option.

The resulting knowledge can help to improve future assessment processes. For example, improved knowledge on the cost of stormwater quality improvement measures can be used to reduce the uncertainty associated with estimates from life cycle costing models.

Common sense is needed to determine those criteria that can be *easily* monitored and evaluated given the nature of the project. Some criteria are likely to be simple to monitor and should be part of standard project management activities (e.g. cost), while others may be relatively complex and/or expensive (e.g. monitoring reductions in loads of nutrients in stormwater).

The assessment manager should keep in touch with the stormwater project as it proceeds, to ensure that this form of evaluation occurs and that the resulting knowledge is transferred to people who may be involved with future TBL assessment processes.

EXAMPLE ONE

Fletcher Park - 'basic' level of assessment: For the Fletcher Park scenario, the assessment manager liaises with fellow stormwater engineers who are involved with the design and construction of the chosen option. She recommends that the project evaluation examine the:

- Total acquisition cost of the project (i.e. all preliminary design, detailed design and construction costs).
- Annual maintenance cost of the project over its first five years (i.e. to allow for the vegetation in the bioretention system to establish).
- The hydrologic and hydraulic performance of the bioretention system (note that undertaking meaningful monitoring of stormwater quality treatment performance was considered impractical given available funds for monitoring).
- Views of maintenance staff and residents on issues such as safety and aesthetics using informal feedback mechanisms (i.e. one-to-one discussions).

Once this information is available, the assessment manager communicates the findings to relevant stormwater managers and researchers in the region to help inform future decisions.

EXAMPLE TWO

Pleasantville - 'intermediate' level of assessment: For the Pleasantville scenario, the development of the impact matrix (Step 8) highlighted several areas where data was sparse. One area involved the vehicle-related safety risks associated with bioretention systems in residential streets (i.e. lens shaped 'bioretention pods' that extend into the road corridor like landscaped traffic calming devices).

During the assessment process, the Expert Panel agreed that data needed to be collected on vehicle-related accidents associated with these assets. Subsequent to the assessment process, the assessment manager develops a 'monitoring and evaluation plan' in consultation with infrastructure and traffic management staff. This plan includes a brief literature review, discussions with experts from other cities that use such measures, and the collection of accident-related data over several years within the city.

Once a suitable research budget is secured, the 'monitoring and evaluation plan' is implemented as part of the organisation's stormwater-related research program. The assessment manager keeps informed of the findings by being a member of the project's steering group. These findings are then communicated to relevant urban stormwater managers and researchers in the region via one-to-one discussions, conference papers, guidelines and presentations.

4. Useful Web-based Resources

The following web-based resources may assist users of this guideline who need easy access to more detailed information or background information.

- Department of Sustainability and Environment's (2003) *Draft Guidelines for Planning and Reporting Recycled Water Programs* (available at: www.vicwater.org.au, June 2005). These are draft triple bottom line assessment guidelines.
- National Economic Research Associates' (2001) *Multi-criteria Analysis Manual* (available at: www.odpm.gov.uk, June 2005).
- The Cooperative Research Centre for Coastal Zone, Estuary and Waterway Management's *Citizens Science Toolbox*. A web-based resource that provides guidance and case studies on a wide variety of public participation and consultation methods. Available at: www.coastal.crc.org.au/toolbox/index.asp (June 2005). Appendix B of these guidelines draws heavily on the information provided in this toolbox.
- City of Melbourne's *Triple Bottom Line Toolkit* (available at: www.melbourne.vic.gov.au > search for 'triple bottom line'), which includes a sustainability assessment process for proposed capital works (if their value exceeds $20,000). These tools are a set of checklists, guidelines, templates and case studies for the application of the TBL to decision making and performance reporting.
- The Queensland Department of Natural Resources and Mines and Coastal Zone Australia Ltd (2003) host *The MODSS (Multiple Objective Decision Support Systems) Web Site* (available at: www.coastal.crc.org.au/modss/index.html, June 2005). This site contains information on MODSS (i.e. links, papers and explanatory notes) as well as the freely available Facilitator program. Facilitator is a simple multi criteria analysis software tool that enables options to be ranked. A plain English User Manual is also provided for Facilitator.
- The US Ecosystem Valuation website (available at: www.ecosystemvaluation.org/, June 2005). This website describes how economists attempt to place a monetary value on the beneficial ways that ecosystems affect people and is designed for non-economists. It provides explanations of ecosystem valuation concepts, methods and applications. It is a resource that supports the use of information provided in Appendix C.
- *Techniques to Value Environmental Resources: An Introductory Handbook* prepared by CDEST *et al.,* (1995) (available at: www.deh.gov.au/pcepd/economics/value/index.html, June 2005). This on-line reference introduces the techniques of environmental valuation, illustrates them with Australian examples and indicates how to use the techniques and the values to make more informed decisions. The aim of this document is to "assist practitioners and non-practitioners who need to appraise resource use decisions and to aid effective policy formulation". It is a resource that supports the use of information provided in Appendix C.
- The NSW Envalue database (available at: www.epa.nsw.gov.au/envalue/, June 2005). The Envalue environmental valuation database was developed and is maintained by the NSW Environmental Protection Authority. It is a collection of Australian and overseas environmental valuation studies. Some of the information provided in Appendix C has been sourced via this database. The Envalue database aims to assist decision makers to incorporate environmental values into benefit-cost analyses, environmental impact statements, project assessments and the overall valuation of changes in environmental quality. In the context of these guidelines, information from this database can be used as qualitative information to support multi criteria analysis. A similar, but smaller New Zealand database (i.e. the New Zealand Non-market Valuation Database) is available at: http://learn.lincoln.ac.nz/markval/ (June 2005).

5. Glossary

Adaptive Management Philosophy: A systematic process for continually improving management policies and practices by learning from the outcomes of previously employed policies and practices.

ARI: Average recurrence interval. For example, the frequency at which a storm event occurs on average.

Benefit Transfer Method: A valuation method used to estimate the approximate monetary value of ecological or social services by transferring available information from valuation studies already completed in another location that has a very similar context (King and Mazzotta, undated).

Benefit-Cost Analysis (BCA): The identification, economic valuation, and quantitative comparison of the advantages and disadvantages of projects or policies based on the net contribution to society's overall well-being.

Bequest Value: The value placed on an environmental good for one's descendants (i.e. the value of knowing that a resource will exist for the enjoyment of one's children in the future).

Brainstorming: A simple method for developing creative solutions to problems. It works in a group setting by focusing on a problem, and then having participants suggest as many deliberately unusual solutions as possible (CRC-CZEWM, 2004).

Citizen Science: "A participatory process for including all sectors of society (the general public, government and industry) in the development and conduct of public interest research in order to bridge the gaps between science and the community and between scientific research and policy, decision making and planning. Bridging these gaps involves a process of social learning through sound environmental research, full public participation, the adoption of adaptive management practices and the development of democratic values, skills and institutions for an active civil society." (CRC-CZEWM, 2003).

Citizens' Jury: A deliberative public participation method, where 8 to 24 paid participants (who are usually randomly selected to represent an affected population) deliberate over a decision with the assistance of expert witnesses and a facilitator. The process aims to generate a consensus, may take several days, and may be structured by using multi criteria analysis.

Consensus: General opinion or agreed decision. Processes that seek to generate a consensus often focus on generating wise solutions that meet the needs and perspectives involved in the process, rather than compromise or deal-making (Co-Intelligence Institute, 2004).

Consumer Surplus: The difference between how much consumers value a product and the price they pay.

Contingent Choice Method: A valuation method that is similar to contingent valuation, in that it can be used to estimate economic values for virtually any ecological or social service, and can be used to estimate use and non-use values. Like contingent valuation, it is a method that asks people to make choices based on a hypothetical scenario. However, it differs from contingent valuation because it does not directly ask people to state their willingness to pay in monetary terms. Rather, values are inferred from the hypothetical choices or tradeoffs that people make (King and Mazzotta, undated).

Contingent Valuation: A type of 'willingness to pay' study that places a monetary value on services that do not exist in a market (e.g. a person's willingness to pay for the existence value of a healthy estuary).

Cost Effectiveness Analysis: Involves either: assessing options according to their ability to achieve the desired goal, given an equal unit of expenditure on each option; or assessing options according to their cost to achieve a desired goal.

Deliberative: In the context of these guidelines, deliberative public participation methods include an opportunity for participants to discuss and debate their views and those of experts.

Direct Use Value: The contribution an ecological or social asset makes to consumption or production (e.g. production of timber).

Discount Rate: A rate used in benefit-cost analysis and life cycle costing to account for the time preference of money (i.e. a dollar available for spending or investing today is valued more than a dollar not available until some time in the future).

Discursive: In the context of these guidelines, discursive public participation methods are free to explore all aspects of the project.

Ecologically Sustainable Development: Development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987). Also defined as using, conserving and enhancing the community's resources so that ecological processes on which life depends are maintained, and the total quality of life, now and in the future, can be increased (Commonwealth of Australia, 1992).

Economic Agent: A person or group of persons (e.g. a firm) that undertakes economic transactions.

Economic Analysis: Full analysis of a project or policy change including all costs and benefits from the consumption and production of all goods and services.

Ecosystem Services: The terms 'nature's benefits', 'nature services' and 'ecosystem services' have been used to describe the processes and conditions by which natural ecosystems sustain and fulfil human life (Cork and Shelton, 2000; Westman, 1997; Daily, 1997; and Mooney and Ehrlich, 1997).

Effective Imperviousness or Effective Impervious Area: The proportion of a catchment covered by impervious surfaces (e.g. roads and roofs) that are directly connected to waterways by pipes and channels. It is a strong predictor of the cumulative impact of altered hydrology, water quality and habitat quality on ecological health of waterways as a result of urbanisation (Walsh *et al.*, 2004). Also being used as a design objective for developments that are proposed in catchments with healthy aquatic ecosystems (i.e. capping the development's effective impervious area to a percentage that is determined through local science).

Electre: Stands for Elimination et Choix Traduisant la Réalité. An outranking multi criteria analysis technique where the predominant idea is that an option can be eliminated if it is dominated by other options. The various versions of Electre differ in their use of thresholds, weights, outranking relations and a credibility index (Ashley *et al.*, 2004).

Existence Value: The value of knowing something exists, based on, for example, moral conviction.

Experimental Learning: Learning from active and hands-on experience. Regarded as one of the most powerful and natural form of learning. See 'Citizen Science'.

Externalities: A cost or benefit that arises from an economic transaction (e.g. the construction of a wetland) and falls on a person who doesn't participate in the transaction (e.g. a person living next to the wetland). That is, there is no market feedback from the person who experiences the loss or gain to the person who created it (Young, 2000). For example, where untreated stormwater is discharged to a swimming beach, loss of swimming opportunities after rain as a result of stormwater pollution is an 'externality' associated with the catchment's stormwater management arrangements.

Financial Analysis: Analysis of a project or policy change that only includes the costs and benefits of goods and services that have markets.

Greenway: In the context of these guidelines, a 'greenway' is a natural area in an urban environment, such as a waterway drainage corridor with impact riparian vegetation.

Hedonic Pricing Method: A valuation method used to estimate economic values for ecological and/or social services that directly affect market prices (e.g. the water quality and aesthetics of a water body in a residential area). It is most commonly applied to measurable variations in housing prices that reflect the value of local ecological or social attributes (King and Mazzotta, undated).

Human Capital: "The knowledge, skills and competencies of people in an organization. Unlike structural capital, human capital is owned by the individuals that have it, rather than the organization." (University of Texas, 1998). The term can also be used to describe the knowledge, skills and competencies of citizens.

Indirect Use Value: The value derived from the actual use of a good or service, albeit an indirect use (e.g. increased property prices due to the enhanced health of a local waterway may be seen as an indirect use value).

Intangible Goods / Values: Goods for which there are not markets, for example, healthy ecosystems in urban waterways.

Integrated Urban Water Management: "Integrated urban water management takes a comprehensive approach to urban water services, viewing water supply, stormwater and wastewater as components of an integrated physical system and recognises that the physical system sits within an organisational framework and a broader natural landscape." (Mitchell, 2004, p. 5).

Intrinsic Values: In relation to ecosystems, those aspects of ecosystems and their constituent parts which have value in their own right (e.g. their biological and genetic diversity).

Lateral Thinking: "The use of ideas from other fields applied to the problem" (Ashley *et al.*, 2004, p. 30).

Life Cycle Assessment: A methodology for the "compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle" (Standards Australia, 1998, p. 2). This methodology includes an assessment of the procurement of raw materials, production, use and end-of-life disposal.

Life cycle Costing: 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" (Standards Australia, 1999, p. 4). In the context of these guidelines, the 'life cycle cost' relates to the project costs directly associated with a particular asset (e.g. the proposed stormwater infrastructure) and does not include land costs or costs associated with externalities.

Market Goods: Goods which are traded in markets (also known as tangible goods).

MAUT (Multi Attribute Utility Theory): A multi criteria analysis technique based on the construction of a decision maker's utility function in order to represent his / her preferred structure (Ashley *et al.*, 2004).

Mode: The most frequently occurring number in a data set.

Monte-Carlo Simulation: A technique used for sensitivity analysis. Monte-Carlo simulation allows the user to examine the effect of simultaneous changes in all of the parameters in the analysis. This can be done by assigning appropriate probability distributions to all of the elements in the analysis, then sampling and combining values of these elements in an iterative process to generate a probability distribution dissociated with the results. For example, Monte-Carlo simulation could generate a range of possible ranking scores for each option in a multi criteria analysis (Ashley *et al.,* 2004).

Multi Criteria Analysis (MCA): "A method for weighting and aggregating data, and prioritising options and alternatives" (CRC-CZEWM, 2003, p. 9). It is also called multiple attribute decision making or modelling (MADM), multiple objective decision support (MODS), multiple criteria decision modelling (MCDM) and multiple criteria decision aid (MCDA).

Multiple Objective Decision Support System (MODSS): "The process of identifying objectives, goals, criteria and options or alternatives" (CRC-CZEWM, 2003, p. 9).

MUSIC: Model for Urban Stormwater Improvement Conceptualisation. A model developed by the Cooperative Research Centre for Catchment Hydrology which is widely used across Australia to develop stormwater management plans involving structural best management practices. For more information see: www.toolkit.net.au.

Natural Capital: Resources and services provided by nature.

Net Present Value: The projected value of a project where costs and benefits in future years are discounted according to the discount rate in order to reflect the time preference of money. Note that the 'life cycle cost' is similar but it also includes the costs at year zero (i.e. the year where costs are not discounted).

Nominal Cost: The expected price that will be paid when the cost is due to be paid, including estimated changes in prices due to the forecast changes in efficiency, inflation / deflation, technology and the like (Standards Australia, 1999).

Nominal Group Technique: This participation method aims to balance and increase participation of people in a group setting, to use different processes for different phases of problem solving and to minimise the errors associated with aggregating individual views into group decisions. Typical steps in the process include: 1. Silent generation of ideas in writing; 2. Recorded round-robin listing of ideas on a chart; 3. A very brief discussion and clarification of each idea on the chart; 4. Preliminary vote on priorities (silent, independent); 5. Meeting break; 6. Discussion of the preliminary vote; 7. Final vote on priorities (silent independent); and 8. Listing and agreement on prioritised items (CRC-CZEWM, 2004).

Non-market Goods / Values: Goods which are not traded in markets (also known as intangible goods).

Non-structural Stormwater Measures / Projects: Institutional and pollution-prevention practices designed to prevent or minimise pollutants from entering stormwater runoff and/or reduce the volume of stormwater requiring management (US EPA, 1999). They do not involve fixed, permanent facilities and they usually work by changing behaviour through government regulation (e.g. planning and environmental laws), persuasion and/or economic instruments (Taylor and Wong, 2002b).

Non-use Value: The value of a resource that is not related to its use. Such values include option values, bequest values and existence values.

Opportunity Cost: The value of the best alternative to a given choice, or the value of resources in their next best use (King and Mazzotta, undated).

Option Price: The sum of use, preservation and option values.

Option Value: The value placed on a resource to be able to access it at some stage in the future.

Participatory Democracy: All of those actions undertaken by citizens that are intended to influence the behaviour of those empowered with decision making roles (Chekki, 1979).

Pragmatic Design: "The use of existing available materials and methods without innovation" (Ashley *et al.*, 2004, p. 30).

Preservation Value: The sum of existence and bequest values.

Promethee: Stands for Preference Ranking Organisation Method for Enrichment Evaluation. An outranking multi criteria analysis technique, based on the Electre procedure, which utilises the decision maker's preferences. (Ashley *et al.*, 2004).

Public Participation: Involving stakeholders in the decision making process. The degree of involvement and influence can vary greatly, leading to many classification schemes for public participation (e.g. Sherry Arnstein's [1969] famous 'eight rungs on a ladder of citizen participation': manipulation, therapy, informing, consultation, placation, partnership, delegated power and citizen control).

Real Cost: The cost expressed in values of the base date (e.g. year 2005), including estimated changes in prices due to forecast changes in efficiency and technology, excluding general price inflation or deflation (Standards Australia, 1999).

Sensitivity Analysis: The process of changing the value of one element in an analytical model, whilst retaining the original value of all other elements to determine the influence that that element has on the overall analysis (Ashley *et al.*, 2004).

Small Deliberative Panel: A term used in these guidelines to describe a scaled-down Citizens' Jury, so that it is more cost effective to run for stormwater projects. The number of people would be kept at or below 12 and they would meet for only 1-2 days.

SMART (Simple Multiple Attribute Rating Technique): A multi criteria analysis technique that is a simple version of the MAUT procedure.

Social Capital: Institutions, relationships and norms that shape the quality and quantity of a society's social interactions. The term is based on the view that social cohesion is critical for societies to prosper economically, and for development to be sustainable (City of Melbourne, 2003).

Stakeholders: People or groups that can be affected by a policy or project. In the context of these guidelines, 'traditional stakeholders' refers to stakeholder groups that are traditionally consulted for stormwater projects, such as waterway-related community groups, local government Councillors and directly affected local residents. 'Non-traditional stakeholders' may include the broader public (e.g. randomly selected citizens), who may be consulted to obtain their view on what is best for the broader community.

Strategic Gaming: When a participant in a group exercise (e.g. a group voting procedure) adjusts their behaviour to further their interests based on what other people in the group are doing (e.g. deliberately over-weighting or under-weighting specific criteria).

Sustainability: Economic activity that meets the needs of the present generation without compromising the ability of future generations to meet their needs.

Sustainable development: In the context of this guideline, the term is equivalent to 'ecologically sustainable development' which is defined as "using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased" (DEH, 1992).

Tangible Goods / Values: Goods traded in markets (also known as market goods).

Threshold Approach: Determines the minimum willingness to pay for benefits in order for the project to be justifiable. The decision maker typically assesses whether this figure is reasonable considering the ecological and/or social benefits / costs.

Traditional Stakeholder Groups: See 'Stakeholders'.

Travel Cost Method: A valuation method used to estimate economic use values associated with ecosystems or sites that are used for recreation. The theoretical foundation of the travel cost method is the time and travel cost expenses that people pay to visit a site represent the price of access to the site. The willingness of people who use a recreational site to pay to access the site can be estimated based on the number of trips that they make and the cost of access (King and Mazzotta, undated).

Triple-Bottom-Line (TBL): A management framework used for assessment and performance reporting that explicitly considers an organisation's financial, ecological and social performance.

Use Value: The value derived from the actual use of a good.

Utilitarianism: An ethical framework based on the objective of creating the greatest good to the greatest number of people. Such an ethical framework does not address issues such as intra-generational equity or 'duties' relating to the preservation of essential ecosystem services.

Utility: The benefit or satisfaction that a person obtains from the consumption of a good or service.

Welfare: An indication of all things of value that are possessed. A measure of well-being.

Willingness to Pay: The maximum amount an economic agent is willing to pay for a good or service.

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APPENDIX A

The Rationale for Using Multi Criteria Analysis

1. Introduction

This appendix expands on the information in Section 2.3 of the TBL guidelines by explaining why multi criteria analysis (MCA) was selected as the decision support 'engine' in the triple-bottom-line guidelines as opposed to common alternatives such as benefit-cost analysis (BCA).

For an explanation of terms used this appendix, reference should be made to the glossary in Chapter 5 of the TBL guidelines.

2. The Rationale

2.1 Multiple objectives

Multi criteria analysis has the ability to be easily used for projects with multiple and sometimes conflicting objectives. This is one of the reasons it is widely used for natural resource management. When undertaking a triple-bottom-line assessment process for stormwater projects, it would be normal to have *many* objectives (e.g. minimise the project's life-cycle cost, maximise social benefits to the greatest number of people, maximise inter- and intra-generational equity, improve water quality, be practical to quickly implement, be socially and politically acceptable, minimise the risk of failure, etc.).

In addition, several of these could be expected to be competing (e.g. minimising the asset's 'life-cycle cost' may compete with criteria relating to enhanced 'recreational values' and 'aesthetics'). MCA can highlight tradeoffs between 'competing' criteria during the process and make these a focus of attention and discussion (Joubert *et al*., 1997).

Alternative decision support frameworks such as benefit-cost analysis cannot manage multiple and competing objectives as easily or as transparently.

2.2 The form of decision criteria

Multi criteria analysis has the ability to easily incorporate a wide variety of decision criteria that can be expressed in qualitative and/or quantitative forms (Munda *et al*., 1994). This is important, as many social and ecological externalities are very hard to quantify in the context of urban stormwater improvement projects (e.g. traditional valuation methodologies that quantify ecological or social values in the absence of a market can be prohibitively expensive, time-consuming, and produce results with an unknown level of confidence). This feature of MCA has led to its popularity as a tool for aiding decisions involving complex ecological, financial and social issues (Proctor and Drechsler, 2003), especially in the area of environmental management (Munda *et al*., 1994).

2.3 Structuring the analysis process

Multi criteria analysis logically and transparently structures complex decision making processes based on how most people normally make decisions (Proctor and Drechsler, 2003; CSIRO Sustainable Ecosystems, 2003). For example, when people make decisions about every day issues such as which school to send their child to, most people will use a range of criteria, some of which will be quantified (e.g. the cost per term and the cost of transport), while others will not be quantified (e.g. the reputation of the school and the family's history with the school). Multi criteria analysis accommodates this approach and does not try to 'force' individuals to place monetary values on aspects that are not normally considered in a monetary form.

2.4 Managing several different views

Multi criteria analysis has the ability to consider the views of more than one person or group (e.g. experts, traditional key stakeholders and citizens). The methodology in the triple-bottom-line guidelines explains how this can be simply done. Specialist MCA decision support software is also available for group processes (e.g. 'Logical Decisions® for Groups').

Multi criteria analysis can also help to resolve conflict (Munda *et al*., 1994) and build a consensus amongst a group by revealing people's views on the importance of various decision criteria, and providing an opportunity for discussion, debate and learning.

Sensitivity analysis can also be performed during the analysis to see if the ranking of alternatives changes if inputs to the process (e.g. weights on decision criteria) are altered to accommodate different points of view. The triple-bottom-line guidelines also provide some suggestions on how this can be simply achieved.

2.5 Incorporating a deliberative element

Multi criteria analysis can easily incorporate a *deliberative* element into the decision support process (CSIRO Sustainable Ecosystems, 2003) - an approach that is increasingly popular. That is, the process can provide an opportunity for those people involved in the analysis to unravel an issue, learn about it, *construct* preferences (e.g. the relative importance of decision criteria), discuss and debate these preferences, and then refine them (where necessary). This feature can lead to more informed decision making, increased human and social capital, and reduced conflict amongst stakeholders.

Proctor (2001) contrasted this approach with techniques such as benefit-cost analysis which may provide an 'optimal' result from the process, but not necessarily increase the understanding of the important elements of the process.

Gregory *et al*. (1993) also highlighted the importance of providing an opportunity in the process for value *construction* (e.g. by using a Small Deliberative Panel, Citizens' Jury or Consensus Conference), stating that "in our view, improved methods for valuing non-market natural resources can be found by paying closer attention to the multidimensional nature of environmental values and to the constructive nature of human preferences" (p. 178).

Proctor (2001) and Munda (2000) have also warned against optimising techniques that result in a precise numerical result without deliberation (e.g. BCA) as being potentially misleading for lay people who may interpret such precision as being indicative of the 'truth'. "The use of precise, quantitative data based on monetary valuations (such as market prices) where complexity and uncertainty are pervasive can be misleading. There is a certain degree of comfort associated with precise numbers despite the fact that the unidimensional answer can lack any actual relevance, i.e. being precise and wrong" (Munda, 2000, p. 8).

2.6 Public participation

While most commentators on public participation methods stress their value, some go further, suggesting that in a democracy it is a *right* for citizens to be involved in decisions involving policies or projects that potentially affect them. The consequence of this view is that decision making methodologies involving publicly funded projects need to accommodate a suitable level of public participation. Joubert *et al*. (1997) used this point to support the use of MCA in preference to traditional benefit-cost analysis, stating that "multi-criteria decision analysis approaches are especially appropriate in participatory democracies where decision making methods need to allow for direct input from those affected" (p. 123). They concluded that "cost benefit analysis may no longer be appropriate as the primary tool in decision making about projects with social and environmental externalities within a participatory democracy" (p. 129).

2.7 Managing equity issues

Unlike BCA, MCA can adequately incorporate consideration of intra-generational and inter-generational equity in the decision support process (two of the principles of ecologically sustainable development). For example, MCA can include inter-generational equity as a decision criteria, while traditional BCA discounts the value of benefits incurred in the future (using a real discount rate currently around 7 or 8%), so that an option with a small benefit in the short term may be favoured over an option with a large benefit in the long term (i.e. a benefit that future generations can enjoy). Discounting the importance of costs and benefits experienced by future generations along with the adoption of utilitarianism[1] are two of the implicit ethical choices made by the BCA method that have led to criticisms when the method is applied to decisions with ecological and/or social dimensions (Splash, 2001).

[1] An ethical framework based on the objective of creating the greatest good to the greatest number of people. Such an ethical framework does not address issues such as intra-generational equity or 'duties' relating to the preservation of essential ecosystem services.

Concern over the use of discounting in the context of BCA that seeks to ascribe a monetary value to future environmental and social benefits has led to a range of proposals to overcome what some see as a flaw in the methodology (Green and Tunstall, 1991). For example, it has been proposed that a different discount rate be used for environmental goods (Fisher and Krutilla, 1978; Nash, 1973), a growth factor be applied to the value of environmental goods to take into account the likely increase in the real value of these goods in the future (Krutilla and Fisher, 1975), a reduced discount rate be applied beyond 30 years (Rabl, 1996), and the temporal distribution of project costs/benefits be examined during the analysis to elucidate the nature of real (i.e. non-discounted) benefits over time (Green and Tunstall, 1991). Despite these attempts, there appears to be no widely accepted and applied methodology to address concerns regarding how BCA manages inter-generational equity.

Solutions have also been proposed to address the issue of intra-generational equity within BCA (e.g. equity within a given population that is affected by a decision). For example, the use of income distributional weights has been proposed. In practice however, these are rarely used (Joubert *et al*., 1997).

2.8 Transparently separating facts from values

Multi criteria analysis provides users with the benefit of separating facts from values (Gregory *et al*., 1993). For example, an 'impact matrix' may be developed by technical experts that summarises how each option will perform against each of the decision criteria (i.e. it summarises the facts/information supported by data). While the weightings (or ranking) used for each of the criteria would reflect the collective values of the assessment team. Alternative techniques, such as BCA supported by willingness to pay studies do not offer such transparency.

2.9 An alternative to some unappealing valuation methods

Multi criteria analysis (when supported by input from experts, traditional stakeholders and/or citizens) provides a simple alternative to some time-consuming, expensive and controversial valuation methods such as contingent valuation[2]. The people undertaking the analysis can be supplied with the best available information on a social or ecological issue (e.g. information from relevant studies conducted locally and/or elsewhere), be given the opportunity to deliberate over this information, and use this information to generate preferences in either a qualitative or quantitative form (e.g. decision criteria can be ranked or provided with a numerical weighting).

Avoidance of the need to quantify the monetary value of ecological and/or social impacts that exist outside of a market is a major advantage of MCA, given the ferocity of the debate over the legitimacy of *some* of the methods used to estimate a monetary value (e.g. contingent valuation studies). Criticisms of these methods include:

- Willingness to pay surveys can produce unreliable results with responses varying with the way a question is focused or framed (Sagoff, 1998). For example, many studies have demonstrated an 'embedding effect' where individuals tend to state the same willingness to pay for part of the service as for the whole (e.g. Kahneman and Knetsch, 1992; Desvousges, 1993). Similarly, the context in which the question is asked can affect the response. This is known as the 'framing effect' (Gregory *et al*., 1993; Hogarth, 1982; Tversky and Kahneman, 1981; Samples *et al*., 1986). The order in which questions are asked also appears to influence the amount respondents say they are willing to pay (Samples and Hollyer, 1990).
- Users of contingent valuation methods assume that people have previously defined and quantified values about non-market goods and that these values just need to be 'revealed' during the survey process. This assumption has been strongly rejected in the literature (Cummings *et al*., 1986; Mitchell and Carson, 1989; Sagoff, 1998; Schkade and Payne, 1993; Slovic *et al*., 1993; Gregory *et al*., 1993). Evidence suggests that individuals actually *construct* preferences and values during

2. A type of 'willingness to pay' study that places a monetary value on services that do not exist in a market (e.g. a person's willingness to pay for the existence value of a healthy estuary).

the valuation process, often with scant information, no opportunity for deliberation and no consequences resulting from a poor decision.

- These methods are poorly suited to the valuation of multifaceted ecological impacts associated with resource management decisions (Kahn, 1996; Prato, 1999).
- The placement of a monetary value on some ecological services is rejected by some people on ethical grounds (Kahn, 1996; Prato, 1999).
- Systematic biases are associated with willingness to pay surveys. For example some people may refuse to respond to the question believing that an ecological or social value cannot be described in monetary terms (Splash, 2001). Spiritual values may fall into this category. The resulting data from the survey usually excludes any consideration of these types of views, even though people who express them may feel *very* strongly about the importance of relevant values.
- Valuation methodologies that do not include an opportunity for discussion and in-depth exploration of people's responses (e.g. traditional willingness to pay surveys and subsequent BCA) may be more susceptible to 'strategic behaviour'. That is, manipulation of the results by people with vested interests.
- Uncertainty exists over the population that benefits from non-use values such as existence, bequest and option values (Green and Tunstall, 1991). In BCA, the size of this population may be needed to convert the willingness to pay survey results into an over-all monetary value for a service or asset that exists outside of a market.
- Studies have found that willingness to pay for an environmental improvement is often many times less than the willingness to accept compensation to forego that improvement (Bishop and Heberlien, 1979; Rowe *et al*., 1980).
- According to Sagoff (1998), results from willingness to pay surveys may be a reflection of the cost to 'purchase' a clear conscience (Kahneman and Knetsch, 1992), gain the approval of the questioner (Bishop *et al*., 1986), contribute to a worthy cause (Daum, 1993; Guagnano *et al*., 1994), improve the lot of future generations, or avoid violating the rights of others (Opulach and Grigalunas, 1992). In short, researchers are unclear as to what willingness to pay surveys are actually measuring.
- Willingness to pay studies capture attitudinal intentions rather than actual behaviour (Ajzen and Peterson, 1988). Behaviour can be measured for some services using less controversial valuation methods such as the travel cost method or the hedonic pricing method, that are often used for 'use values' (e.g. the recreational values associated with the waterway).

In response to some of these criticisms, many social scientists have recently revised their approach to valuing non-market goods by using valuation methods within the context of informed group deliberation (Sagoff, 1998). For example, Robinson *et al*. (2002) used the choice modelling method combined with the Citizens' Jury to determine a willingness to pay per household for moderate improvement in water quality within the Bremer River catchment in South East Queensland. While such methods are an improvement on contingent valuation surveys, they still do not overcome many of the criticisms which fundamentally relate to the placement of monetary values on non-market ecological and social goods. As Gregory *et al*. (1993) stated, "we applaud these improvements. However, the central problem remains: holistic responses to complex stimuli are not sufficiently sensitive to multidimensionality, because they require respondents to make difficult, unaided tradeoffs across attributes" (p. 184). Gregory *et al*. (1993) argue that "if values are constructed during the elicitation process in a way that is strongly determined by context and has profound effects on the resultant evaluations, we should take a deliberate approach to value construction in a manner designed to rationalise the process" (p. 186). They go on to summarise the merits of a MCA framework as a rational way of considering the multidimensional nature of market and non-market values.

Given the cost, time needed and complexity associated with undertaking valuation methods such as the hedonic pricing method (e.g. to determine the impact that water quality has on the value of neighbouring properties), contingent valuation, the choice modelling method, and the travel cost method for all potentially significant social and ecological externalities, an obvious alternative would be to use the benefit transfer method to support BCA. That is, quantified benefits or benefit-transfer functions from the literature could be used locally to *estimate* possible values. While the results of similar studies conducted elsewhere are potentially useful in a qualitative sense, they are less useful in a quantitative sense, the latter of which is required for BCA.

For example, knowing that numerous studies have found strong and positive correlations between water clarity (and other easily observable water quality characteristics) and residential house prices may be useful *qualitative* information for a group of people undertaking an analysis of several constructed wetland designs, each with differing areas of open water. However, if one attempts to use benefit transfer in a *quantitative* sense to generate a monetary estimate of the likely increase in housing prices associated with the design options, it is likely that the confidence intervals around these estimates would be greater than the difference between the estimates for each design option. That is, taking a quantitative approach, it would not be possible to realistically distinguish between the options being analysed.

2.10 Management of uncertainty

In decisions involving natural resource management there is often a high degree of uncertainty associated with some of the inputs to a decision. This is particularly the case in decisions involving urban stormwater management, where there is a great deal of uncertainty over issues such as the long-term maintenance requirements for some of the new, vegetated measures for stormwater treatment. In MCA, the degree of risk associated with an option (e.g. risk of failure) can be included as a specific decision making criterion if needed. Alternatively, uncertainty can be included as one of the inputs when constructing an 'impact matrix' that summarises the likely performance of each option against the decision criterion.

Note that BCA has been criticised for the way it manages and communicates risk (Gomboso and Morrison, 1996).

2.11 Practical considerations

A review of attempts to use BCA in a stormwater context further highlights the practical problems with this methodology for assessing the triple-bottom-line. Identified problems included the use of many unsupported assumptions (e.g. the methodology used Lund *et al*., 2000), impracticality in terms of the time and cost to run the methodology, a lack of existing data to attempt to quantify the costs and benefits of impacts on values that exist outside of a market, poor outcomes and the inability to distinguish between the quantified benefits of similar design options due to high levels of uncertainty. For example, CSIRO undertook a major benefit-cost study of a proposed water sensitive urban design project in Heathwood, Brisbane (CSIRO, 2002). Despite a highly qualified team and resources that would be in excess of the vast majority of stormwater projects, the report concluded with respect to quantified stormwater costs and benefits that "it is not possible at this [conceptual design] stage to discriminate between alternative scenarios at Heathwood" (p. 55). Triple-bottom-line assessments for urban stormwater projects need to be done at the conceptual design stage, typically using modest resources.

In contrast, the use of practical and scalable MCA methods has produced positive results for Australian projects that involve urban stormwater/water quality management. For example, the Gold Coast City Council's Water Futures Project used a comprehensive MCA process to develop and assess water management options for urban development in the Pimpama Coomera region (GCCC, 2003). A very similar methodology was used by Brisbane City Council for the Rochedale master planning exercise involving a large integrated water cycle management project (BCC, 2004; and Brisbane Water, 2004).

Another example originates from the CSIRO's Ecosystems Services Project, where MCA was used in conjunction with a Citizens' Jury process in the Goulburn-Broken Catchment of Victoria (see Proctor, 2001; Proctor and Drechsler, 2003). A simple MCA process was also undertaken to broadly evaluate the merits of structural and non-structural urban stormwater management practices on the Swan Coastal Plain in Perth, Western Australia (Parsons Brinkerhoff and Ecological Engineering, 2004).

In terms of the degree of effort to run an assessment process, MCA is also appealing when compared to alternative approaches such as BCA that incorporate attempts to quantify costs and benefits that exist outside of a market. The view that MCA is usually no more demanding than BCA is supported by Gregory *et al*. (1992) and Gregory *et al*. (1993). Given that the MCA process has been widely used for water resource planning, forestry, agriculture, power supply and energy policy (Joubert *et al*., 1997), the process would seem to be a practical tool for large-scale projects. The challenge in terms of practicality would seem to be tailoring the methodology so that it is also applicable for small to medium scale urban stormwater projects. To address this issue, the triple-bottom-line guidelines have incorporated three levels of assessment (i.e. basic, intermediate and high).

2.12 Cost efficiency analysis

Cost efficiency analysis is not recommended as an alternative to MCA in the context of these guidelines as this methodology typically assumes that the outcome and unassessed *benefits* of project alternatives are equal, and all that remains is to determine the lowest cost option. A choice such as whether to install a stormwater pond or whether to use streetscape bioretention systems have very different ecological and social benefits that need to be considered in the decision making process. For example, residents with small children may find the drowning-related risk associated with a stormwater pond to be a major concern that should be paramount in any decision making process.

3. Summary

In summary, the decision support framework provided by MCA is considered to be practical in the context of these guidelines, provides a high level of structure and transparency, can accommodate data in a variety of forms (e.g. qualitative or quantitative), can manage multiple and sometimes competing objectives, can manage uncertainty, can accommodate more than one participant, can help to build a consensus, avoids some impractical and controversial valuation methods, and provides the opportunity for public participation and deliberative decision making.

Due to the shortfalls of BCA that have been highlighted in this appendix, it is not recommended as a decision making framework in the context of the CRC's triple-bottom-line guidelines. These shortfalls have prompted other researchers, such as Joubert *et al*. (1997), to more broadly conclude that it is not an appropriate tool for evaluating investments that generate social and environmental externalities[3] (Prato, 1999).

3. An 'externality' can be defined as a cost or benefit that arises from an economic transaction (e.g. the construction of a wetland by a local Council) and falls on people who don't participate in the transaction (e.g. people living next to the wetland). These costs / benefits may be positive or negative and the values affected may be tangible (i.e. have markets) or intangible.

APPENDIX B

Incorporating Public Participation into a Triple-Bottom-Line Assessment

1. Introduction

The purpose of this appendix is to briefly examine 'public participation' methods and discuss how such methods can be integrated into a triple-bottom-line assessment process involving urban stormwater infrastructure. It has been written for people who are not experts in the area but need to quickly review potential options and gain an overview of how to undertake a selected method. It has been written primarily for *public* stormwater management authorities that typically have a greater need to involve stakeholders in the assessment process compared to private developers.

While there are numerous, clear benefits from involving stakeholders in the assessment process, there are also significant practical constraints on the extent to which this can be done. The challenge is to identify the most suitable public participation method(s) to use for each project to ensure the resources required to run the method(s) are commensurate with the benefits stakeholders receive from the exercise. In practice, this requires a careful balance to be struck between the sometimes competing objectives of ensuring public participation methods are rigorous, inclusive and deliberative, while the overall process is relatively simple and cost-effective for stormwater management agencies to run.

2. What is Public Participation?

Public participation can be defined as the "active involvement of people in making decisions about the implementation of processes, programs and projects which affect them" (Blamey *et al*., 2000, p. 2 quoting Slocum and Thomas-Slatyer, 1995). Under this definition, the "people" (or public) may be traditional stakeholders (e.g. local catchment-based community groups) or potentially affected citizens.

Central to public participation "is the belief that ordinary people are capable of critical reflection and analysis and that their knowledge is relevant and necessary" (Slocum and Thomas-Slatyer, 1995, p. 11). Note that this underlining belief may not always be accepted by technical experts and managers within stormwater management agencies.

Blamey *et al*. (2000) suggested that the theoretical basis for much of public participation lies with the concept of 'participatory democracy'. Participatory democracy can be defined as all of those actions undertaken by citizens that are intended to influence the behaviour of those empowered with decision making roles (Chekki, 1979).

Authors such as James and Blamey (1999b) distinguish between two types of participatory democracy: co-determination models and self-determination models. The former involves mutual cooperation between non-expert citizens and experts as well as joint decision making (e.g. using methods such as Negotiated Rule-making, Citizens' Juries and Consensus Conferences). The later refers to a situation where citizens have complete autonomy in decision making. The types of public participation methods incorporated within these triple-bottom-line assessment guidelines only involve *co-determination models* of participatory democracy. That is, cooperation occurs between experts and non-expert citizens, however authority for the ultimate decision is *not* devolved to citizens. This reflects a political reality that exists within stormwater management agencies across Australia.

Public participation can occur in many forms which has led to several typologies being developed (e.g. those developed by Hart, 1992; Stiefel and Wolfe, 1994; Cornwall, 1996; Pimbert and Pretty, 1997; Land and Water Australia, 2001; and Biggs, 1998). Perhaps the most famous is Sherry Arnstein's (1969) "eight rungs on a ladder of citizen participation". Arnstein's eight rungs (or types) of public participation are shown in Figure B.1.

In this typology, Arnstein believes rungs 1 and 2 describe levels of "non-participation" where agencies that initiate the process enable people to participate in planning or conducting programs, but are primarily seeking to "educate" or "cure" the participants, rather than to genuinely seek their views. According to Arnstein, rungs 3 to 5 typically involve "degrees of tokenism" and limited sharing of power, while rungs 6 to 8 involve "degrees of citizen power". In short, as one steps up Arnstein's eight rung ladder, there is a greater degree of genuine public involvement and citizen control over the issue.

Building on earlier work by Pimbert and Pretty (1997), Blamey *et al*. (2000) developed a typology for public participation that has most relevance to the context of Australian environmental management. This typology is summarised in Table B.1.

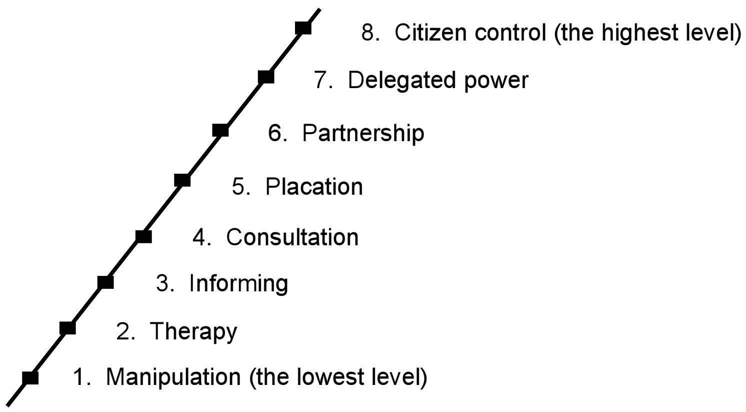

Figure B.1 Arnstein's Eight Rungs on a Ladder of Public Participation

Source: Arnstein (1969).

Table B.1 A Typology of Public Participation

Description of the Type	Components	Australian Environmental Management Example
1. Passive participation *(broadly equivalent to Arnstein's 'manipulation', 'therapy' and 'informing' types)*	▪ Unilateral announcement by authorities. ▪ No room for response by others. ▪ People are told what will happen or has happened.	Declaration of new National parks.
2. Participation in information-giving *(broadly equivalent to Arnstein's 'consultation' type)*	▪ Information extracted from participants through surveys or questionnaires. ▪ Participants cannot directly influence outcomes, as the results of the information collection process are not shared.	Visitor surveys conducted in National parks.
3. Participation by consultation *(broadly equivalent to Arnstein's 'placation' type)*	▪ Participants are consulted. ▪ Views are noted. ▪ Problem definition and solutions may be modified. ▪ There is no obligation to accept participants' views.	National park and State Forest planning in Victoria.
4. Participation for material incentives	▪ Participants provide resources (e.g. labour) in exchange for payment. ▪ Participants have no stake in continued involvement once the project ends.	Hiring of local residents as seasonal labour involved in National park or forest management.
5. Functional participation	▪ Participants form groups to meet pre-determined project objectives. ▪ Groups are often dependent on external initiators.	Friends of the Parks groups.
6. Interactive participation *(broadly equivalent to Arnstein's 'partnership' and 'delegated power' types)*	▪ People participate in joint analysis of options. ▪ Formation or strengthening of local groups occurs. ▪ Groups may continue after project ends.	Planning for the Great Barrier Reef Marine Park.
7. Self mobilisation *(broadly equivalent to Arnstein's 'citizen control' type)*	▪ Participants initiate action independently of the project.	Landcare groups.

Note: As one moves from type 1 to 7, there is increasing community involvement and empowerment.

Source: Blamey *et al*. (2000); James and Blamey (1999).

2.1 Discursive and deliberative forms of public participation

Throughout the 1990s, several researchers examined the potential of *discursive and deliberative* forms of public participation[1] to assist decision making in environmental management (e.g. James and Blamey, 1999b). These forms of participation are sometimes referred to as an expression of the 'deliberative democracy' philosophy. The increased use of deliberative methods for involving communities in decision making involving public policies and projects over the last decade is thought to be a worldwide trend (Land and Water Australia, 2001).

Under the 'deliberative democracy' philosophy, "deliberation is democratic, to the extent that it is based on a process of reaching reasoned agreement amongst free and equal citizens" (Bohman, 1997, p. 321). In addition, participants are seen as being able to act as 'citizens', considering the broader public good, rather than just 'consumers' (James and Blamey, 1999) or representatives of a segment of society.

James and Blamey (1999b) contrast the philosophy of 'deliberative democracy' with that of 'elite theory'. Under elite theory, citizens in modern democracies are seen as apathetic, politically uninformed and able to be manipulated (Bohnian and Rehg, 1997). In addition, under the 'elite theory' the scope of democracy is restricted to elected leaders who have the power to make decisions on behalf of all citizens, typically being advised by technical experts.

Discursive and deliberative forms of public participation have many advantages, including:

- the ability to build human and social capital during the *process* (i.e the process may have intrinsic value);
- the ability to allow participants to *construct* preferences by providing a forum for access to the best available information, discussion and debate;
- the production of results which, being more fully considered, are typically more robust and less susceptible to manipulation (Sagoff, 1998);
- reinforcement of larger democratic institutions and processes (Sagoff, 1998);
- the ability to identify possible options that were not previously considered by 'experts' (i.e. deliver enhanced outcomes);
- the creation of an enhanced level of political credibility to the public participation process as well as the final decision; and
- improved implementation of the ultimate decision due to genuine involvement of affected stakeholders.

One of the reasons there has been focus on this form of public participation is that it provides a mechanism to more confidently characterise a community's views on ecological and social values compared to traditional methods that are used in benefit cost analysis, such as 'willingness to pay' surveys. As explained in Appendix A, there are significant drawbacks with using willingness to pay studies to elucidate a monetary value on a good or service that exists outside of a market (e.g. the intrinsic value of a local aquatic ecosystem). Deliberative and discursive public participation methods, such as Citizens' Juries and Consensus Conferences, have the ability to explore a community's views on such goods or services, without necessarily placing a monetary value on them. When coupled with multi criteria analysis as a framework to systematically work through the pros and cons of various options, these public participation methods can be highly valuable tools to explore the financial, social and ecological costs and benefits in qualitative and/or qualitative terms.

In this context, Sagoff (1998) suggested that "the possibility that the dynamics of group discussion and deliberation - as well as access to information - might improve the reliability of socio-economic research into

[1] In this context, 'discursive' means the process is free to explore all aspects of the project and 'deliberative' means including an opportunity for participants to discuss their views and those of experts.

environmental values draws on a large body of established theory in social psychology (Delbecq *et al*., 1975; and Habermas, 1984), social learning (Bandura, 1971), public participation (Fiorino, 1990; and Laird, 1993) and group decision making processes (Burns and Uberhorst, 1998; and Clarke, 1989) in relation to environmental problems. Introduction of a more discursive approach to value elicitation also makes intuitive sense" (p. 227).

As a consequence of these beliefs, new decision support systems have been developed to combine technical expertise with the community's values and preferences, within a process of rational decision making (Stern, 1991; and Renn *et al*., 1993). For example, Renn *et al*. (1993) outlined a three-step procedure to involve traditional stakeholders, citizens and experts in public policy-making decisions that incorporates multi criteria analysis and deliberative public participation techniques (i.e. Citizens' Panels/Juries). This model is one of the foundations for the methodology developed in these triple-bottom-line assessment guidelines for urban stormwater projects.

3. Additional Terminology

The discussion above has broadly defined 'public participation'. Additional terms that are used in this appendix are briefly defined below.

Citizen science

The CRC for Coastal Zone, Estuary and Waterway Management (CRC-CZEWM) defined 'citizen science' as a "participatory process for including all sectors of society in the development and conduct of public-interest research in order to bridge the gaps between science and the community and between scientific research and policy, decision making and planning. Bridging these gaps involves a process of social learning through sound environmental research, full public participation, the adoption of adaptive management practices and the development of democratic values, skills and institutions for an active civil society" (CRC-CZEWM, 2004). Involving the community in deliberative participatory processes such as those promoted in the triple-bottom-line assessment guidelines for urban stormwater infrastructure for 'high' level assessments is a form of citizen science.

Consensus

Public participation techniques that involve group deliberation and decision making usually aim for consensus on the issue being assessed. At a superficial level, consensus can be interpreted as meaning broad agreement. At a deeper level however, a "true consensus process taps into the creativity, insights, experience and perspectives of all parties involved. Significantly, a consensus process treats the differences between people not as problems, but as stimulants to deeper inquiry and greater wisdom" (The Co-intelligence Institute web site, 2004).

Deliberative public participation methods

Deliberative public participation methods allow for the construction and elicitation of informed preferences from stakeholders. These techniques include Citizens' Juries and Consensus Conferences, where stakeholders (e.g. randomly selected members of the public) have the opportunity to carefully consider information that is presented to them, ask questions of experts, share views with other stakeholders, and over several days come to an informed decision.

Democracy

Public participation techniques (particularly those that are deliberative) are often described as being an expression of 'participatory democracy' (Carson, 2001). In such contexts, 'democracy' is the antithesis of centralised power, referring to the ability of citizens to influence policy and projects that potentially affect them at any level. As Carson (2001) explains, "we need not restrict our thinking to systems of government - we can do democracy at any time, any place".

Stakeholders

In the context of this paper, stakeholders include any person or group who may be potentially affected by the project.

The term 'traditional stakeholders' is used to describe those groups traditionally consulted during urban stormwater projects (e.g. local catchment groups, local resident groups, local councillors, etc.). Note however, that some public participation methods primarily target randomly chosen representatives of the public[2]. This tactic aims to foster cooperative decision making that considers the broader *public good* rather than narrow, sectional interests.

4. Principles of Public Participation

Land and Water Australia (2001) summarised the principles of effective public participation in the context of natural resource management. They concluded that effective participation should:

- be broad and not limited to those with direct interests in the outcomes;
- incorporate the values and interests of participants;
- be negotiated to accommodate the needs of potential participants, not just at the beginning but throughout the life of the project;
- engender intrinsic motivation and therefore creativity;
- enhance human and social capital;
- be aligned with the available resources;
- cater for the cultural differences of participants; and
- ensure that participants are truly representative of the potentially affected population.

5. Why Involve the Public?

Increasingly, many community representatives in Australia want and expect to be involved with public policy decisions involving natural resource management.

Blamey *et al*. (2000) suggested there are two main reasons why public participation in projects with an environmental management dimension is justified. Firstly, it is likely that the project will fail or deliver limited success if all of the relevant stakeholders are not effectively involved. Secondly, stakeholders, who by definition are potentially affected by the project, have a *right* to be involved in a democratic society.

Webler *et al*. (1995) supported the first of these two reasons, suggesting that processes of public participation in environmental and social impact assessments produce high quality decisions due to the incorporation of local knowledge and the public examination of 'expert' knowledge. They also suggested that the legitimacy of the final outcome is higher when affected parties have had the opportunity to state their case in the presence of other members of the community and provide input to the final decision.

Land and Water Australia (2001) also supported the view that public participation can be a means to achieve enhanced on-the-ground results (i.e. enhanced natural, financial and/or physical capital). Another perspective is that public participation leads to empowerment of individuals and greater social practice. That is, enhanced social and/or human capital may also result (e.g. increased cohesiveness amongst individuals and groups in the community, greater confidence of individuals, increased knowledge and skills of individuals, etc.).

Some commentators believe that genuine community involvement in projects such as proposed urban water infrastructure may not only play a part in reviving the public interest in environmental protection per se, but may also renew the energy and enthusiasm of citizens to contribute to public policy development in other areas (Civic Environmentalism Working Group web site, 2003). As Webler *et al*. (1995) stated: "when citizens become involved in working out a mutually acceptable solution to a project or problem that affects their community and their personal lives, they mature into responsible democratic citizens and reaffirm democracy" (p. 444).

[2] Note that traditional stakeholders are not excluded from these methods. They are typically involved as 'expert witnesses' with as much status as technical experts from government agencies or research bodies.

In an important research project in the context of Australian stormwater management, Ryan and Rudland (2001) examined ways in which engaging the community could substantially increase the performance of urban stormwater quality management. They concluded that the primary keys to success for sustainable and integrated stormwater management were increased community participation (involving individual activity, community stewardship and deliberative decision making), an improvement to the knowledge-base on which decisions are based, enhanced capacity building activities and systematic analysis of institutional arrangements.

This new approach is a response to the failure of traditional practices in stormwater management to deliver sustainable outcomes. These traditional approaches are characterised by lack of clarity and knowledge about community views and a reliance on limited professional perspectives (Ryan and Rudland, 2001). Drawing on experience derived from a stormwater management case study in Waverly, Sydney, Ryan and Rudland (2001) concluded that genuinely involving citizens in decision making processes can serve to "build capacity across the community and local government and hence the quality of outcomes, encourage sustainability and ensure integrated approaches to stormwater management" (p. 5).

Ryan and Brown (2000) examined the effectiveness of community education as a ‘non-structural measure’ to improve urban stormwater quality in Australia. They argued that the traditional, top-down, technocratic, elitist approach where education programs are devised by ‘experts’ and imposed on stakeholders has not produced tangible results. Instead, Ryan and Brown advocate a bottom-up approach, "which is concerned with spreading control and ownership as widely as possible throughout the urban watershed community to enable the most effective treatment outcomes" (p. 14). They recommended the use of deliberative public participation programs that involve the community early in both the examination of the problem *and* the development of possible solutions as a superior alternative to traditional educational strategies. They concluded that "community education is limited in its impacts if deliberative participation strategies are not *also* employed in stormwater management" (p. 15).

Ryan and Brown's conclusions generally reinforce the view that the process of deliberative public participation can produce more long-lasting and far reaching benefits than just an informed decision on a particular stormwater project.

The importance of public participation in delivering sustainable solutions has also been highlighted through the CSIRO's Ecosystem Services Project[3]. For example, Cork and Shelton (2000) suggested that to learn from past mistakes and to achieve sustainable natural resource management solutions, requires:

- accumulation of a strong and relevant knowledge base relating to ecosystem services;
- active communication amongst the community;
- institutions that are flexible and able to adapt and learn despite uncertainties and gaps in our understanding of the Australian environment; and
- more effective involvement of "ordinary people and private enterprise" in the development and implementation of policies and plans.

One of the key findings from a case study of the Ecosystem Services Project that was undertaken in the Goulburn Broken catchment in Victoria is particularly relevant to the methodology adopted in the triple-bottom-line assessment guidelines for stormwater projects. CSIRO concluded that “combining Citizens’ Juries and multi criteria evaluation is a powerful way to capture and develop community values. … The jury process combined well with multi criteria evaluation, which allowed for the unravelling of complex decision problems and the identification of trade-offs” (CSIRO Sustainable Ecosystems, 2003, p. xv).

[3] The CSIRO's Ecosystem Services Project aimed to "provide a detailed assessment of the goods and services coming from a range of Australian ecosystems, an assessment of the consumers and consumption of these services, and an evaluation of the economic costs and benefits of the services under future management scenarios" (Cork and Shelton, 2000, p. 156).

Berry *et al*. (2003) suggested that involving *citizens* in deliberative and representative participatory processes (in contrast to traditional stakeholder groups) can be an effective way of minimising the influence of self- or sectorial-interests in public policy development. They also argued that decision making that incorporates deliberative participatory techniques can build a mandate for change that can help to sustain policies or decisions within corporate structures. This view is supported by Webler and Renn (1995) who noted that public participation can assist in the implementation phase of the decision making process by increasing the responsiveness of public organisations that are charged with acting on the outcomes.

Finally, in some cases, deliberative and discursive forms of public participation can help to resolve or reduce conflict between stakeholders (Webler and Renn, 1995; Fiorino, 1990; Davis, 1986; Elliott, 1984; and Grima, 1983). For example, 'negotiated rule-making' is a form of public participation where conflict exists between stakeholders and mediation is used typically in the design of regulations (e.g. State government statutes) or legally binding licence conditions (e.g. on major industrial premises). In this context (i.e. where conflict exists), environmental dispute resolution (or mediation) techniques can be seen as one of the strongest forms of public participation (Ross, 2003). Reported benefits of these techniques include improved outcomes, greater credibility and legitimacy of outcomes, greater understanding of the views and interests held by other stakeholders, and improved relationships between stakeholders (Susskind and Secunda, 1998; Schneider and Tohn, 1985; and Ross, 2003).

6. Who to Involve

Choosing who to be involved in a public participation program can be a challenging task. Ethics and practical considerations play major roles.

From an ethical perspective, it is suggested that all people should be involved as stakeholders when they are likely to be affected by the outcome of the project and there is a reasonable chance of their involvement influencing the final decision. This ethical principle is strongly advocated by the 'civic environmentalism' movement which is "based on the simple premise that the people who live in a particular place should, to the extent possible, make the crucial decisions about common issues involving its physical resources and public space. By so doing they develop their capacity to deliberate about the subtle and difficult choices which such decisions necessarily involve. The character and quality of the citizenry is improved by means of its effort to improve its physical surroundings" (Civic Environmentalism Working Group web site, 2003). Note however that in the context of the triple-bottom-line guidelines for urban stormwater projects, public participation is proposed as a means to *inform* the ultimate decision maker, not replace them (i.e. ultimate control over a stormwater decision is not intended to be fully devolved to unelected citizens).

From a practical perspective, finite resources limit the extent to which people can be involved in public participation processes. For example, resources may limit the type of public participation program that can be used, the number of people involved or the type of stakeholders involved (e.g. traditional stakeholder groups versus a statistically representative sample of potentially affected citizens). In recognition of these constraints, resources such as the Citizen Science Toolbox (www.coastal.crc.org.au/toolbox/details.asp) have been developed to help people choose a public participation method that best suits the project's aims as well as available time, budget, skills, etc.

In the context of decisions relating to major urban stormwater projects over the past few decades in Australia, public participation has *typically* been non-existent or consultative in nature (i.e. at best, only half way up Arnstein's eight rung ladder as shown in Figure B.1). Consulted stakeholders have typically included local community groups, directly affected citizens (e.g. those who may be adjacent to a proposed constructed wetland), technical experts and local government councillors. In contrast to this traditional approach, deliberative public participation methods like Citizens' Juries and Consensus Conferences attempt to *also* involve citizens who are representative of the population potentially affected by the project. These citizens will not normally be representatives of traditional stakeholder groups (e.g. local catchment groups) or those that have a strong self-interest (e.g. people whose land may be purchased as a result of the project). This strategy is to encourage the participants to consider the views of traditional stakeholders and then act cooperatively for the broader public good rather than any sectional interest.

In the methodology developed for the triple-bottom-line assessment guidelines for stormwater projects, it has been recommended that *deliberative* public participation methods (e.g. those for the highest tier of assessment) should target a representative group of potentially affected citizens who are likely to act for the broader public good, while *consultative* public participation methods (e.g. those for the lower tiers) should target traditional stakeholder groups and directly affected citizens for the sake of practicality.

7. Relevant Trends in Public Participation

Researchers and commentators have noted two relevant trends over the last decade:

- Recognition by public authorities of the need to empower communities in order for them to genuinely participate in decisions that have the potential to affect them (Blamey *et al*., 2000; and Slocum and Thomas-Slatyer, 1995).
- Public participation has grown considerably as a management methodology in natural resource management agencies (Land and Water Australia, 2001).

Land and Water Australia (2001) also highlighted that policy makers and natural resource managers in Australia are now required to use public participation methods that:

- incorporate aspects of inter- and intra-generational equity; and
- include communities and traditional stakeholders in policy and management decisions.

Land and Water Australia (2001) also stressed the importance that public participation can play in supporting the current focus on 'sustainability' in natural resource management and ecologically sustainable development. For example, the 'capital assets model' of sustainability suggests there are five types of capital which summarise the total stock of assets. These are natural, social, human, physical and financial capital (Pretty and Frank, 2000). This model suggests that sustainable systems accumulate these stocks, while unsustainable systems deplete them. Using the capital assets model, *sustainable* policy decisions involving stormwater management should at least partially aim to build the capacity of citizens, groups and social cohesion. Deliberative and discursive public participation methods can assist this process.

8. Practical Constraints in the Context of these Assessment Guidelines

An analysis of public participation options within the context of triple-bottom-line assessment decisions involving urban stormwater projects must be cognisant of the practical constraints experienced by institutions that would need to run the process (e.g. local government authorities). The need for practicality has been strongly emphasised by potential users of the triple-bottom-line assessment guideline. In this context, practical constraints and barriers typically include:

- Limited time to run the public participation process.
- Limited human resources and financial resources to run the process.
- Fear of losing control of the process and the final decision.
- The inability of agency staff to devolve decision making to stakeholders because of political constraints.
- The chosen public participation methodology must have a low risk of adverse political outcomes (otherwise it will not be approved).
- Lack of confidence by some agency staff that citizens may be able to grasp some of the technical issues.

To address many of these issues, stormwater agencies need triple-bottom-line assessment methodologies (which include a public participation element) that are *flexible* so they can be easily applied to small and major projects. Unless this flexibility is delivered, there is a significant risk of the methodology not being used for the vast majority of decisions made by stormwater management agencies that should consider the triple-bottom-line. This is the rationale for the high, medium and low levels of assessment that have been built into the triple-bottom-line assessment guidelines.

9. An Examination of Relevant Public Participation Methods

This section briefly summarises those public participation methods that are potentially useful to support multi criteria analysis involving stormwater projects that aim to improve urban waterway health. A brief summary of each method is provided, as well as a commentary on the pros and cons of the method and potential application to the triple-bottom-line assessment guidelines. References for further information are also provided.

Table B.2 lists nine public participation methods that are considered to be relevant to decision making involving stormwater projects to improve urban waterway health. The table indicates the *relevance* of these methods to the three levels of assessment in the triple-bottom-line assessment guidelines (i.e. 'basic', 'intermediate' and 'high'). In addition, the table highlights those methods that are *recommended* for each level of assessment and have been included in the methodology for the triple-bottom-line assessment guidelines.

Table B.2 Relevant Public Participation Techniques to the Triple-Bottom-Line Assessment Guidelines

	LEVEL OF ASSESSMENT FOR THE STORMWATER PROJECT		
	High	**Intermediate**	**Basic**
Multi Criteria Analysis (MCA) details:	Process undertaken by a group of representative citizens who are likely to act for the broader public good with input from relevant 'experts' (e.g. technical experts, representatives from traditional stakeholder groups and directly affected citizens with strong self-interests).	Process undertaken by a group of technical 'experts' with *consultation* involving community stakeholders (e.g. traditional stakeholder groups and directly affected local citizens).	Process undertaken by one stormwater manager with basic *consultation* involving technical 'experts' and other stakeholders (e.g. traditional stakeholder groups and directly affected local citizens).
RELEVANT PUBLIC PARTICIPATION METHODS		**Relevance**	
1. Consensus Conference	✓	×	×
2. Small Deliberative Panel (i.e. a scaled-down Citizens' Jury/Panel)	✓ (shaded)	×	×
3. Fishbowl	✓	~	×
4. Deliberative Opinion Poll	✓	×	×
5. Expert Panel	✓ (shaded)	✓ (shaded)	~
6. Delphi Study	✓	✓	✓ (shaded)
7. Workshop	~	✓ (shaded)	✓
8. Public Meeting	~	✓	✓
9. Public Conversation	~	✓ (shaded)	✓ (shaded)

Notes:

- **Key:** shaded box = recommended and incorporated into the triple-bottom-line assessment guidelines (where more than one option is shaded, a *combination* of the options is recommended); '✓' = relevant/applicable; '~' = potentially relevant/applicable albeit with significant limitations; and '×' = not relevant and/or practical.
- The public participation methods summarised in the above table is not an exhaustive list of available options. Many methods have been ruled out as being not relevant, practical and/or too limiting (e.g. focus groups, electronic democracy, referenda, etc.).
- If conflict between participants in the process is considered likely or has occurred, 'environmental mediation' (also known as 'environmental conflict resolution') may need to be incorporated into the public participation methods. For example, mediation may be needed in the context of deliberative public participation methods. For more information on mediation, see Susskind and Secunda (1998) and Ross (2003).
- See Table 3.2 in the triple-bottom-line assessment guidelines for more details on the three assessment levels.

1. Consensus Conference	
Description:	A Consensus Conference is a forum that is open to the public where a dialogue occurs between experts and citizens. Typically, a 'planning committee' prepares a 'charge' (i.e. a description of the issue to be addressed), organises a public meeting, selects participants for a 'citizen panel' (i.e. a representative sample of 10-20 people from an affected community), organises a neutral facilitator and selects an 'expert panel' in consultation with the citizen panel. Fourteen (14) people are commonly chosen to represent each panel. The conference lasts for two to four days, during which experts respond to questions from the citizen panel, the audience (i.e. the general public) has the opportunity to ask questions, and the citizen panel prepares a position statement with the goal of achieving consensus on the issue being discussed. At the end of the process, the planning committee prepares a report based on the outcomes presented by the citizen panel. This method has been used for major policy issues in Australia such as the nation's constitution and genetically modified foods. The method is also popular overseas, for example during 1987 to 2002, twenty-two Consensus Conferences were conducted in Denmark.
Primary benefits:	▪ Does not exclude any stakeholder. ▪ Engages *citizens* in the decision making process to foster decisions that consider the broader public good, rather than entrenched, uni-dimensional sectional or personal interests. ▪ Provides the opportunity for lay people to learn about an issue in depth, share their views and construct preferences (i.e. a deliberative approach). ▪ Bridges the gap between lay people and experts. ▪ Can generate new knowledge, ideas, human capital and social capital. ▪ Able to consider more than just 'yes/no' decisions due to the deliberative nature of the approach. ▪ Usually attracts interest from the media.
Primary limitations:	▪ One of the most expensive and time-consuming public participation methods (e.g. may cost $10,000 to $100,000 and the whole process can take up to 6 months to plan, run and review). ▪ Selection of panellists can be challenging (e.g. ensuring all interests are represented). ▪ Traditional stakeholder groups may resent not being included in the citizen panel. ▪ Requires excellent facilitation skills. ▪ Panellists typically require preliminary training and briefing (typically this takes two full weekends). ▪ Requires a lot of preparatory work. ▪ Relies upon lay people sifting through and evaluating potentially complex expert evidence. ▪ There is no guarantee that the recommendation(s) from the conference will influence the final decision (this limitation applies to all public participation methods summarised in this appendix).
Relevance to the triple-bottom-line assessment guidelines	For this method to be applicable to stormwater-related decisions, the project would need to be very significant in terms of its impacts on a community (i.e. require a 'high' level of assessment). Even then, it is suggested that the Consensus Conference would need to be *significantly scaled down* to make it practical to run (e.g. reduce the size of the panels, preparation time and time of the actual conference). Examples exist where this has been successfully done (e.g. the 'mini-consensus conference' reported by The Co-Intelligence Institute, 2004b).
References and further information:	▪ Andersen and Jaeger (2002). ▪ Aslin and Brown (2002). ▪ Blamey *et al.* (2000). ▪ COSLA (1998). ▪ CRC for Coastal Zone, Estuary and Waterway Management (2004). ▪ The Co-intelligence Institute (2004c).

2. Small Deliberative Panel (i.e. a scaled down Citizens' Jury / Panel)	
Description:	A Small Deliberative Panel is a term used in these guidelines to describe a Citizens' Jury/Panel that has been scaled down in terms of the number of people involved in the length of time it takes to operate, so that it is applicable to assessment processes involving stormwater projects. Citizens' Juries are a deliberative participation technique that have been widely used overseas for 30 years and are increasing in use in Australia. This technique uses a representative sample of 8-24 citizens who are usually selected at random. Paid jurors are briefed on the 'charge' of the jury (i.e. the issue to be resolved), supplied with background information and trained on aspects such as the rules of the proceedings, questioning witnesses, taking notes, etc. Expert witnesses address the jury and respond to questions from the jury. These witnesses can include representatives from traditional stakeholder groups. The witnesses should present all significant 'sides' of a controversial issue. An independent moderator/facilitator assists the process of deliberation among the group, which can take two to four days for a full Citizens' Jury. A jury report is produced and submitted to the ultimate decision making body. The decision making body finally responds to the jury's recommendations. This technique can be combined with: ▪ The Fishbowl method, where members of the public can observe the proceedings and sometimes interact with the jury. ▪ The Expert Panel method where a group of experts support the jury/panel, along with expert witnesses. Sometimes the Expert Panel and witnesses are collectively called an 'advisory group'. In the context of these guidelines, the Small Deliberative Panel would be run like normal Citizens' Jury/Panel except: ▪ The number of people on the panel would be limited to 8-12. ▪ The sitting time for the panel would be between 1 and 2 days. ▪ Pre-panel briefings and training would be replaced by simply supplying written material to participants prior to the event. ▪ The number of options, assessment criteria, and expert witness presentations would be minimised so that the process can be undertaken in 1 to 2 days. ▪ Some expert witness presentations may be replaced by brief written submissions to save time. ▪ Citizens on the panel would be paid approximately $200 for their involvement.
Primary benefits:	▪ Engages a broad range of *citizens* rather than just traditional stakeholder groups who may have narrower perspectives. ▪ This technique cleverly combines expert knowledge with the common sense and popular will of ordinary citizens into a final judgment. ▪ Can be used to engage members of the community who are distant from the issue (e.g. the usually 'silent majority'). ▪ A transparent process that allows opportunity for discussion, discovery and deliberation. ▪ An expression of public democracy. ▪ It enables expert opinion to be reviewed and challenged. ▪ It helps build human and social capital (e.g. increases the knowledge of participants, can promote a culture of citizenship and can help to generate social cohesion). ▪ May generate new options. ▪ Reflects a genuine commitment to community involvement on behalf of the host agency. ▪ Can attract the attention of the media. ▪ Draws on a long history of similar methods in the legal arena.

2. Small Deliberative Panel (i.e. a scaled down Citizens' Jury / Panel)	
Primary limitations:	▪ Obtaining a truly representative jury is difficult given the jury sizes are typically 8 to 14 people. ▪ Relatively expensive in terms of time and cost. ▪ The process depends heavily on the skills of the moderator/facilitator. ▪ The jury may not reach a consensus. ▪ Open to manipulation (e.g. selection of expert witnesses). ▪ May not be accepted by traditional stakeholder groups who are not on the jury. ▪ Citizens may have to learn about technically complex issues. ▪ Some citizens on the jury may have narrow personal interests and not act for the broader public good.
Relevance to the triple-bottom-line assessment guidelines	This deliberative public participation method is currently considered to be on the 'cutting edge'. It provides an opportunity for ordinary citizens to come to terms with complex issues, as well as scrutinise expert opinion. When the jury size is small (e.g. 8 – 12 people) and deliberation time is kept at a minimum (e.g. 1 - 2 days), the technique becomes potentially applicable to major decisions on stormwater projects that require a 'high' level triple-bottom-line assessment. In addition, a number of case studies have used this technique in combination with multi criteria analysis with positive results (e.g. see CSIRO Sustainable Ecosystems, 2003).
References and further information (for Citizens' Juries):	▪ Armour (1995). ▪ Aslin and Brown (2002). ▪ Blamey *et al.* (2000). ▪ Carson (2003) – note that this is a simple "how to" guideline for Citizens' Juries. ▪ Carson *et al.* (2000). ▪ Cork *et al.* (2001). ▪ COSLA (1998). ▪ CRC for Coastal Zone, Estuary and Waterway Management (2004). This resource contains a significant list of additional references. ▪ Crosby (1995). ▪ Crosby (1999). ▪ Guston (1998). ▪ James (1999). ▪ Jefferson Centre for New Democratic Processes (2002). ▪ Land and Water Australia (2001). ▪ Land and Water Australia (2002). ▪ Lenaghan (1999). ▪ Rippe and Schaber (1999). ▪ Robinson *et al.* (2002).

3. Fishbowl	
Description:	The Fishbowl method consists of an inner group of participants who are involved in a decision making process (e.g. around a round table) that is observed by a larger group who have opportunity for input and questioning. In some cases, people who are observing the proceedings may be able to join the inner group. Role plays are sometimes used to complement the method. Members of the public and/or experts can be participants of the inner group or observers.
Primary benefits:	▪ Useful when consultation with the broader community is required. ▪ Demonstrates a high level of transparency (e.g. the general public can be invited to observe). ▪ Can use the technique to complement other methods such as Citizens' Juries/Panels.
Primary limitations:	▪ Requires skilled facilitators. ▪ Works best where presentations are brief.
Relevance to the triple-bottom-line assessment guidelines	It is suggested that this technique could be applied in combination with a Small Deliberative Panel/Citizens' Jury for decisions involving stormwater infrastructure that require a 'high' level of assessment. That is, a typical Small Deliberative Panel could be undertaken, but members of the general public (including traditional stakeholder groups) could be invited to *observe* the panel and where appropriate, make comment on the proceedings and/or ask questions. This would increase the level of transparency and minimise the risk that traditional stakeholders would reject the process and its Recommendations.
References and further information:	▪ CRC for Coastal Zone, Estuary and Waterway Management (2004). ▪ Atlee (2002).

4. Deliberative Opinion Poll	
Description:	For this method, participants who are randomly selected from an affected community are surveyed, informed on a topic, then surveyed again. Briefing information and access to experts is provided typically at a 1 to 3 day public hearing. During the public hearing, participants have the opportunity to ask questions and hear from others. Often, the participants have the opportunity to split into groups and discuss the issue at hand.
Primary benefits:	▪ Given the method typically involves surveying 100 - 600 people using a random sample, the results can be extrapolated to the broader community. ▪ This method includes a baseline and post-information survey so that the effect of providing information and an opportunity for discussion can be assessed. ▪ The method can have broad educational benefits and promote informed citizenship.
Primary limitations:	▪ The cost and time requirements can be very high given the number of participants and the length of the public hearing. ▪ The process is largely dependent on the quality and type of information provided. ▪ Managing data from the surveys can be a challenge. ▪ Getting people to participate may be difficult given the time required to analyse detailed background information and attend the hearing.
Relevance to the triple-bottom-line assessment guidelines	A scaled-down version of this method could potentially be used for decisions involving proposed stormwater projects that involve a 'high' level of assessment. The affected community could be survey, provided with information and then surveyed again. However, the relatively large number of people typically involved would limit the ability of the stormwater agency to pay participants, which could significantly reduce the extent of participation. Compared to methods such as Citizens' Juries, Deliberative Opinion Polls are more representative, but provide less opportunity for deliberation, the sharing of views, and consensus building.
References and further information:	▪ COSLA (1998). ▪ CRC for Coastal Zone, Estuary and Waterway Management (2004). ▪ International Association for Public Participation (2000).

5. Expert Panel	
Description:	An Expert Panel is typically used when highly specialised input is required, the issue is highly contentious and/or there are possible legal ramifications. A panel of experts is first selected, which may include members from traditional stakeholder groups. Background information is provided to the panellists as well as operational ground rules for the panel. Public input may be incorporated (e.g. using the Fishbowl method). Panel discussion is moderated by an independent facilitator, usually over a period of one day.
Primary benefits:	▪ Allows contentious and/or complex issues to be quickly addressed. ▪ Outcomes are likely to have a high credibility from a technical and legal perspective. ▪ The briefing process may take less time than techniques involving citizens. ▪ Can attract the attention of the media.
Primary limitations:	▪ Does not easily incorporate public opinion or values into the decision making process and does not allow much time for deliberation. ▪ The cost of engaging experts can be significant. ▪ May appear elitist. ▪ It may be difficult to coordinate the schedules of busy experts. ▪ Not a tool that copes well with addressing the social element of the triple-bottom-line. ▪ Experts may not reach a consensus (e.g. due to egos, fixed paradigms, etc.). ▪ Non-invited experts may be offended and hinder the success of the assessment process.
Relevance to the triple-bottom-line assessment guidelines	Despite the name, some Expert Panels involve traditional stakeholders and members of the public as ‘experts’ in various fields (e.g. Pont and Osborne, undated). Expert Panels can also be used as part of a Consensus Conference. In the context of triple-bottom-line assessment for major stormwater decisions, it is suggested that an Expert Panel should be used for: 1. ‘High’ levels of assessment if it is supplemented by other *deliberative* public participation methods that elucidate values and considered opinions of the public. For example, a Small Deliberative Panel for a ‘high’ level assessment could: ▪ examine options and draft criteria that were developed by a small Expert Panel; ▪ call witnesses from the same panel (as well as other witnesses); and ▪ use information from the panel that predicts impacts on the assessment criteria that that would be associated with each option (i.e. an ‘impact matrix’). Such a strategy incorporates both expert opinion and the considered views of the public. The triple-bottom-line assessment guidelines adopts this approach, but uses the term ‘advisory group’ to refer to the Expert Panel and key representatives of traditional stakeholder groups. The ‘advisory group’ supports the Small Deliberative Panel. 2. ‘Intermediate’ levels of assessment when combined with *consultation* methods such as Workshops and Public Conversations which are used to engage other stakeholders.
References and further information:	▪ CRC for Coastal Zone, Estuary and Waterway Management (2004). ▪ International Association for Public Participation (2000). ▪ Pont and Osborne (undated).

6. Delphi Study	
Description:	Delphi Studies involve sharing information, ideas and views amongst a group that does not have to physically meet. It is similar to an Expert Panel or Workshop that communicates via phone, mail or e-mail. It is typically used to generate ideas and to facilitate consensus among individuals who may have special knowledge of an issue but do not usually meet. It involves circulating written information as well as subsequent notes and comments. It is a simple, low-cost method for quickly gaining views of stakeholders and sharing these amongst a group.
Primary benefits:	▪ Relatively low-cost, simple and easy to run. ▪ Allows stakeholders to participate even when they are geographically isolated. ▪ Useful at producing a consensus decision. ▪ Useful for managing technical issues. ▪ Convenient for most participants.
Primary limitations:	▪ Often, large amounts of data need to be assessed and distributed. ▪ Involvement of participants may decline if the process is too lengthy or too much information is provided. ▪ May discriminate against participants without computing skills or facilities (as e-mail is often used as a communication tool). ▪ The ability of participants to interact with each other is limited compared to many face-to-face methods. ▪ Only a relatively small group of people are typically involved.
Relevance to the triple-bottom-line assessment guidelines	It is suggested that this method could be used in three contexts: ▪ For projects requiring a 'basic' level of assessment, where public participation needs to be simple, quick, low-cost and *consultative* in nature, an e-mail or post-based Delphi Study could be established using traditional stakeholder groups and directly affected citizens. The purpose would be to quickly gain feedback from the group as part of the decision making process. ▪ For projects requiring an 'intermediate' level of assessment, a Delphi study could be used when involving experts in the multi criteria analysis (i.e. a substitute for an Expert Panel), and again when stakeholders are being consulted on the preliminary work done by the experts. ▪ For projects requiring a 'high' level of assessment, a Delphi Study consisting of technical experts could be used to support deliberative public participation methods like Small Deliberative Panels/Citizens' Juries (i.e. like an Expert Panel, except all the experts do not have to physically meet).
References and further information:	▪ Aslin and Brown (2002). ▪ CRC for Coastal Zone, Estuary and Waterway Management (2004). ▪ Nehiley (2001).

7. Workshop	
Description:	Workshops are a commonly used, traditional participation method to resolve issues. Workshops may be used to understand the public's views, discuss issues and/or build consensus for action. Workshops with a small number of people maximise participation. A neutral facilitator is typically needed to structure discussions and ensure all participants are engaged. Various techniques can be used within the workshop setting to gain feedback from participants (e.g. 'brainstorming' to generate ideas and the 'nominal group technique' to prioritise issues).
Primary benefits:	▪ A well-known technique that is not likely to intimidate participants. ▪ Well-suited to the analysis of alternatives. ▪ Builds ownership and credibility for the outcomes. ▪ Enables group discussion and group learning. ▪ Maximises the involvement of participants. ▪ Relatively inexpensive and easy to organise (depending on the length of the event and complexity of the issue).
Primary limitations:	▪ May need to break up the group if it is large. ▪ May need several facilitators if the group is split into sub-groups. ▪ Difficult to absorb complex material unless supplemented with additional techniques (e.g. presentations by experts). ▪ A decision needs to be made on who should be involved (e.g. technical experts, traditional stakeholders, citizens, agency staff, etc.). ▪ Some participants may be inhibited when asked to comment within a group setting. ▪ Can be difficult for the facilitator to maintain control of the workshop's process and direction. ▪ Groups can be dominated by one or two participants. ▪ Getting people to attend can be difficult.
Relevance to the triple-bottom-line assessment guidelines	A basic Workshop involving traditional stakeholders and directly affected participants could be used as a simple *consultation* tool for 'basic' to 'intermediate' assessment levels involving stormwater projects. The purpose of this Workshop would be to review and comment on the results of a multi criteria analysis that has been done by an Expert Panel ('intermediate' level) or experienced stormwater manager ('basic' level). Once the Workshop starts to incorporate elements such as presentations by technical experts, detailed background briefing material, deliberations that last more than a day, and the use of multi criteria analysis that is *conducted by the workshop participants*, the event has evolved into a deliberative participation method and would only be suitable for stormwater projects subject to a 'high' level of assessment (see the notes for a Small Deliberative Panel).
References and further information:	▪ Aslin and Brown (2002). ▪ COSLA (1998). ▪ CRC for Coastal Zone, Estuary and Waterway Management (2004). ▪ International Association for Public Participation (2000).

8. Public Meeting	
Description:	Public Meetings are intended to engage a wide audience in information sharing and limited discussion. The size may vary from a few people to hundreds. A facilitator encourages two-way communication and a recorder makes notes of suggestions and issues. A public meeting is a traditional, well-known technique for gauging the degree of public interest in an issue, bringing people together to express their opinions, share information and receive feedback. Smaller focus groups may be organised to assist people to participate if they do not feel comfortable speaking before a larger group. The findings of these focus groups can then be incorporated into the larger public meeting. Conducting a smaller group exercise before the public meeting is also a sensible strategy to ensure that the public meeting is designed to adequately address community concerns. Public meetings can involve the presentation of technical material from experts and allow for limited discussion.
Primary benefits:	▪ Allows for the involvement of a wide range of people. ▪ A good mechanism to disseminate information throughout a local community and get a 'snapshot' of public opinion on an issue. ▪ Provides an opportunity to explore alternative options (albeit in a superficial manner).
Primary limitations:	▪ Individuals may dominate the meeting. ▪ Conflict may reduce the productivity of the meeting and damage social capital. ▪ May not achieve a consensus. ▪ Difficult to communicate very detailed or complex information within the context of public meeting due to time constraints. ▪ Difficult to get meaningful discussion and deliberation amongst participants during the meeting. ▪ Difficult to get a good attendance if the meeting extends for more than a few hours.
Relevance to the triple-bottom-line assessment guidelines	Like Workshops, Public Meetings involving traditional stakeholders and directly affected participants could be used as a simple *consultation* tool for 'basic' to 'intermediate' assessment levels involving stormwater projects. The purpose of these Workshops would be initially gauge public opinion (e.g. on options, criteria and weights/values) and then review and comment on the results of a multi criteria analysis that has been done by Expert Panels or experienced stormwater managers. Typically two meetings would be needed to achieve this goal. Using this method, limited background material could be provided, limited opportunity could be provided for the participants to interact with each other and experts, and participants would be commenting on the decision making process rather than actually participating in the process.
References and further information:	▪ Aslin and Brown (2002). ▪ COSLA (1998). ▪ CRC for Coastal Zone, Estuary and Waterway Management (2004).

9. Public Conversation	
Description:	Also known as 'interviews', Public Conservations are discussions that allow participants to be engaged in an informal, personal and direct manner. They can be used to discover issues of relevance/concern, who is affected by an issue, as well as people's knowledge, beliefs and values. The process is free-ranging, unstructured and designed to be non-threatening. While *group* Public Conversations are possible, the individual version of this method (i.e. one-to-one conversations) is considered most relevant to the triple-bottom-line guidelines for stormwater projects. Face-to-face interviews/conversations are recommended at a time and place that is suitable to the participant. The interviewer's role is critical. The person must have suitable skills and engender trust.
Primary benefits:	▪ Can be used as a precursor to more advanced styles of public participation (e.g. a Workshop or Small Deliberative Panel). ▪ Can be used to understand people's values and beliefs prior to undergoing a decision making processes. ▪ Maintains and establishes good community relations. ▪ Directly involves participants in a non-threatening manner.
Primary limitations:	▪ Because it is an intensive technique, it can be costly and time-consuming to use, thereby limiting the number of people that can be involved.
Relevance to the triple-bottom-line assessment guidelines	It is suggested this technique has relevance in two contexts: ▪ For projects undergoing a 'high' level of assessment, the technique can be used as an *initial step* to identify key stakeholders, their concerns, values, current level of understanding, etc. ▪ For projects undergoing a 'basic' or 'intermediate' level of assessment, the technique could be used to: o *inform* a decision making process conducted by a panel of experts or experienced stormwater manager; and/or o *gain feedback* from stakeholders on the option recommended by a panel of experts or experienced stormwater manager.
References and further information:	▪ CRC for Coastal Zone, Estuary and Waterway Management (2004). ▪ International Association for Public Participation (2000).

10. Sources of Additional Information on Public Participation Methods

Given the wide variety of public participation methods that can be applied for a specific issue and context, several resources are available that briefly summarise potential options from which a manager may choose. The following resources are recommended as a supplement to this appendix:

- The 'Citizen Science Toolbox' developed by the Cooperative Research Centre for Coastal Zone, Estuary and Waterway Management and the Cooperative Research Centre for Catchment Hydrology provides an online reference for over 60 types of public participation methods. The Toolbox also includes a search engine to help users choose a suitable method. The Citizen Science Toolbox is available at www.coastal.crc.org.au/toolbox/index.asp (October 2004).
- 'Focusing on Citizens: A Guide to Approaches and Methods' (COSLA, 1998) provides a good summary of many public participation methods including their benefits and drawbacks. It can be accessed on-line at www.communityplanning.org.uk/documents/engagingcommunitiesmethods.pdf (October 2004).
- 'Terms of Engagement: A Toolkit for Community Engagement for the Murray-Darling Basin' (Aslin and Brown, 2002) is a good general public participation reference with advice on various participatory methods, including commentary on their strengths and weaknesses. It also includes some good secondary references. It is available at www.affa.gov.au/output/ruralscience.html (October 2004).
- 'Public Participation Toolbox' developed by the International Association for Public Participation (2000) is similar to the 'Citizen Science Toolbox'. Available at www.iap2.org/boardlink/toolbox.pdf (October 2004).
- 'Bibliography on Participation and Participatory Methods in Development Work and Research' (Andreassen and Mikkelsen, 2003) contains a comprehensive list of literature and websites that relate to participation and participatory methods. Available at www.cdr.dk/working_papers/wp-03-3.PDF (June 2005).
- The 'Participation Toolkit' developed by the Toolkit Partnership (a group of non-government organisations and local government agencies) is primarily a database of public participation case studies from around the world. Available at: www.toolkitparticipation.com (June 2004).
- 'Citizens' Juries and Environmental Value Assessment' (Blamey *et al*., 2000) provides a good summary of *deliberative* public participation methods (e.g. Citizens' Juries, Consensus Conferences, Environmental Mediation, etc.). It is available at http://cjp.anu.edu.au (October 2004).

11. Concluding Remarks

Decisions involving new stormwater projects to improve urban Waterway health should involve stakeholders to the maximum practicable extent. This view is based on the numerous potential benefits of involving stakeholders, as well as the ethical principle of enabling those people who are potentially affected by the project to have a genuine opportunity to influence the decision making process. The caveat of *practicality* reflects the reality of the decision making environment in stormwater management agencies, where the time, human and financial resources to run multi criteria analyses with public participation components are always limited.

For triple-bottom-line assessment decisions involving a '*high*' level of assessment, deliberative and discursive forms of public participation are encouraged to support the multi criteria analysis. Such public participation methods have been rare in the field of Australian stormwater management and represent a significant change to typical decision making processes in most stormwater management agencies. Implementing such change is likely to challenge some organisational cultures, processes and personal beliefs of some staff. This appendix has been prepared to help *explain* the reasons why such change has been promoted via the methodology in the triple-bottom-line assessment guidelines.

APPENDIX C

Information from the Literature on Externalities Potentially Associated with Urban Stormwater Projects to Improve Waterway Health

Table of Contents for Appendix C

1. Introduction

1.1 Purpose of this appendix

When undertaking a triple-bottom-line assessment of a proposed stormwater project to improve waterway health, it will be necessary to predict how the proposed project will affect social and ecological values (e.g. the amenity of the adjacent parkland, the value of the downstream recreational fishery) as well as related financial costs (e.g. reduced mains water use due to stormwater recycling). Section 3 of this appendix summarises qualitative and quantitative information from relevant valuation studies that can be used to help predict these consequences. This information has been provided as the vast majority of urban stormwater triple-bottom-line assessment projects would not have the time, financial or human resources to undertake site-specific valuation studies to estimate changes to social and ecological values.

Note that it is intended that the information in this appendix be used only in a qualitative and approximate manner to help with the rapid appraisal of proposed projects.

It is suggested that the information contained in this appendix will be of most use when creating the 'impact matrix' in the triple-bottom-line assessment process. That is, when potential options are being assessed against a range of assessment criteria by technical experts drawing on all available local information, experience and information from the literature.

The information presented in this appendix has been highly condensed so that stormwater managers can quickly identify information to assist their decision-making. References are provided to allow users to search for more detail should they require it. Additional information can also be obtained from relevant on-line environmental valuation databases (see Section 1.3 below).

Note that the financial figures provided in Section 3 of this appendix are in Australian dollars with the base date being the same as the reference date, unless otherwise stated. For example, a figure of "$435" referenced as "Taylor (2002)" would be $435 in 2002 Australian dollars.

1.2 Terminology

For guidance on terms used within this appendix, refer to the glossary in Chapter 5 of the main guideline.

1.3 Resources for further information

Estimating a monetary value for social and ecological costs / benefits is a relatively complex field of expertise, particularly when these costs / benefits exist outside of a market (e.g. the existence value of a healthy urban waterway). This field is associated with specialist terminology, many different types of valuation methods, and healthy debates about the legitimacy of several techniques (e.g. those that examine people's willingness to pay for non-use values).

This appendix will not attempt to summarise the theory of environmental valuation, as many references are easily available that can provide this background. The following documents and websites are recommended for those that want more information on valuation methods and terminology:

- *Techniques to Value Environmental Resources: An Introductory Handbook* (Commonwealth Department of the Environment, Sport and Territories, and the Commonwealth Department of Finance, and the Resource Assessment Commission, 1995). This is available at www.deh.gov.au/pcepd/economics/value/index.html (June 2005).
- The US *Ecosystem Valuation* website (King and Mazzotta, undated). Available at: www.ecosystemvaluation.org/ (June 2005). This web site describes how economists value the beneficial ways that ecosystems affect people and is designed for non-economists. It provides explanations of ecosystem valuation concepts, methods and applications.
- *Valuing the Costs and Benefits of Water Use* (Thomas, 2001). This paper provides an overview of valuation methods and the types of values /

externalities that may need to be considered in triple-bottom-line assessments involving major water projects. Available at: www.nlwra.gov.au (April 2003).

- *Valuing Externalities: A Methodology for Urban Water Use* (Bowers and Young, 2000). This report discusses externalities associated with urban water use as well as many types of values that may be affected by water use. It also recommends and explains types of valuation methods that can be used to place an approximate monetary value on different types of externalities. Available at www.clw.csiro.au/publications/consultancy/2000/Valuing_Externalities.pdf (June 2004).
- *The Economic Appraisal of Environmental Projects and Policies: A Practical Guide* (Winpenny, 1995).
- *Economic Analysis of Environmental Impacts* (Dixon, 1994).
- *Project Appraisal and Valuation of the Environment* (Abelson, 1996).
- *Cost-Benefit Analysis and the Environment* (Hanley and Splash, 1993).[1]

In addition to these general references, there are several on-line databases that summarise the results of a wide variety of valuation studies including social and ecological values. While this appendix attempts to summarise much of the information from such databases that is relevant to stormwater projects that aim to improve waterway health, new valuation studies will be continually added to these databases.

At least four databases exist which are relevant:

- *The Envalue Database* (www2.epa.nsw.gov.au/envalue/) which is maintained by the NSW Department of Environment Conservation (Environmental Protection Agency). It contains values derived from studies of a wide variety of environmental aspects including land, air and receiving water quality.
- *The New Zealand Non-market Valuation Database* (http://learn.lincoln.ac.nz/markval/) which is a similar, but smaller version of the Envalue Database.
- *The Beneficial Use Value Database* (http://buvd.ucdavis.edu) which is maintained by the University of California. It is an informational database of economic values for beneficial uses of water collected from a variety of sources, including journals, books, conference proceedings, government reports and working paper series.
- *The Canadian Environmental Valuation Reference Inventory™* (www.evri.ca/english/default.htm) is available by subscription. It is a searchable storehouse of empirical studies that involve placing an economic value on environmental aspects.

1.4 The need for caution

Information on costs and benefits that are described in financial terms can be used to powerful effect during decision-making processes. However, such power can easily be misused. This section highlights some of the areas where caution and commonsense are needed.

Most of the information summarised in this appendix is associated with unquantified levels of certainty and should be used with this in mind. For example:

- Studies suggest that there is a tendency for respondents to overestimate their actual willingness to pay in contingent valuation surveys that are often used to estimate non-use values (Holder, 2003).
- Information on the value of local recreational fisheries (which are dependent on healthy waterways) is controversial. Some economists argue that if recreational fishers were not spending money on fishing, they would be spending money on other recreational pursuits, so that the value of the industry to the local economy is minimal or non-existent. Other economists estimate the value of the fishery based purely on the income that

[1] For full referenced details, refer to the list of references in the main guideline.

could be generated if the caught fish were sold at market prices (either "wholesale" at the wharf or "retail" in the shops). Others estimate the value of the fishery based on the total expenditure by fishers during their fishing activities (e.g. money spent on their fishing gear, bait, food, fuel, boat, etc.).

The issue of transferring value (or 'benefit') related economic information from a study done in one area to another location is an important issue worthy of further discussion. For the triple-bottom-line assessment process outlined in these guidelines, it is recommended that results determined from an economic study in one location be transferred to the location of the assessment only in *qualitative* terms and only if the contexts of the two studies are very similar. For example, if a variety of valuation studies from the literature have demonstrated that at least a 5-10% premium exists on property values surrounding open water bodies in urban areas (i.e. they are worth more), one could use this information to conclude during the triple-bottom-line assessment that property values (and Council's rate revenue) are likely to slightly rise for properties immediately surrounding constructed wetlands with open water or ponds that are installed for the treatment of urban stormwater.

As Van Bueren and Bennett (2001) explain, monetary estimates of the value of environmental services are sometimes required when managing natural resources. Because the techniques to estimate these values when there is no market in place are usually expensive, time-consuming and sometimes controversial, it is a common practice to transfer estimates from an existing study to the site of interest (called 'benefit transfer'). This practice can lead to poor value estimates unless undertaken with care. People wishing to transfer values from one context to another to produce qualitative or quantitative value estimates should:

- examine whether the primary study was flawed;
- examine the similarities and differences between the context of the source and destination of the transferred information (e.g. the physical, ecological and social characteristics of the site and the extent of ecological / social change);
- understand the assumptions made during the original study;
- be conservative when using the transferred data (e.g. use a qualitative approach rather than a quantitative approach); and
- place appropriate caveats on the final conclusions that are produced from the transferral of information (Van Bueren and Bennett, 2001; and Hajkowicz *et al*., 2000).

Robinson (2002) provides a good discussion on the validity of benefit transfer to estimate monetary values within a *water management* context. She concludes that benefit transfer should be used only for broad decision-making exercises (e.g. policy decisions), where the monetary results are considered to be order of magnitude estimates. This conclusion highlights the potential error associated with benefit transfer when used in quantitative sense, and supports the approach taken in these guidelines to use benefit transfer only in a qualitative sense (i.e. to help inform people undertaking triple-bottom-line assessments whether ecological or social values are likely to be positive, negative, small, medium or large).

While this appendix is based upon the assumption that there are legitimate valuation techniques that can be used to place an approximate monetary value on *all* social and ecological benefits, it is acknowledged that some people disagree with this assumption. In fact, there is a healthy academic debate in the environmental economics literature about:

- whether natural assets (natural capital) and the ecosystem services they provide should be valued in a monetary sense (i.e. some people argue on an ethical basis that their non-use value is priceless);
- the strengths and weaknesses of some valuation methods (e.g. what valuation methods such as 'willingness to pay studies' are actually measuring for non-use values); and
- the significance of errors associated with some valuation methods.

For a brief summary and discussion of these concerns, see Appendix A. Note however that many of the arguments against using monetary descriptions of non-use values are negated or become less relevant if one intends to use the results of valuation studies in a *qualitative* manner.

The caveats and assumptions associated with estimates derived from various valuation methods should not be forgotten. For example:

- Travel cost valuation methods assume that the travel cost to gain access to a recreational site is a measure of recreational preference. This assumption may be violated if an individual moves to an area to improve access to a site. In this case the value to the individual of the recreational benefits of the site will be reflected not just in their travel costs but also in the costs of locating themselves in the area. As such, travel cost methods can underestimate the value of recreational benefits.
- Travel cost valuation methods *only* estimate the use-value benefits (e.g. the value of a recreational fishery to those who use it).

Care is also needed not to 'double count' values when using the results of more than one valuation method. For example, consider a study that uses hedonic pricing to value changes in residential property values around a waterway with recreational features (as a measure of amenity) *and* the travel cost method to value the wetland's recreational benefits. In this case, only visits by non-locals to the area should be included in the travel cost estimates for recreational benefits to ensure that no double counting takes place.

1.5 Knowledge gaps

There are many potential benefits and costs associated with projects to manage stormwater to improve the urban waterway health. While this appendix provides a good summary of results from relevant valuation studies that are currently available, it is apparent that many costs and benefits have not been valued in a monetary sense. Such gaps have also been highlighted by Thomas (2001) who broadly examined the data available for valuing the costs and benefits of water use in Australia. Areas highlighted by Thomas as being in most need of new valuation studies include:

- option and existence values for 'in-stream uses', both anthropogenic and ecological, for all types of surface water;
- long-term option values for 'withdraw uses' of surface waters (e.g. use of water for irrigation);
- damage and abatement costs associated with nutrients and heavy metals in surface waters;
- damage and abatement costs associated with groundwater contamination (e.g. by nutrients and heavy metals); and
- the economics associating with sustainable management of aquifers.

These knowledge gaps represent an opportunity for researchers to provide information that will assist the quality of triple-bottom-line assessment processes in the future and help to deliver better outcomes for residents and ecosystems within urban environments.

1.6 Acknowledgements

Some of the economic information summarised in Section 3 has been sourced directly from a project report commissioned by the Water Resources Branch of Brisbane City Council (i.e. Taylor, 2002). Their permission to use this information is acknowledged.

In addition, the assistance of Toby Holder (a summer student for the CRC for Catchment Hydrology in 2003) is acknowledged in gathering some of the economic information during a preliminary literature review.

2. Externalities and Values

2.1 Definitions

Externalities

Young (2000) defines an externality as "economic jargon for something that influences the welfare of individuals or a community through a non-market process. There is no market feedback from the person who experiences the loss or gain to the person who creates it. Costs and values are not revealed and, hence, not taken fully into account in the production process" (p. 4).

To illustrate this concept, consider a conventional stormwater drainage network in an urbanised catchment that discharges stormwater without treatment into a marina on the shores of an estuary. The 'life-cycle cost' of the stormwater *infrastructure* (as defined by the Australian Standard AS/NZS 4536:1999) does not include costs associated with periodically dredging sediment from the marina, removing floating litter that is trapped in the marina, reduced swimming opportunities in the estuary (due to high pathogen concentrations following rain), reduced recreational fishing opportunities in the estuary (due to smothering of seagrass beds by sediment), and the reduced amenity of the marina due to odour produced by rotting organic matter (which may result in reduced income for the operators of the marina). All of these additional costs that are not borne by the area's stormwater management agency are "externalities".

The inclusion of externalities in decision-making is particularly important when water sensitive stormwater drainage designs are being compared with conventional designs. For example at the first national water sensitive urban design (WSUD) conference in Australia, "conference participants flagged inclusion of externality costs as extremely important when assessing cost effectiveness [of WSUD infrastructure], because WSUD potentially provides a high level of protection for the environment and quality of life for urban communities" (Lloyd, 2001, p. 19). Using the marina example above, a water sensitive stormwater drainage design may have cost more in terms of stormwater infrastructure (i.e. the life-cycle cost of the asset), but may have substantially reduced the cost of externalities. The *net benefit* to the community may have been better served if the stormwater manager had adopted a water sensitive stormwater drainage design.

When seeking to include externalities into an assessment process, is important to clearly define the limits to which externalities will be included. To illustrate using the marina example above, a decision would need to be made whether to just focus on water quality-related costs and benefits in the marina or to also include broader benefits to the health of the estuary. Usually, all potential costs and benefits are initially listed but then screened so that only those that are likely to be substantial in nature and help to differentiate between options are included in the assessment.

Values

In this guideline, the term 'values' refers to services or assets that are important to people. For example, a proposed constructed wetland in public open space may effect surrounding recreational values. These values may be enhanced by the constructed wetland (i.e. create benefits). For example, the constructed wetland may create an aesthetic environment which is attractive to walkers and joggers. Conversely, these values may be adversely affected by the constructed wetland (i.e. create a cost). For example, the wetland may occupy a space once used for kicking a football, or has created a new drowning-related risk for young children using the public open space.

Specific types of values (e.g. non-use values, bequest values, existence values, etc.) that are commonly referred to in valuation studies are defined in the glossary (see Chapter 5 of the main guideline).

2.2 A typology of values

Table C.1 summarises those values that are potentially relevant to stormwater projects that aim to enhance urban waterway health. The values are grouped using a typology which builds on categorisation work by US EPA (2001b), Bowers and Young (2000) and WSDoT (2002).

Such values may be enhanced by the project (i.e. be a benefit) or be diminished (i.e. be a cost). The list of *possible* values in Table C.1 should be considered during the triple-bottom-line assessment process when assessment criteria are being developed.

Figure C.1 provides a conceptual model of how such values may be spatially represented around a major structural stormwater management measure that aims to improve waterway health (e.g. a constructed wetland or pond).

Table C.1 Values Potentially Affected by Stormwater Projects to Improve Urban Waterway Health

Types of Values to Consider	**Usually a Benefit or Cost?**	**Usually Considered an Externality?**	**Spatial Location for Stormwater Projects**		
			Upstream	**Within and Immediately Around the System**	**Downstream**
1. Use Values					
1.1. Direct use values (i.e. values associated with people correctly using the stormwater asset, the immediate environment, or downstream waters)					
1.1.1. Market values (i.e. a market exists to easily quantify these values)					
Use of recycled stormwater and/or recharged groundwater to reduce the need for mains water.	Benefit	Yes		✓	
Commercial fishing and/or aquaculture in affected receiving waters.	Benefit	Yes			✓
Tourism and/or water-based transport in affected receiving waters.	Benefit	Yes			✓
Opportunities for vandalism or theft in association with the stormwater infrastructure.	Cost	Yes		✓	
1.1.2. Non-market values (i.e. a market does not exist to easily quantify these values)					
Recreational fishing in affected receiving waters.	Benefit	Yes			✓
Swimming in affected receiving waters.	Benefit	Yes			✓
Boating in affected receiving waters.	Benefit	Yes			✓
Transport opportunities along or through the waterway / drainage corridor like walkways, bikeways and bridges.	Benefit	Yes	✓	✓	✓
Provision of a research / educational asset such as a constructed wetland or pond.	Benefit	Yes		✓	
Safety of residents who use the area immediately around the stormwater asset (includes the risk of drowning)	Cost	Yes		✓	
Passive and active recreation around the stormwater asset (walking, jogging, bird-watching, etc.).	Benefit	Yes		✓	✓
1.2. Indirect use values (i.e. values to people that are indirectly affected from the use of the stormwater asset)					
Surrounding property values and property rates.	Benefit	Yes		✓	
Rate of property sales for land / houses on new estates.	Benefit	Yes		✓	
Aesthetics.	Benefit	Yes		✓	✓
The area's spiritual values (indigenous or otherwise).	Cost or Benefit	Yes		✓	✓
The health and wellbeing of surrounding residents that may be affected by disease vectors, pests, odour, etc.	Cost or Benefit	Yes		✓	
Reduced need for detention infrastructure downstream (e.g. if stormwater reuse is occurring on-site).	Benefit	Yes			✓
Reduced need for downstream maintenance of drainage infrastructure and waterways (e.g. due to reduced downstream erosion).	Benefit	Yes			✓
Maintenance burden on residents, such as maintaining a road-side vegetated swale.	Cost	Yes		✓	
Nuisance flooding around the stormwater measure, such as ponding in a road-side vegetated swale.	Cost	Yes		✓	
Parking restrictions around the stormwater measure, such as keeping off a road-side swale.	Cost	Yes		✓	

Types of Values to Consider	Usually a Benefit or Cost?	Usually Considered an Externality?	Spatial Location for Stormwater Projects		
			Upstream	Within and Immediately Around the System	Downstream
Cooling due to shading, air quality improvement and carbon sequestration benefits from the use of *vegetated* treatment measures (e.g. street trees that filter road run-off).	Benefit	Yes		✓	
Broad educational and/or research benefits in association with the stormwater project.	Benefit	Yes		✓	
Availability of shallow groundwater for reuse.	Benefit	Yes		✓	✓
2. Intrinsic (non-use) Values (i.e. values that are not related to people using the stormwater asset or improved conditions that are created as a result of the project)					
2.1. Existence values (i.e. the value of simply knowing something exists)					
The intrinsic value of healthy aquatic and riparian ecosystems (downstream and/or along the waterway corridor). May also include the *spiritual* values associated with a healthy waterway.	Benefit	Yes	✓	✓	✓
2.2. Option values (i.e. the value of having access to a resource in the future)					
The value of having unfettered future access to the land that the proposed stormwater asset will occupy (e.g. to develop more housing lots). Sometimes called an 'opportunity cost'.	Cost	Yes		✓	
The value of having healthy aquatic and riparian ecosystems for future use.	Benefit	Yes	✓	✓	✓
2.3. Bequest value (i.e. the value of future generations having the option to enjoy benefits)					
The value of having healthy aquatic and riparian ecosystems over the long-term.	Benefit	Yes	✓	✓	✓

Types of Values to Consider	Usually a Benefit or Cost?	Usually Considered an Externality?	Spatial Location for Stormwater Projects		
			Upstream	Within and Immediately Around the System	Downstream
3. Constructed Asset Values / Costs					
3.1. Conventional costs (tracked as part of 'normal' project cost accounting)					
The life-cycle cost of the stormwater asset (which can be broken down into cost elements such as total acquisition cost, typical annual maintenance cost, renewal and adaptation costs, and decommissioning costs – see Taylor [2003]).	Cost	No		✓	
The cost of the land needed for the stormwater asset.	Cost	No		✓	
3.2. Potentially hidden costs					
Costs associated with approval delays, environmental permits, environmental monitoring, taxes, environmental management during construction, insurance, etc.	Cost	No (except for 'approval delays')		✓	
3.3. Contingent costs (costs that may or may not be incurred in the future)					
Excessive construction costs, property damage, environmental rehabilitation, legal expenses, etc. during construction.	Cost	Yes		✓	
3.4 Organisational values					
The stormwater manager's corporate image and relationship with stakeholders as a result of construction.	Benefit	Yes		✓	

Notes:

- See the guideline's glossary for full definitions of particular types of values.
- When assessing values, care is needed not to 'double count' costs or benefits. For example, changes to local 'property prices' around a new constructed wetland are the result of the importance people place on values such as the area's 'aesthetic appeal', 'safety', 'passive recreational opportunities', etc.
- Each project must be assessed on its merits to determine if specific values represent an *overall net cost or benefit*. For example, a well-designed constructed wetland may reduce average annual nutrient loads entering a downstream estuary (which may be a major benefit) but increase the nutrient concentrations and temperature of low flows in the creek immediately downstream (which may be a minor cost). In this case, the overall net 'existence value' of downstream waterways may be increased as a result of the project (i.e. the project provides a net benefit).

Traditional life-cycle costs of the measure:

- Costs associated with site selection and feasibility studies.
- Design costs.
- Construction costs.
- Routine maintenance costs.
- Renewal and adaptation costs.
- Decommissioning costs.

- Costs associated with the provision of land for the measure (both actual and lost opportunity costs).
- Tax associated with the measure (e.g. GST).
- Provision of vegetation may assist with urban cooling in warm climates, CO_2 sequestration and improved air quality.

Stormwater management measure

Surrounding housing

- Costs associated with the need for enhanced erosion and sediment control during construction.
- Changes in the rate of property sales and property values within close proximity to the measure (or enhanced water body).

Social cost-benefits reflected in property values around the measure (or enhanced water body):

- Aesthetics of the measure and the waterway features it protects.
- Safety of the measure.
- The measure's maintenance burden.
- Pests (e.g. mosquitos, snakes) associated with the measure.
- Nuisance flooding and odours associated with the measure.
- Parking restrictions due to the measure.
- Recreational opportunities/ constraints due to the measure.
- Opportunities for vandalism.
- Greater availability of shallow groundwater.

- Changes to passive and active recreational values surrounding the measure (e.g. within a multiple use drainage corridor).
- Educational benefits around the measure (e.g. through interpretive signage and/or research opportunities).

Open space around measure

- Savings associated with reduced need for maintenance of downstream drainage infrastructure (e.g. desilting) and waterways (e.g. rehabilitation).
- Savings associated with reduced mains water use and need for 'upstream' water supply infrastructure (e.g. reduced need for water supply due to recycling of stormwater).

Downstream water bodies

- Changes to the values of downstream waterways and wetlands, including active and passive recreational values (e.g. boating, swimming, fishing, walking, bird watching, etc.), aesthetic values, the intrinsic/non-use values of healthy ecosystems, spiritual values, commercial fishing, aquaculture, tourism, transportation (on the waterway or along the waterway corridor), and the use of water (e.g. for irrigation).

Figure C.1 Potential Costs and Benefits Surrounding Structural Urban Stormwater Management Measures to Improve Waterway Health. (Not exhaustive – for more values that can be affected, see Table C.1)

3. Summary of Potentially Relevant Information From Valuation Studies

3.1 General comments about the relative importance of values

Table C.1 highlights the many values that have the potential to be directly or indirectly affected by urban stormwater projects. This section makes some general comments on which values are likely to be the most significant and worthy of close examination.

Economic studies estimating the national benefit of changes to US water quality policy in the 1970s reported that 77% to 92% of the total benefits of water quality improvements were derived from the values of recreation, aesthetics and ecology[2] (Feenberg and Mills, 1980).

After a brief review of the literature, Holder (2003) suggested that in an urban stormwater context, recreational values, amenity and non-use values (e.g. the intrinsic value of healthy waterways) are likely to be the *most* significant determinants of the benefit derived from a stormwater project that aims to improve waterway health. Note that recreational and aesthetic values are likely to be reflected in the prices of nearby properties (e.g. residences near well-designed stormwater 'treatment trains').

According to Holder (2003), other potentially significant benefits of stormwater management projects include productivity improvements, protection of human health and flood protection. Note however, that most stormwater management projects that aim to improve waterway health provide minimal flood mitigation benefits unless they *also* aim to detain large volumes of stormwater (i.e. during major storms) for recycling.

3.2 Use values – direct use

3.2.1 Recreational values - general

In developed countries, increased user benefits associated with recreation are often the most significant benefits reported from economic studies involving water quality improvement projects (Holder, 2003). Recreational benefits include improved opportunities for activities such as swimming, boating and fishing (see Table C.1 for more examples). Stormwater management projects may also incorporate footpaths, bikeways, open space, bridges, interpreted signage, boardwalks and other features that provide further opportunities for passive and active recreational pursuits.

Green and Tunstall (1991) examined the willingness to pay for improved water quality at 12 sites along river corridors in England by those who would experience enjoyment from such improvement. Thus, the study sought to examine recreation-related 'use values' associated with these river corridors. The study found that respondents who would gain enjoyment from water quality improvement were prepared to pay approximately $44.74 p.a. (in 2002 Australian dollars) as an increase in water rates. Note however, that the sample included a large percentage of respondents who nominated a willingness to pay of $0 (i.e. 41% - 47%). This was at least partially attributed to discomfort with the choice of payment vehicle (i.e. the water rates). Like most contingent valuation studies, the 'zero responses' were not included in the willingness to pay estimates. If the zero responses were included, the willingness to pay estimate drops significantly to $23.73 p.a. (in 2002 Australian dollars).

Sanders *et al*. (1991) estimated the recreational value of sections of 11 rivers in Colorado using both the contingent valuation and travel cost methods. The average willingness to pay estimates, in 2002 Australian dollars, were $59.41 per visitor day (using the contingent valuation method) and $56.05 per visitor day (using the travel cost method). Note however that the study only surveyed local residents, despite 40% of the site users being tourists. It is therefore likely that these value estimates are conservative (as tourists are likely to be willing to pay more to visit these sites).

[2] "Ecology" is interpreted to mean the non-use (intrinsic) values associated with having a healthy ecosystem. See Table C.1 for examples of non-use values.

Siden (1990) also examined the recreational value of rivers, by estimating people's willingness to pay for recreation at 24 sites along the Ovens and King rivers in northern Victoria. Siden used the travel cost method to estimate that people who used the rivers to recreate on day trips were willing to pay approximately $31.56 per household per annum for the opportunity (in 2002 Australian dollars). Note however, that this estimate is likely to be conservative, due to an unusually low visitation rate during the study and the assumptions in the travel cost method.

Walpole (1991) also examined the recreational value of the Ovens and King rivers in northern Victoria. Walpole used the contingent valuation method to estimate people's willingness to pay for recreation at eight selected sites along the rivers. The willingness to pay estimates per household per visit (in 2002 Australian dollars) range from $10.33 to $43.47, with the average being $23.69.

Read Sturgess and Associates (1990) concluded that Victorians would be willing to pay an *additional* $0.6 to 1.8M p.a. to preserve the natural values of the Goulburn River (Victoria). Note that the population of Victoria in 1990 was approximately 4.3M. This is considered to be a significant underestimate of the river's total value as this value estimate only relates to the river's use values (e.g. recreational uses). Read Sturgess and Associates (1998a) reported that similar studies that also considered non-use values (e.g. willingness to pay for simply knowing that the natural intrinsic values are being maintained) found that these can far exceed the use values (see Section 3.4.2 for more information).

3.2.2 Recreational fishing values

An Australian Bureau of Statistics (1993) study in Queensland found that in 1993, residents (on a Statewide and annual basis) spent approximately $185 on recreational fishing (these estimates normally include boating-related costs). Note that the population of Queensland is approximately 3.9M.

A 1998 economic analysis estimated the value of the recreational fishing industry in the Brisbane River and Moreton Bay region of South East Queensland to be approximately $200M p.a. (KPMG, 1998). An equivalent estimate of greater than $120M p.a. was made by BRMBWMS (1997). Note that the population of South East Queensland is approximately 2.5M. It is noted however that value estimates based on recreational fishing are controversial, as different valuation methods can produce very different results (see Taylor, 2002).

Silvander and Drake (1991) undertook a Swedish contingent valuation study that estimated the willingness to pay per angler for the preservation of a fishery threatened by pollution. The amount was equivalent to $400 p.a. per fisher (in 1998 Australian dollars). Given that some government resources would have already been spent on waterways and fisheries management, the $400 p.a. per fisher figure is assumed to be an *additional* amount. KPMG (1998) used the results of this study in the benefit transfer method to suggest that each recreational angler in the Moreton Bay region of South East Queensland *may* be willing to pay an additional amount in the order of $400 p.a. to ensure no loss of welfare (assuming the willingness to pay data is transferable).

Taylor (2002) provided the following information on the value of the *freshwater* recreational fishery in the Brisbane region:

- Approximately 300,000 recreational fishers spent 1.5 million fishing days in the region per year (BRMBWMS, 1997). In Queensland, on a Statewide basis, approximately 71% of the fishing population in 1995 only went saltwater fishing, 22% went saltwater and freshwater fishing, and 7% only went freshwater fishing (1995 data reported by Queensland Fisheries Management Authority website, 2001). Taylor (2002) used these figures along with the assumption that 10% of the region's total recreational fishing effort is spent on freshwater fishing, and $20 is spent per recreational fishing trip/day (City Design, 2000), to estimate the value of the freshwater recreational fishing industry in the region to be approximately $3M p.a..

- Taylor (2002) also estimated the potential value of freshwater recreational fishing in the Brisbane region by comparing the 1999 calendar year catch estimates (from QDPI, 1999) for Australian Bass and Golden Perch / Yellowbelly (the two most sought after freshwater species in the region) with the estimated value for "trophy fish" ($20 per fish, according to City Design, 2000). The estimated number of Australian Bass caught in the catchments feeding into Moreton Bay in 1999 was approximately 321,000 (worth approximately $6.42M if all fish are considered "trophy fish" and the $20/trophy fish value is valid). The equivalent estimates for Golden Perch / Yellowbelly are approximately 165,000 and $3.3M. Using this method, the estimate of the value of the freshwater recreational fishery in the Moreton Bay region is estimated to be approximately $9.7M. p.a.

A study by Kelly and Bright (1992) of trout fishers in the New England region of New South Wales found that each angler spent, on average, approximately $850 to $950 p.a.. On average, these anglers were active for 15 fishing days per year (spending approximately $60 per day) and were willing to pay an additional $5 to $100 p.a. for the opportunity to fish in a sustainable fishery.

Holder (2003) reported that a 1980 US travel cost study estimated willingness to pay for improved water quality from a standard that only supported catfish to one that supported trout as approximately $10.51 per person per fishing day (in 1999 Australian dollars).

Holder (2003) reported another US travel cost study in 1978 that estimated the willingness to pay of anglers for improved water quality from 51% to 64% dissolved oxygen (i.e. from a quality that supported catfish to one that supported trout) as approximately $13.27 per person per fishing day (in 1999 Australian dollars).

A fishing based study in the Ord River region of North-west Australia (WRC, 2001a) found recreational fishers spent 19.6 days per year fishing and spent on average $821 per fisher per year (i.e. approximately $42 per day).

The national expenditure in Australia on *recreational* fishing was approximately $2.9B p.a. in 1999 (McIlgorm and Pepperell, 1999). Note that the population of Australia in 1999 was approximately 19.1M.

Layton *et al*. (1999) undertook a willingness to pay survey of Washington households in 1989 and found that people would be willing to pay approximately $127 million (in 1998 US dollars) over a 20 year period for a 0.2% to 0.5% increase in fish populations. They also found that people's willingness to pay increased if they assumed the fish populations were declining (Washington State Department of Ecology, 2003). Note that the population of Washington State in 1998 was approximately 5.7M.

The Washington State Department of Ecology (2003) undertook a brief review of studies that attempted to value recreational fishing in the US. The approximate value per fishing day (in 2003 US dollars) for *trout fishing* ranged from $25.03 to $42.75, and averaged $33.74 over four studies. The approximate value per fishing day (in 2003 US dollars) for "warm water" fishing (i.e. fishing for warm water species) ranged from $20.34 to $46.60, and averaged $31.51 over six studies.

3.2.3 Commercial fishing values

A study by KPMG (1998) concluded that the value of commercial fishing in the Moreton region was $33M p.a. (in 1998 dollars). This estimate was obtained by converting an average annual *wholesale* value of fish caught commercially (approximately $13M) to an equivalent *retail* value of $33M. Taylor (2002) reported more recent commercial catch statistics for 1998, which indicate that the gross value of production for net, pot, and trawl catches was $15.7M (i.e. the wholesale value at the wharf). This figure would translate to an equivalent retail value of approximately $40M p.a. using the same wholesale / retail value relationship as used by KPMG (1998).

In the United States, stormwater run-off reportedly costs the commercial fish and shellfish industry approximately $17M to $35M p.a. in US dollars (US

EPA, 1997). Note that the population of the US in 2000 was approximately 282M.

3.2.4 Value of swimming, boating and fishing

Urban stormwater pollution has the potential to adversely impact the water quality of receiving water bodies and therefore the environmental values of primary and secondary contact recreational activities (e.g. swimming, canoeing, sailing, etc.).

Van Bueren and Bennett (2000 and 2001) undertook an economic study to develop value estimates for generic environmental attributes using the choice modelling method that could be transferred across Australia with a reasonably high level of confidence. One of these attributes was 'healthy waterways'. This work was done to minimise the risks associated with transferring costs and benefits from one study context to another using the benefit transfer method. One of the findings was that on a national basis there was a willingness to pay $0.08 p.a. (mean) or $0.04 to $0.16 p.a. (95% confidence interval) per household as an environmental levy over 20 years to restore 10km of nearby waterways for fishing or swimming. These values represent year 2000 dollars. Thomas *et al*. (2002) reported that the value of $0.008/km/household/yr is equivalent to an upfront lump-sum payment of $0.15/km/household using a real discount rate of 5% over a 50 year period.

Bennett and Morrison (2001) sought to place approximate monetary values on some of the key environmental values of rivers in New South Wales. They selected five rivers for their analysis. They also considered five 'river health attributes', namely: water quality suitable for fishing (use value); water quality suitable for swimming (use value); healthy riverside vegetation and wetlands (non-use value); native fish species present (non-use value); and waterbirds and other fauna species present (non-use value). The resulting value estimates that are relevant to fishing and swimming on a *Statewide basis* (i.e. $ per New South Wales household in 2001 dollars) were:

- $44.05 (the value of an improvement in river water quality that would make it safe for fishing along a length of the river); and
- $87.17 (the value of an improvement in river water quality that would make it safe for swimming along a length of the river).

Read Sturgess and Associates (2001) undertook an economic analysis of the benefits associated with nutrient load reduction in the Port Phillip Bay catchment in Victoria. They examined the value of recreation on and around the Yarra River and found that the approximate value of recreational rowing on the river was $0.31M to $0.36M p.a.[3]

Taylor (2002) estimated that the annual running costs associated with recreational boating in the Brisbane region as being in the order of $29M p.a. (i.e. the total cost of boat registration, maintenance, and running expenses). Note that this estimate did not consider the large capital costs associated with owning a boat and annual mooring / marina fees.

An Australian Bureau of Statistics (1993) study in Queensland found that in 1993, residents (on a Statewide and annual basis) spent on average, approximately $48 each on surf sports (e.g. windsurfing, surfing).

Cocklin *et al*. (1994) used the travel cost method to estimate the value of direct use benefits (i.e. trout fishing, rafting, kayaking and canoeing) of the Upper Wanganui and Whakapapa Rivers in the North Island of New Zealand. These benefits were estimated at $104 per visit for rafters, kayakers and canoeists and $45 per visit for anglers (in 1988 New Zealand dollars). Cocklin *et al*. (1994) reported that these estimates were broadly consistent with similar studies in New Zealand.

Williamson (1997) estimated the value associated with improving water quality of the Orakei Basin in Auckland from 'suitable for boating' to 'suitable for swimming' as approximately $1.2 million to $1.3 million per year (in 1997 New Zealand dollars). The

[3] The study ultimately found that the total "consumer surplus value" of the riparian zone in the lower Yarra was approximately $20.0M - $55.3M p.a.. This estimate considered only recreational values (e.g. boat hire at $0.06M - $0.13M p.a., rowing at $0.31M - $0.36M p.a., use of riverside parks at $13.9M - $33.4M p.a., the annual Moomba Festival at $0.6M - $1.1M p.a.) and increased property values for waterfront properties in urban areas of the lower Port Phillip Bay catchment (at $5.2M - $20.3M p.a.).

equivalent net present value (using a real discount rate of 7.5% per annum over 25 years) was reported as being between $15 million and $16 million. The best estimate of the mean willingness to pay per household per year was $10.88.

Desvousges *et al*. (1987) examined people's willingness to pay for improved water quality to allow certain recreational uses to be achieved or maintained in the Monongahela River, Pennsylvania. The approximate willingness to pay figures per person per year (in 2002 Australian dollars) are given below:

- To prevent water quality degradation from a "boatable" standard to a "non-boatable" standard: $65.37.
- To improve water quality from a "non-boatable" standard to a "swimmable" standard: $144.34.
- To improve water quality from a "boatable" standard to a "fishable" standard: approximately $42.42.
- To improve water quality from a "boatable" standard to a "swimmable" standard: $66.97.
- To improve water quality from a "fishable" standard to a "swimmable" standard: $23.21.

It should be noted that like many 'willingness to pay' studies, in Desvousges *et al*.'s study, zero "protest bids" are not included in the estimates. That is, if people say that they are not willing to pay for a variety of reasons, which may include concern over the nature of the suggested payment vehicle or an ethical belief that certain values cannot be measured in monetary terms, their responses are not included in the data analysis.

Georgiou *et al*. (1998) examined people's willingness to pay to ensure a polluted swimming beach in the United Kingdom passed the European Community standards with respect to concentrations of pathogens in the water. The beach in question, Great Yarmouth, was failing to meet the European Community Bathing Water Quality Corrective Standard at the time of the study. The willingness to pay estimate (in 2002 Australian dollars) was approximately $30.84 per respondent per year.

Gramlich (1977) investigated the willingness to pay of Boston families for improved water quality from "boatable" to "swimmable" in: 1) the Charles River Boston; 2) all United States rivers; and 3) all United States rivers other than the Charles River. The results (in 2002 Australian dollars) were $166.92, $302.96 and $139.32, respectively. These figures are willingness to pay per family per year where the payment would occur in the form of increased taxes.

A 1974 US travel cost study estimated willingness to pay for a 30% reduction in oil, chemical oxygen demand, turbidity and faecal coliform pollution for:

- Thirty (30) beach sites included in the study: approximately $52.70 per household per season (in 1999 Australian dollars).
- Only downtown Boston beach sites: approximately $26.83 per household per season (in 1999 Australian dollars). [Source: NSW EPA / DEC Envalue database, reported by Holder (2003).]

A 1980 US travel cost study estimated the willingness to pay for a reduction of 10% in oil, colour and bacteria at beaches as approximately $3.07 per person per annum (in 1999 Australian dollars). [Source: NSW EPA / DEC Envalue database, reported by Holder (2003).]

In the US, Americans take more than 1.8 billion trips to waters to swim, fish, boat, or just relax each year at an estimated daily value of $30.84 (in 1995 US dollars) to each individual (US EPA, 2001b).

3.2.5 Value of water-related tourism and festivals

In theory, severe stormwater pollution in urban areas could depress the value of water-based tourism (e.g. river cruises) and festivals (e.g. water-side events). It is unlikely however that one stormwater project could significantly affect these values.

An economic analysis by KPMG (1998) in Brisbane found that the value of tourism on the Brisbane River and Moreton Bay was approximately $5.3M p.a. (in 1998 dollars). Of this, $4.8M was attributable to tourism activities on the Brisbane River, while the remainder related to Moreton Bay. Note however, that KPMG's value estimates were conservative, in that they *only* considered the number of trips taken by tourists on ferries and charter boats operating on the River and Bay and the cost per trip. Note that the population of the greater Brisbane region is approximately 1.3M, while the population of the South East Queensland region is approximately 2.5M.

An economic impact assessment was conducted after the 1998 Brisbane River Festival (Paddenburg, 1999). The total economic impact of the inaugural Festival was found to be approximately $3.9M and generated the equivalent of 102 full-time jobs (for one year). Note that this analysis only considered expenditure as an economic benefit if it would not have occurred without the Festival. That is, expenditure was not counted as an "economic benefit" of the festival if it:

- is likely to be 'switched' if the event did not proceed (e.g. spent on another form of entertainment); and/or
- was transferred from other activities within the host economy (e.g. funding from Brisbane City Council's annual budget that would have been spent elsewhere if the event did not proceed).

Note that the event ran for 10 days, attracted 515,000 attendees, included 235 events and involved 15 riverside venues. The event had an operating cost of $2.235M, sponsorship of $1.805M, and ticket sales of $0.43M. The non-Brisbane visitor expenditure was significant, being estimated at approximately $2.5M (Paddenburg, 1999).

3.2.6 Value of stormwater as a replacement for mains water

Increasingly, urban stormwater is being reused as part of urban design in Australia, either directly (e.g. from a constructed wetland or rainwater tank) or indirectly (e.g. from aquifer storage and recovery systems). This water is typically used for irrigation of public open space, gardens and lawns, or for toilet flushing. This 'reuse service' has a value than can be estimated by its replacement cost (i.e. the cost of using potable mains water instead of stormwater).

The cost to use mains water in major Australian cities usually consists of an annual service / access fee and a consumption fee that is dependent on the amount of water used. For example, the annual *service / access fee* is approximately $105 in Brisbane (Brisbane City Council, 2004) and $144 in Perth (Western Australia Water Corporation, 2002), while a summary of the *consumption fees* in Australia's major cities is provided in Table C.2. Note that these prices are generally considered to poorly reflect the *true* value of mains water (i.e. the real cost should be higher). For example, the Council of Australian Governments (COAG) water reforms (including the Intergovernmental Agreement on a National Water Initiative) promote 'full cost pricing' of mains water to incorporate environmental externalities (e.g. the ecological cost of diverting water away from river systems).

Table C.2 Summary of Typical Reticulated Water Consumption Charges in Urban Areas of Australia (as of 2002)

City	Amount of Water Used (kL/year)	Approximate Consumption Fee (¢/kL) *[as of 2002, unless otherwise stated]*
Sydney	One fee applies regardless of the amount.	94
Melbourne	One fee applies regardless of the amount.	75 - 78
Brisbane	One fee applies regardless of the amount.	82 (85 in 2004)
Perth	0 - 150	40
	151 - 1,950	7 pricing tiers exist for this range
	>1,950	147
Adelaide	0 - 125	40
	>125	97
Canberra	0 - 200	41
	>200	97

Note: These figures are subject to frequent change. For up-to-date figures, visit the web sites of the relevant water authorities.

Source: Western Australia Water Corporation (2002).

With increasing fees for mains water and an increased emphasis on water recycling in urban areas, it is possible that people place an increased value on Australian water sensitive developments that generate treated stormwater that can be reused for non-potable use with little treatment and with little maintenance of irrigation infrastructure.

Widespread and significant reuse of stormwater also has the potential to reduce costs associated with water supply headworks and distribution infrastructure. For example, the need to develop a new source of raw water can be deferred and the maximum daily peak demand for mains water can be reduced through the widespread use of rainwater tanks, resulting in a reduced need for (and cost of) water distribution infrastructure (SIA, 2004).

Research Wise (2002) reported on a comprehensive water sensitive urban design-related market acceptance and buyer attitudes survey conducted in Melbourne. The survey involved 300 property owners and prospective buyers drawn from four estates in Melbourne's growth corridors. Respondents indicated that the two most important aspects of water sensitive urban design to them were water reuse and litter reduction.

Note that Holder (2003) concluded after a brief literature review that productivity benefits associated with stormwater projects (e.g. ability to use water for irrigation, industry, agriculture and aquiculture) are not usually as significant as recreational, aesthetic and non-use values.

3.2.7 Productivity values (e.g. aquaculture, agriculture, industry, etc.)

Valuation methods used to quantify these values include the avoided cost method (e.g. estimates are made on the maintenance costs avoided by using a higher quality of water when irrigating) and the dose response method (e.g. a numerical relationship is determined that relates water quality with aquaculture productivity).

Estimates are available on the value of aquaculture in specific areas. For example, KPMG (1998) reported that the approximate value of aquaculture in the Moreton Bay region of South East Queensland was $17M p.a. (in 1998 dollars). However, it is considered unlikely that aquaculture enterprises would be located in areas where they would be significantly impacted by just urban stormwater run-off. It is more likely that they would be impacted by *catchment* run-off during major rainfall events, but it would be hard to distinguish the contribution made by urban stormwater. In addition, stormwater projects that aim to improve waterway health typically do little to improve water quality during very large, infrequent rainfall events (i.e. they focus on treating stormwater associated with small, frequent storm events).

An approximate annual value of the Hawkesbury-Nepean catchment near Sydney was estimated in 1993 (Water Board, 1993). The catchment supports a population of approximately 1 million and its waterway health is threatened by a range of pollution sources, including urban stormwater. The study only examined the value of *industries* that the freshwater and estuarine parts of the catchment supported (e.g. water supply, commercial fishing, extractive industries, etc.) and found the value to be approximately $1.2B p.a. (in 1993 dollars). This estimate therefore relates to direct use values.

A 1983 study attempted to estimate the total benefit of improving the quality of Dutch surface waters. Such waters are potentially affected by stormwater pollution. Only ‘use values’ were calculated with their total being estimated at 198 – 556 million Dutch guiders p.a. (approximately 143 – 400 Australian dollars). Of this total, approximately 35% was attributed to averted costs for the public water supply and industry, and productivity gains for agriculture. Most of the remaining benefits were the result of improved recreational fishing and swimming opportunities. This study does not shed any light on the direct link between stormwater pollution and productivity values, but does highlight the *relative importance* of recreational fishing and swimming as use values that need to be carefully considered during triple-bottom-line assessments.

In Australia, urban stormwater is not currently a significant source of raw municipal, industrial or agricultural water in most areas, so that productivity gains associated with stormwater quality improvements are likely to be minimal.

3.2.8 Global estimates of value for ecosystem services provided by healthy waterways

In a high-profile, widely quoted and controversial study involving academics from 12 research organisations, Costanza *et al*. (1997) estimated the average global value of the ecosystem services that 'lakes and rivers' provide as $8,498/ha/year (in 1994 US dollars)[4]. This study provided estimates of the monetary value associated with ecosystem services within 16 biomes (e.g. rivers and lakes, wetlands, forests, etc.). Seventeen ecosystem services are used to estimate a total value, with most of these relating to direct and indirect use values (e.g. the service of 'waste treatment'). Relevant ecosystem services for the 'lakes and rivers' biome include water regulation, water supply, waste treatment, food production and recreation. The breakdown of Costanza *et al*.'s value estimate for this biome (in 1994 US dollars per hectare per year) is: water regulation ($5,445), water supply ($2,117), waste treatment ($665), food production ($41) and recreation ($230).

Costanza *et al*. (1997) also estimated the average global value of:

- The ecosystem services that 'estuaries' provide as $22,832/ha/year (in 1994 US dollars). This included the services / values of disturbance regulation, nutrient cycling, biological control, provision of habitat, raw materials, food production, cultural values and recreation.
- The ecosystem services / values that 'seagrass' and 'algal beds' (which are common in estuaries) provide as $19,004/ha/year (in 1994 US dollars). This included the services of nutrient cycling and raw materials.
- The ecosystem services / values that 'wetlands' provide as $14,785/ha/year (in 1994 US dollars). This estimate included the services of gas regulation, disturbance regulation, habitat, raw materials, water regulation, water supply, waste treatment, food production, cultural values and recreation.

3.3 Use values – indirect use

3.3.1 Amenity and property values

Stormwater projects have the potential to improve the amenity (i.e. general attractiveness) of a location. For example, a 'water sensitive' development's streetscape may incorporate landscaped bioretention systems which may enhance the development's aesthetic appeal. Improved amenity may be reflected in property values in the immediate vicinity (e.g. properties overlooking a constructed wetland with an open water zone may command a premium price).

This section summarises the results of studies that have examined the relationships between stormwater management features, improved water quality, market acceptance and property values. Studies involving property values are particularly useful, as they translate a wide variety of use values (e.g. aesthetics and recreational values) that may be affected by stormwater projects into monetary terms (e.g. an increase in property value). This knowledge is potentially transferable to other contexts, at least in qualitative terms.

<u>Community perceptions</u>

Nassauer, a landscape architect involved in researching low impact development in the US, cautioned stormwater managers not to underestimate the importance of public perceptions regarding stormwater infrastructure (i.e. the social dimension). She stated that "if we design and implement something that might be extraordinarily effective from the standpoint of

4 Costanza *et al*.'s work, although open to criticism because of the nature of approximations and assumptions made (see Balmford *et al*., 2002), provides a valuable source of information to those who are seeking to obtain an 'order of magnitude estimate' of the monetary value of ecosystems services in the absence of local research. Costanza *et al*. (1997) acknowledge that while "there are many conceptual and empirical problems inherent in producing such an estimate, we think this exercise is essential in order to:
1. make the range of potential values of the services of ecosystems more apparent;
2. establish at least a first approximation of the relative magnitude of global ecosystem services;
3. set up a framework for their further analysis;
4. point out those areas most in need of additional research; and
5. stimulate additional research and debate" (p. 253).

stormwater management or the standpoint of ecology, but people don't particularly like it in their neighbourhood or their yard, it's just not going to be there in five or 10 years" (quoted in Hager, 2003).

Lloyd *et al*. (2002), Lloyd (2004) and Research Wise (2002) reported on a study that evaluated the market acceptance of different types of water sensitive stormwater designs (i.e. grassed bio-filtration systems and landscaped bio-filtration systems that can be located in a residential road reserve). They surveyed 300 property owners and prospective buyers from four greenfield development areas in Melbourne. They found that 85% - 90% of respondents supported the integration of grassed and landscaped bio-filtration systems into local streetscapes to manage stormwater. The surveys examined a range of positive and negative perceptions, which are summarised in Figures C.2 and C.3, respectively.

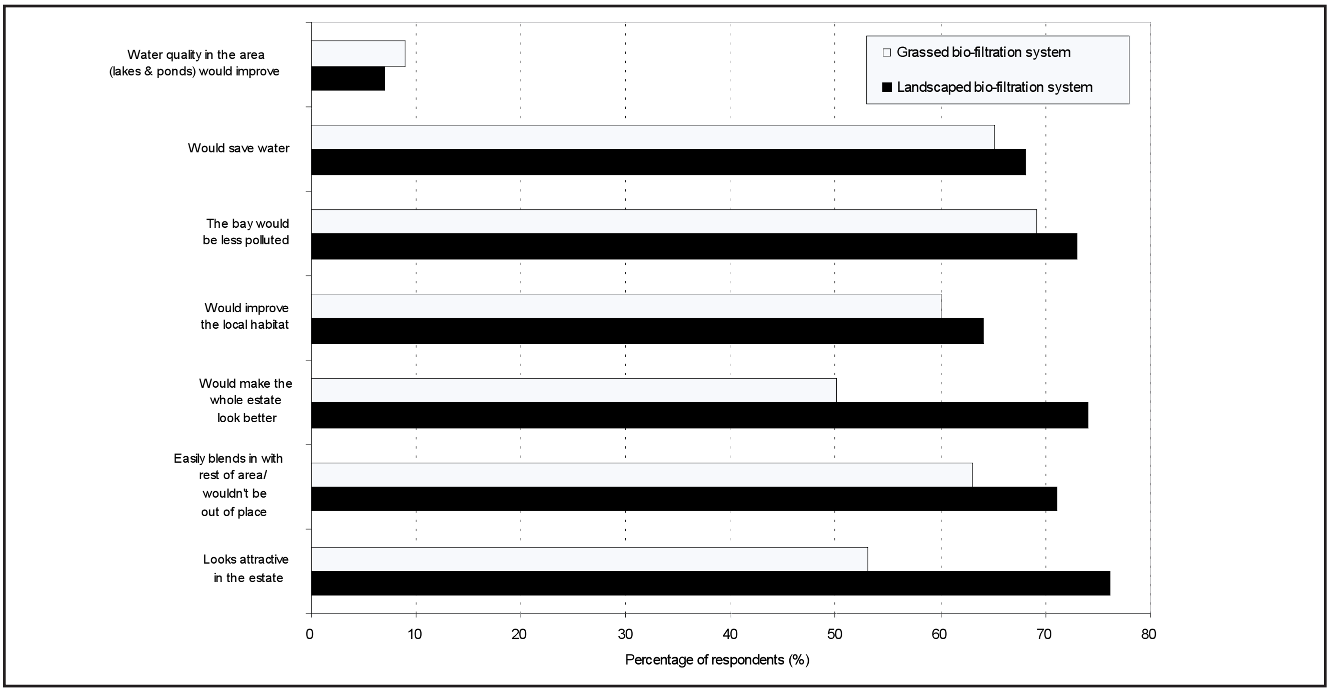

Figure C.2 Positive Perceptions of Bio-filtration Systems in Melbourne **Source:** Lloyd *et al*. (2002).

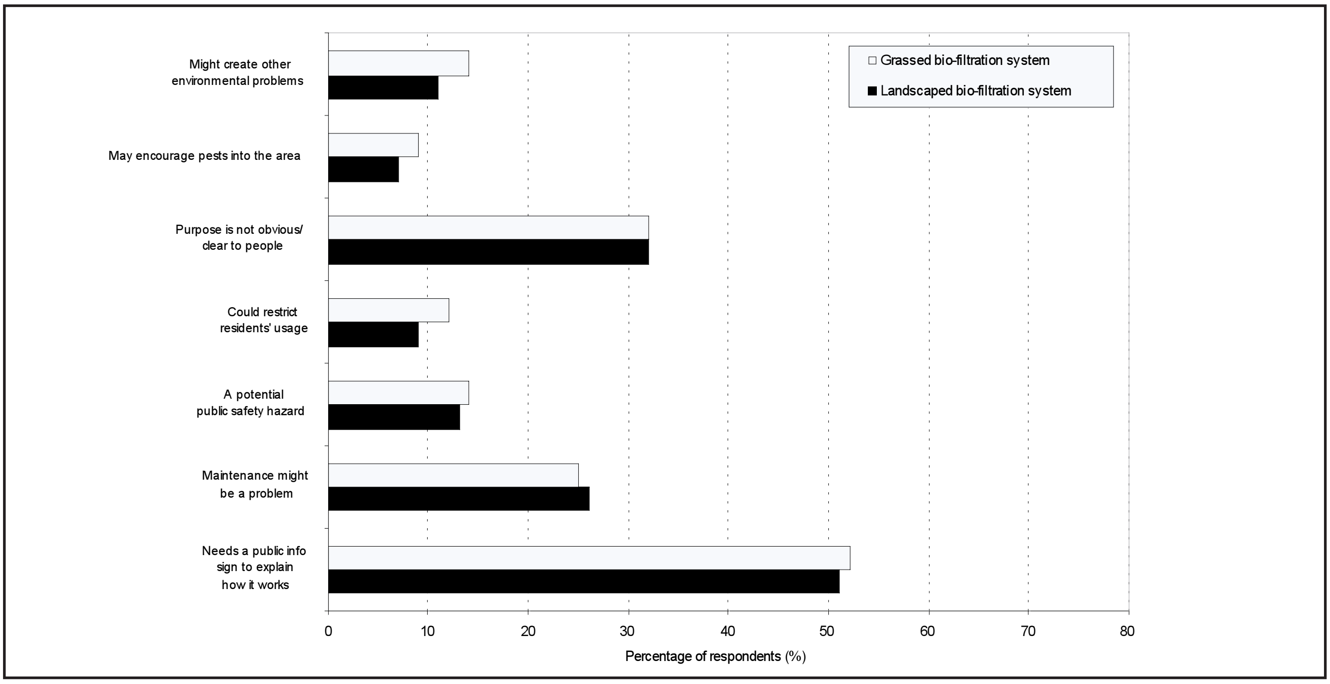

Figure C.3 Negative Perceptions of Bio-filtration Systems in Melbourne **Source:** Lloyd *et al*. (2002).

The Department of Natural Resources (1986) in Maryland reported the following results from a survey of residents living near stormwater ponds:

- 87% of respondents thought the ponds were an attractive and desirable feature.
- 79% of respondents thought the ponds had a beneficial impact on nearby property values.
- 98% of respondents thought that the ponds provided benefits for wildlife (e.g. habitat).
- 60% of respondents thought that the ponds were associated with a drowning hazard for children.
- 14% of respondents thought the ponds could lead to increased mosquitoes / insects.
- 16% of respondents thought the steepness of the ponds' banks created a safety hazard.
- 86% of respondents thought the ponds had a positive impact on the quality of the neighbourhood environment.

<u>Property values</u>

In a stormwater context there are a number of different factors that affect amenity and property values. These include issues such as access and proximity to water bodies (e.g. ponds), aesthetics, maintenance requirements, public safety, nuisance flooding, mosquitoes and other pests, odours, parking restrictions, water quality in receiving waters and recreational opportunities.

his section will focus on the influence of access / proximity to water bodies, aesthetics and improved water quality (in receiving waters) on residential property values,

<u>Access / proximity to water bodies</u>

Mahan *et al*. (2000) examined the literature on the effect of lake frontage, lake proximity and water quality to residential property values. They concluded that the common finding across the studies they reviewed is that lake frontage, lake proximity and improved water quality generally increase property values. Such research is relevant as stormwater projects may include open water features that resemble small 'lakes' (e.g. ponds and wetlands with open water zones) and/or improve the water quality of downstream water bodies (e.g. lakes, estuaries, rivers, etc.).

There is considerable evidence in the literature that property values are typically elevated near waterways and stormwater management measures such as ponds, wetlands (with open water zones) and landscaped channels. For example, a 1991 housing survey conducted by the US Department of Housing and Urban Development and the Department of Commerce found that "when all else is equal, the price of a home located within 300 feet from a body of water increases by up to 27.8 percent" (NAHB, 1993). The National Association of Home Builders in the US also concluded that "whether a beach, pond, or stream, the proximity to water raises the value of the home by up to 28%" (US EPA, 2001b).

Table C.3 summarises the nature of premiums (i.e. the increase in value) associated with properties fronting constructed stormwater and waterway features such as ponds, lakes and wetlands with open water.

McInturf (1995) reported that apartments and townhouses at St. Petersburg in Florida (called the 'Lynne Lake Arms') rented for between $336 and $566 a month. Units facing three small stormwater ponds on the development attracted a waterfront premium of $15 per month (i.e. 4.5% to 2.7%). Units facing the larger pond attracted a waterfront premium of $35 per month (i.e. 10% to 6.2%). Apartments fronting a small drainage channel that connected the large pond with one of the smaller detention ponds attracted a waterfront premium of $5 per month (i.e. 1.5% to 0.88%).

At a development in Wichita, Kansas, a developer enhanced deteriorating wetlands, constructed some additional wetlands and built a recreational lake as feature selling points of a development called 'The Landing'. Waterfront lots sold at a premium of 150% above comparable lots with no water view (Baird, 1995).

Information relating to residential properties in the Forest Lake development district in South West Brisbane from Campbell (2001) indicates that:

- Proximity to attractive water features and associated open space is a major factor in determining land value.
- Residential housing lots with open water frontage (i.e. along a large constructed lake) can sell for over $200,000, compared to similar sized blocks away from the lake which may sell for $110,000 (i.e. a premium exists of over 80% for water frontage).
- Lots with immediate access to a park with a landscaped, constructed natural drainage channel / waterway may sell for $115,000 compared to similarly sized lots away from the park which may only sell for $87,000 - $92,000 (i.e. a premium exists of about 25%). Note that Campbell (2001) reports that a smaller premium of only 5% exists if the channel / waterway is not landscaped.
- Lots with immediate access to, and views of, Blunder Creek and its un-landscaped riparian vegetation sell for approximately 10% more than equivalent blocks away from the creek.

Taylor (2002) investigated the influence of waterway values on property prices along the Brisbane River. He reported that a real estate group specialising in this area (Dixon, 2001) estimated that a residential property on the banks of the Brisbane River is likely to be (on average):

Table C.3 Examples of Real Estate Premiums on Property Fronting Constructed Stormwater Features with Open Water

Location	Base Costs of Lots / Homes (US dollars circa 2001)	Estimated Water Premium (US dollars circa 2001)
Chancery on the Lake, Alexandria, Virginia	Condominium: $129,000 - $139,000	Up to $7,500 (approx. 5% – 6% increase)
Centrex Homes at Barkley, Fairfax, Virginia	Home with lot: $330,000 - $368,000	Up to $10,000 (approx. 3% increase)
Town homes at Lake Barton, Burke, Virginia	Town home with lot: $130,000 - $160,000	Up to $10,000 (approx. 6% – 8% increase)
Lake of the Woods, Orange County, Virginia	Varies	Up to $49,000
Dodson Homes, Layton, Faquier County, Virginia	Home with lot: $289,000 - $305,000	Up to $10,000 (approx. 3% – 4% increase)
Ashburn Village, Loudon County, Virginia	Varies	Increase of $7,500 - $10,000
Weston Development Broward, County, Florida	Home with lot: $110,000 - $1,000,000	Increase of $6,000 - $60,000 depending on lake size, location and the percent of lake front property in the neighbourhood (approx. 1% – 55% increase)
Silver Lakes Development, Broward County, Florida	Varies	Increase of $200 - $400 per linear foot of waterfront, depending on lake size and view
Highland Parks, Hybernia, Illinois	Waterfront lot: $299,900 - $374,900	Increase of $30,000 - $37,500 (approx. 8% – 13% increase)
Waterside Apartments, Reston, Virginia	Apartment rental	Up to $10 per month
Village Lake Apartments, Waldorf, Maryland	Apartment rental	Increase of $5 - $10 per month, depending on me apartment floor plan
Lake Arbors Towers, Mitchellville, Maryland	Apartment rental	Up to $10 per month
Marymount at Laurel Lakes Apartments, Laurel Lakes, Maryland	Apartment rental	Up to $10 per month
Lynne Lake Arms, St. Petersburg, Florida	Apartment rental: $336 - $566 per month	Increase of $5 - $35 per month depending on lake size (approx. 1% - 10% increase)
Sale Lake, Boulder, Colorado	Waterfront lot: $134,000	Up to $35,000 (approx. 26% - 30% increase)
Fairfax County, Virginia	Commercial office space rental	Up to $1 per square foot
Laurel Lakes Executive Park, Laurel, Maryland	Commercial office space rental	Increase of $1 - $1.50 per square foot

Source: Frederick *et al*. (2001).

- 100% more valuable compared to an identical property immediately behind it with no river frontage or view.
- 20% more valuable compared to an identical property immediately behind it with no river frontage but with an unimpeded view of the river.

In an economic analysis done by KPMG (1998) for water quality improvement in the Brisbane River and Moreton Bay in South East Queensland, the authors concluded that waterfront residential allotments attracted a premium of 100% over non-waterfront allotments (i.e. the value of the land is typically 100% greater along the River and Bay).

Waterfront property values at the Lynbrook Estate in South East Melbourne during mid 2001 were $10,000 (17%) higher than the average block price ($60,000). The developer indicated that this figure could potentially be extended to $20,000 (Lloyd, 2001). This estate included a constructed wetland with an open water zone.

Taylor (2002) reported that at 'The Waterways, St Claire' residential estate in Melbourne, blocks adjacent to the constructed waterways and wetlands were typically priced 18% higher than those immediately behind them (data obtained from marketing material from the developer with real pricing information, dated 2000).

Read Sturgess and Associates (2001) undertook an economic analysis of the benefits associated with nutrient load reduction in the Port Phillip catchment in Victoria. They considered the impact that algal blooms could have on the amenity of the lower Yarra River. They estimated the value of the waterway frontage premium on the river at approximately $5.2M - $20.3M p.a. During the study Read Sturgess and Associates (2001) assumed:

- a 20% price premium applied to properties with waterway frontage (to generate a low estimate); and
- a price premium of 20% applied to all properties within 100 metres of a waterway (to generate a high estimate).

A valuation study was undertaken for the urbanised portions of the Swan-Canning Catchment in Perth, Western Australia in 1998 (UWA, 1998). The study concluded that the value of water views around the relatively healthy Swan-Canning system (i.e. two main rivers and an estuary), as measured by the annual stamp duty and land tax collected per year from properties with elevated values, was approximately $2.7M p.a. (in 1998 dollars).

A survey of residents in Columbia, Maryland found that approximately 75% of homeowners felt that permanent water bodies enhanced real estate values and approximately 73% said that they would be prepared to pay more for property that was located near stormwater-related assets that were designed to incorporate habitat for fish or other wildlife (Adams, *et al*., 1984; Tourbier and Westmacott, 1992; and US EPA 2001b). Note that these residents lived in an area that contained several stormwater ponds and lakes.

Improved urban stormwater management can lead to healthier riparian vegetation along waterways (e.g. due to a reduction in stormwater flow velocities and subsequent scouring). Streiner and Loomis (1995 and 1996) reported that homes situated near several Californian stream restoration projects had a 3% to 13% higher property value compared to similar homes located on unrestored (i.e. degraded) streams. Restoration activities included maintaining fish habitat, acquiring land, establishing an education trail, stabilising stream banks, revegetating stream banks, cleaning up the stream, and reducing flood damage.

Healthy urban waterway corridors can also provide valuable habitats for wildlife. Adams (1994) found that nearly 60% of suburban US residents actively engaged in wildlife watching in their homes. Adams also reports that the majority of residents are willing to pay a premium for homes located where wildlife is easily accessible.

Mahan *et al*. (2000) examined how the size of, proximity to, and type of wetlands affected the value of residential homes in Portland, Oregon. They found that home values were not influenced by wetland type. However, an increase the nearest wetland's size by one acre was associated with an increase in property value of approximately 0.02%. In addition, reducing the distance to the nearest wetlands by 1,000 feet was associated with an increase in property value of approximately 0.36%. Mahan *et al*. (2000) also examined the effect on property value of reducing the distance to the nearest stream or lake by 1,000 feet. They found that for streams, property value increased by approximately 0.21%, while the corresponding increase was 1.34% for lakes. They concluded from their study that "wetlands are not as desirable to live near as lakes but somewhat more desirable to live near than streams" (p. 112).

Lupi *et al*. (1991) valued urban wetlands in Minnesota using hedonic price analysis. They found that proximity to wetlands slightly increased property value, particularly where wetlands were rare in the region. Doss and Taff (1996) also studied wetlands in the Minnesota region and found that they were generally associated with increased property prices. They also found that people generally preferred 'open-water' and 'scrub-shrub' wetland types rather than 'emergent-vegetation' and 'forested' wetlands. Mahan *et al*. (2000) also found that being closer to wetlands increased the positive impact on housing value, with the effect being noted up to a mile from the wetland.

Earnhart (2002) used survey responses and discrete-choice hedonic analysis to place a value estimate on the amenity associated with restored wetlands in Connecticut. Earnhart's estimate was expressed as a premium on nearby property values, being 2.7% of the average house price. Boyer and Polasky (2002) note that this estimate is high compared to similar studies they were aware of.

Table C.4 summarises the *factors* that have been found to lead to increases and decreases in property values associated with elements of the urban stormwater drainage network.

<u>Aesthetics associated with stormwater management features and improved water bodies</u>

Lloyd *et al*. (2002) reported that positive perceptions of bio-filtration systems in Melbourne (see Figure C.2) were reinforced by land sale records of allotments next to these systems at the Lynbrook Estate in South East Melbourne. They reported that "during the release of each stage of the development that incorporated bio-filtration systems into the street drainage, the rate of land sales and prices at the Lynbrook Estate reflected the high-end of the property market across Melbourne's greenfield site developments" (p. 23).

Mitchell (2004) reported unpublished social research from the Sydney Water Corporation (Roseath, 2003) which was undertaken in association with developments with integrated urban water management features. This research found that non-conventional "water servicing acts as neither an attractor or detractor for a potential residential house purchaser" (p. 13). These comments relate to modern developments that have stormwater management,

Table C.4 Factors That Can Increase and Decrease Property Values Around Stormwater Assets

Factors That Typically Lead to Increases in Property Value	**Factors That Typically Lead to Decreases in Property Value**
▪ Stormwater management measures with standing water (e.g. ponds) located near the entrance to the estate, near lots, near public open space and/or visible from the road so that the development has 'kerb appeal'. ▪ Stormwater management measures with standing water that are associating with recreational features (e.g. walking trails, picnic areas, jetties, bird watching areas, boating, etc.). ▪ The addition of fountains to stormwater management measures with standing water such as ponds. ▪ Ensuring stormwater features have visually appealing landscaping (e.g. landscaped bio-retention systems and rain gardens) and are well maintained. ▪ Ensuring the design of stormwater assets mimics natural features such as creeks, wetlands and ponds.	▪ Safety. In particular, the risk that young children will be attracted to the water and wildlife provided by a stormwater wetland or pond and subsequently drown. Drownings involving children and adults have occurred in detention ponds. Some real estate commentators even suggested that it is the only significant issue with respect to stormwater infrastructure that can adversely affect property values (Jablonski, 1995). ▪ Pests (e.g. mosquitoes, midges, snakes) and odour (e.g. from rotting organic matter) from poorly designed and/or maintained stormwater treatment measures. ▪ Visually unappealing fencing around stormwater management measures. ▪ Floating / trapped litter and/or algal blooms.

Source: Adapted from US EPA (2001b) and Frederick *et al*. (2001).

water conservation (e.g. rainwater tanks) and wastewater reuse features (e.g. third pipe systems) that do not significantly alter the aesthetic or recreational values of the house, street or estate (i.e. the estate appears to be 'conventional' to a layperson). Designers of *stormwater management* features however, have the capacity to significantly influence the amenity of the estate, through the use of features such as landscaped bioretention systems, ponds, natural channels, constructed wetlands, rain gardens, etc.).

Aesthetics plays a major part in the relationship between property prices and nearby stormwater assets. Van Bueren and Bennett (2001) undertook an economic study to develop value estimates for generic environmental attributes using the choice modelling method that could be transferred across Australia with a reasonably high level of confidence. This work was done to minimise the risks associated with transferring costs and benefits from one study context to another (i.e. using the benefit transfer method). One of these attributes related to aesthetics (i.e. the "look of the land"). Relevant findings were:

- On a national basis there was a willingness to pay \$0.07 p.a. (mean) or \$0.02 to \$0.14 p.a. (95% confidence interval) per household as an environmental levy over 20 years to restore 10,000 ha of land for aesthetic reasons. These values represent year 2000 Australian dollars.
- This national value must be scaled upwards for use in regional areas of Australia, as the study found that residents in regional Australia value the "look of the land" attribute much more highly than the national average. The recommended scaling factor for this attribute was 20 to 25 times.

Robinson *et al*. (2002) used a Citizens' Jury combined with the choice modelling valuation method to determine what residents of the Bremer River Catchment in South East Queensland would be willing to pay for improvements in waterway health. They firstly examined what residents would be willing to pay to improve riparian vegetation (non-use value), aquatic vegetation (non-use value) and visual amenity (indirect use value). Such outcomes could be produced by urban stormwater management projects. Their willingness to pay result for the visual amenity value (in 2002 Australian dollars, reported as per person per annum) was \$0.37 to increase the total length of the river with a 'very good' visual appearance by 1%.

<u>Improved water quality in receiving waters</u>

David (1968) undertook a study of lakeshore property values in the State of Wisconsin. She found some attributes were positively related to land value (e.g. water quality, proximity to population centres, and the presence of many other lakes in the area), some were negatively correlated with value (e.g. swampy or steeply sloping banks) and some were not related to value (e.g. access, the amount of public land in the vicinity, or fluctuations in the water level of lakes). Several of these attributes are highly relevant to stormwater projects (e.g. water quality of receiving waters, swampy or steeply sloping banks of ponds and wetlands, and fluctuating water levels in ponds and wetlands).

Mendelsohn *et al*. (1992) measured decreases in house prices which were associated with the degradation of water quality in New Bedford Harbour, Massachusetts. The study involved 1,916 sales of 780 different properties and found that the pollution of water (from PCBs) seemed to have no effect on house prices until public awareness of the issue increased. The study concluded that the mean house price dropped by approximately:

- 6.7% when water quality in the new Bedford harbour dropped from "swimmable" to "fishable"; and
- 8.6% when water quality dropped from "swimmable" to "boatable".

DeLoughy and Marsicano (2001) undertook a contingent valuation survey to estimate the value that waterfront and lake community property owners place on recreation and water quality around Candlewood Lake and Squantz Pond in Connecticut. Both lakes had experienced measurable deterioration in water quality prior to the study. DeLoughy and Marsicano surveyed community members to estimate the likely decrease in property values for waterfront properties and non-waterfront properties under three water quality-related scenarios. These scenarios and the key results of the study are provided in Table C.5. Overall, the study concluded that a continued decline in water quality and the associated loss of recreational values would significantly impact property values and associated local tax revenue.

DeLoughy and Marsicano's study highlights an important aspect that should be considered in triple-bottom-line assessments involving proposed stormwater projects that are likely to affect nearby property values. That is, the potential impact on ongoing revenue to local government as a result of increased property values. This impact has the potential to provide a benefit to the *broader* community on an *ongoing* basis.

Read Sturgess and Associates (2001) reported that algal blooms in Australia have adversely affected property prices. They cited:

- An economic study on the effects of algal blooms in the Peel-Harvey Estuary in South West Western Australia, where the average decrease in land values was estimated at $600 per block (a percentage was not given).
- A drop in property values for water frontage lots around Lake Boga (Victoria) after major algal blooms in the summers of 1993/4 and 1994/5. Following property valuation in late 1995, it was concluded that on average, lakeside properties were worth 20% to 25% less than before the blooms.

The Washington State Department of Ecology (2003) undertook a brief review of six studies that attempted to measure the effect of water quality on the value of nearby properties. The conclusion of this review was that the premium associated with improvements in water quality typically ranges from 1% to 20%.

A hedonic pricing study by Leggett and Bockstael (2000) in Anne Arundel County, Chesapeake Bay, Maryland found that an increase of 100 faecal coliform counts per 100 mL (pathogens) in receiving waters was estimated to produce about a 1.5% decrease in adjacent property prices[5].

Steinnes (1992) suggested that it is a person's perception (or misperception) of water quality rather than actual water quality that implicitly affects property value. Taylor (2002) also suggested that in most cases community *beliefs* about water quality and associated risks to human and/or ecological health are more likely to be related to visual observations (e.g. water clarity, existence of litter or algal blooms) than less easily observed indicators like the concentrations of pathogens.

Table C.5 The Estimated Percentage Loss in Value for Properties Associated with Two US Lakes with Declining Water Quality

Water Quality Scenario	**Waterfront Properties (% decline in property value)**	**Non-waterfront Properties (% decline in property value)**
Decline in water quality from "current" status to "no swimming"	33.8%	20.6%
Decline in water quality from "current" status to "no fishing"	16.3%	11.1%
Decline in water quality from "current" status to "no boating"	34.2%	19.6%

Source: DeLoughy and Marsicano (2001).

[5] Note that information on faecal coliform concentrations had been made widely available to potential purchasers of property in the area (Krysel *et al*., 2003).

Another example concerns the improvement in water clarity around lakes in Maine (North East United States). Michael *et al*. (1996) used a hedonic property price model to find that a three foot (~1m) improvement in water clarity resulted in an increase in property value of $11 to $200 (in 1996 US dollars) per foot of shore line property. This increase in property values equates to premiums of approximately 2% to 17%. Michael *et al*.'s study was later updated and validated by Boyle *et al*. (1998).

In Michael *et al*.'s review of previous literature, they reported that:

- Young and Teti (1984) used a hedonic pricing model to find that degraded water quality was associated with depressed property prices around Lake Champlain in northern Vermont.
- Brashares (1985) examined the effect of numerous indicators of water quality on the value of residential properties around 78 lakes in South East Michigan. The study found that only turbidity and faecal coliforms were water quality indicators that were significantly correlated with property prices. High levels of turbidity were clearly visible to property buyers, while faecal coliforms concentrations were monitored by health agencies and were reported to potential property buyers.

Krysel *et al*. (2003) found that water quality was a significant explanatory variable of lakeshore property prices around Minnesota lakes in the Mississippi headwaters region, for all six types of lake that were studied.

A study conducted by Epp and Al-Ani (1979) examined the relationship between r*ural non-farm residential* property values and stream water quality. A number of variables were tested in the analysis, including perceived water quality, pH and flood hazard. All three of these explanatory variables were found to be significant. The study found that prices of properties adjacent to 'clean streams' (i.e. pH 6.5 – pH 8.5) were sensitive to changes in water quality, while in areas of poor water quality (i.e. pH 3.7 – pH 5.5) there were no property value benefits associated with marginal improvements in water quality. Epp and Al-Ani concluded that only water quality improvement in the 'clean streams' provided for *additional* recreational values such as trout fishing, which led to higher property values.

Ward and Scringeour (1991) summarised the annual value of benefits associated with harbours in the Auckland region of New Zealand that are affected by the ambient water quality. Urban stormwater pollution represents a major threat to the ambient water quality in these harbours. The total annual value was estimated at $442 million (in 1991 New Zealand dollars), of which over half was related to benefits from amenity[6]. The breakdown of the total estimated value is given below:

- Amenity of the harbours: $222 million per year.
- Commerce - tourism: $11 million per year.
- Commerce - fishing: $11 million per year.
- Recreation - beaches: $9 million per year.
- Recreation - boating: $32 million per year.
- Recreation - fishing: $1 million per year.
- Recreation - shellfish gathering: $8 million per year.
- Recreation – water sports: $7 million per year.
- Flow-on effects: $62 million per year.
- Intangibles: $79 million per year.

Collectively, the above studies support the view that stormwater projects that increase amenity in residential areas can significantly enhance adjacent property values (and associated property rates). Amenity may increase as a result of the provision of water bodies (e.g. ponds and wetlands with an open water zone), enhanced water quality in local water bodies, improved aesthetics, provision of recreational opportunities and minimisation of risks to safety.

[6] Note that the approximate population of the greater Auckland region is 1.2 million (in 2005).

3.3.2 Value of water sensitive urban design

The Low Impact Development Centre (2003) in the US summarised the benefits of water sensitive urban design (WSUD) as including:

- multifunctionality (e.g. landscaped features can also be designed to provide stormwater treatment opportunities);
- lower life-cycle costs (e.g. in some circumstances water sensitive designs that manage stormwater at the source can be more cost-effective than designs that rely on 'end-of-pipe' treatment);
- ecological and social benefits in addition to those associated with direct improvements to stormwater quality and quantity (e.g. enhanced groundwater recharge to allow greater reuse, provision of habitat, improvement of air quality, provision of shade, improvement to the area's aesthetic appeal, etc.);
- reduced off-site costs (e.g. projects that recycle stormwater may result in a reduced need for downstream stormwater detention infrastructure); and
- allowing the functional use of open space land (e.g. the use of source controls may avoid the need for large 'end-of-pipe' infrastructure, such as ponds, that are commonly located within public open space).

This section summarises some of the attempts to quantify the *benefits* of WSUD compared to traditional urban stormwater management that focuses on large, end-of-pipe pipe treatment measures (or provides no treatment at all).

A report by the CRC for Catchment Hydrology (Lloyd, 2001) summarised the benefits of five significant WSUD demonstration sites in Australia. Key points include:

- The reduced consumption of potable water on WSUD developments ranged from 50% to 80%.
- Market response to the water sensitive Lynbrook Estate in Melbourne was positive with the Urban and Regional Land Corporation deciding to implement WSUD practices in other development sites. Similar positive responses have been observed by other developers with similar designs (e.g. 'The Cascades' water sensitive development at Forest Lake in Brisbane, as reported by Campbell, 2001).
- Stormwater discharges can be significantly reduced, leading to a reduced need for downstream stormwater detention (see Section 3.3.5).

In addition, modern water sensitive developments around Australia should be able to achieve the following 'design objectives':

- Reductions in the *average annual load of stormwater pollutants* compared to a base case where the development uses traditional, directly connected stormwater drainage designs with no treatment or reuse: total suspended solids (TSS) ≥80%, total phosphorus (TP) ≥60%, total nitrogen (TN) ≥45% and gross pollutants[7] ≥90% (EE and MBWCPS, 2004).
- *Demand management measures* for water conservation within new residential developments should be able to easily reduce potable mains water consumption by approximately 15% (compared to traditional levels of water use) and with significant effort should be able to achieve an approximate reduction of 30% - 40% (EE and MBWCPS, 2004).
- *Source substitution management measures* for water conservation within new residential development should be able to reduce potable mains water consumption by approximately 55% (compared to traditional levels of water use) (EE and MBWCPS, 2004).
- *Wastewater minimisation measures* within new residential development should be able to reduce litres of wastewater discharged to the environment per person per day, excluding system losses / gains by approximately 30% - 40% (compared to traditional levels of wastewater discharge) (EE and MBWCPS, 2004).

[7] Gross pollutants are defined as being material greater than 5 mm in any dimension.

Work by Coombes *et al*. (2000) in the Lower Hunter and Central Coast region of New South Wales indicated that the use of rainwater tanks to supplement mains water supply for toilet, hot water and outdoor use can substantially reduce annual regional water demand, delay construction of new water supply headworks infrastructure by several decades, and eliminate the need for the construction of some new water supply infrastructure, resulting in economic benefits to the community over the next 100 years of up to $6B.

There are now numerous case studies documented in the literature where WSUD (or "low impact development" as it is more widely known overseas) has resulted in monetary savings to the developer or stormwater agency. For example:

- Lehner *et al*. (1999) report that eliminating kerbs and gutters at the Prairie Crossing development in Grayslake, Illinois saved the developer approximately $2.7M (US), with sales being comparable or better than nearby conventional developments.
- Lehner *et al*. (1999) also report that the Oregon Museum of Science and Industry in Portland redesigned its parking lot and used vegetated swales rather than conventional stormwater management to convey stormwater runoff. This design saved $78,000 (US) in construction costs.
- Schueler (1995) found that water sensitive urban design can reduce the need to clear and grade 35% - 60% of the site's total area. This has the potential to generate a significant saving to the developer, given that the total cost to clear, grade and install erosion control measures to meet US standards can range up to $5,000 (US) per acre.
- Auckland Regional Council (Shaver, 2000) estimated that WSUD will generate savings in the order of 10% of the city's stormwater infrastructure and maintenance costs. That is, savings of approximately $5M (NZ) per year by the year 2008 (Eason *et al*., 2004).

Lloyd (2004) reported that over half of the surveyed respondents in a new water sensitive estate (i.e. Lynbrook Estate in South East Melbourne) were willing to pay an annual fee of at least $25 for the ongoing maintenance of integrated water management schemes. The estimated annual cost of maintaining water quality improvement measures at the estate was approximately $14 per household per year.

Note that high standards of erosion and sediment control are usually required during the construction phase of a WSUD development, particularly where infiltration and bioretention systems are being built. The need for improved erosion and sediment control is an obvious cost, but can also be benefit. For example, Herzog *et al*. (1998) reported that a study in Ohio and Indiana found that seeding and mulching reduced erosion by up to 86% and reduced phosphorus export from the site by approximately 80%. In addition, home buyers perceived the vegetated 'green' lots to be worth $750 (US) more than comparable 'brown' lots without seeding or mulching (i.e. developers had the potential to charge a premium on these lots which was more than twice the original cost of the erosion control).

3.3.3 Value of open space / parkland in and around drainage features and waterways

Advice from local government officers in Brisbane City Council indicates that the value that water bodies or drainage features may add to (or detract from) in urban parks is strongly related to the design, construction and maintenance of the waterway / drainage feature (Hunter, 2001). For example, where a degraded water body is in close proximity to a park, the water body would normally diminish the value of the open space asset. However, where a healthy water body is integrated into the design of the open space, the water body can be expected to enhance the value of the open space asset. The magnitude of this effect on the value of public open space would normally:

- be greater when the water body includes open water; and
- be similar to the effect on adjacent residential property values (Hunter, 2001).

Read Sturgess and Associates (2001) undertook an economic analysis of the benefits associated with the reduction in nutrient loads moving through the Port Phillip Bay catchment in Victoria. As part of this study, they examined the value of recreation on the Yarra River and around its banks in Melbourne. They estimated the value of park-based recreation on the banks of the river to be approximately $13.9M - $33.4M p.a.

Research Wise (2002) reported on a comprehensive water sensitive urban design-related market acceptance and buyer attitudes survey conducted in Melbourne. The survey involved 300 property owners and prospective buyers drawn from four estates in Melbourne's growth corridors. The key issues to surveyed respondents were the recreational features and aesthetics associated with the design.

Surrey Parks, Recreation and Culture (2001) commissioned a study to determine if the value of single family residential dwellings that bordered 'greenways' were effected by their proximity to the greenway[8]. The results of such studies could be used to inform decisions about multiple use waterway / drainage corridors. The study found that proximity to greenways typically increases the value of properties, with the design and type of the greenway being factors that influence the magnitude of the price increase. Over four neighbourhoods, the study measured an average price increase of 2.8% (range: 0.8% to 10.2%). Note that the study also found that property values can drop if greenways are small and poorly maintained.

Bolitzer and Netusil (2000) found that proximity to open space and the type of open space have a statistically significant effect on the sale price of residential properties in Portland, Oregon. 'Public parks' in the study area were found to have a positive effect on the sale price of nearby properties.

Espey and Owusu-Edusei (2001) examined the influence of proximity to parkland on property values in South Carolina, as well as the type of parkland (where 'type' relates to the parks' size and amenities). Their study is potentially relevant to decisions involving multiple use waterway / drainage corridors in urban areas that have recreational values. Espey and Owusu-Edusei examined four types of parkland and found that property values could be increased or decreased depending on the type of park and distance from the park. For example, values of properties *immediately* next to the park were depressed by 14% to 50% for two of the four types of parkland studied (these values were increased by 11% for one park type, and remained neutral for the remaining park type). The greatest positive impact was associated with small, basic, neighbourhood parks which were associated with a 15% increase in the values of properties that were located within 300 feet - 500 feet (approximately 100m - 167m) from the park. Overall, Espey and Owusu-Edusei's study highlights how a park's size and amenities can significantly affect the relationship between property premiums and distance from the park.

A number of studies have found that parks with *healthy waterway corridors or features* increase the value of adjacent residential properties. For example:

- Pennypack Park in Philadelphia is thought to be associated with a 33% increase in the value of nearby properties (Chesapeake Bay Foundation, 1996).
- A multiple use corridor (also known as a 'greenway' or 'greenbelt') in Boulder, Colorado was associated with an increase in aggregate property value in the area of $5.4M (in 1996 US dollars), resulting in $500,000 (US) of additional tax revenue per year (Chesapeake Bay Foundation, 1996).
- Fisher (1990) examined the effect that proximity to Skeleton Creek in Melbourne had on average residential property values. This work involved three residential estates. He concluded that properties that were orientated towards the waterway and had access to significant open space such as the Seabrook Estate, exhibited significantly higher valuations compared to equivalent properties that were remote from the waterway but within the same estate. For the Seabrook Estate, the premium associated with

[8] In this context, a 'greenway' is a natural area in an urban environment, such as a waterway drainage corridor with intact riparian vegetation.

access to a waterway and public open space was statistically significant and approximately 16.5%.

- Correl *et al*. (1978) found that for every 100 metre increase in distance away from an urban greenbelt (e.g. a multiple use corridor with a waterway or drainage channel that runs though an urban area), the value of an average house fell by approximately 2.3% (this trend occurred up to 1 km from the greenbelt). It is noted that Correl *et al*.'s observations imply a linear relationship between property value and proximity to waterway corridors. Other studies have found a non-linear relationship when examining the change in property value with the proximity to either waterways, wetlands and/or open space. Figure C.5 for example, is a conceptual diagram of a non-linear relationship from Daugherty (1997) that relates property value to proximity to open space. As noted in Figure C.5, some studies have even found a relationship where values are depressed for property abutting parks with nuisance factors (e.g. high usage rates, noise, etc.), but then become elevated in the vicinity of these parks.

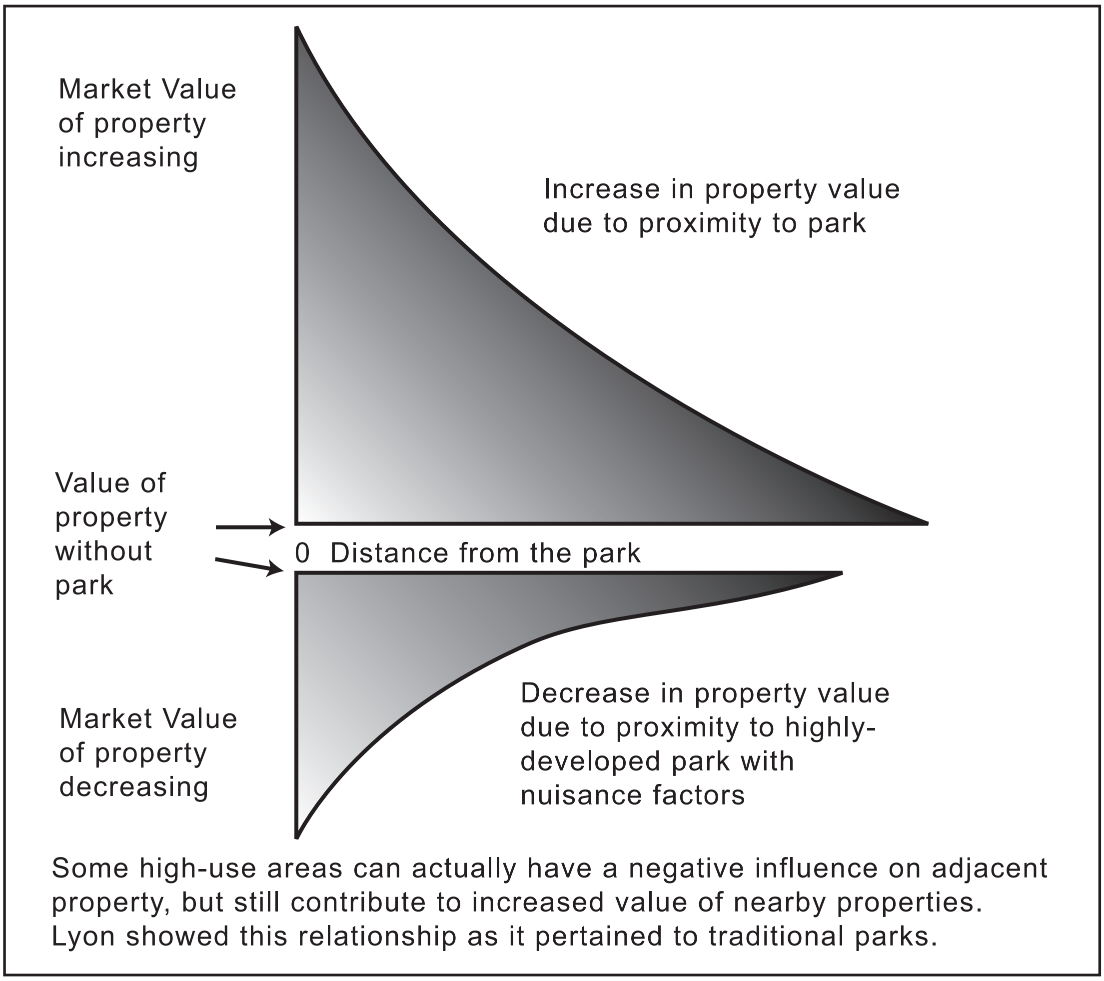

Figure C.5 Conceptual Relationship Between Property Value and Proximity to Open Space / Parks (With or Without Water Bodies)

Source: Daugherty (1997).

Farber (1999) suggested the following general guidelines with respect to how 'environmental amenity' can impact residential property prices:

- the effect of amenity on property prices generally diminishes with distance from a site or event;
- effect on property value is usually localised;
- markets are typically sensitive to perceived and real impacts on amenity; and
- reductions in property prices tend to rebound after an event (e.g. algal bloom or flood).

3.3.4 Human health values

In the context of stormwater management, Holder (2003) concluded that the main human health issues are safety (e.g. the risk of children drowning), disease vectors (e.g. mosquitoes, particularly in sub-tropical and tropical areas), water-borne pathogens at swimming beaches after wet weather (e.g. faecal coliforms) and hazardous litter (e.g. syringes on beaches). Quantifying these values is extremely difficult because the risks are hard to estimate and there are moral dilemmas of trying to place a monetary value on pain, suffering and death. Because of these concerns, evaluation of health-related costs and benefits associated with stormwater management projects is best done on a *qualitative* basis (Holder, 2003).

Lloyd (2004) and Research Wise (2002) reported on a comprehensive water sensitive urban design-related market acceptance and buyer attitudes survey conducted in Melbourne. The survey found that while community acceptance for bio-filtration systems, wetlands and water reuse schemes was a very high (over 85% of respondents supported such strategies in their neighbourhood), a small proportion of respondents were concerned about safety issues and long-term maintenance of treatment measures.

Daugherty (1997) reported that Norwegian and Swedish studies have found that residents of large cities with numerous greenways and waterway parks disbursed *within* the city limits have, on average, fewer physical and mental health problems compared to residents in cities where the parks are located on the outside periphery of the city. If a similar association between waterways / open space and people's 'quality of life' could be demonstrated with confidence, it could provide water managers with a good case for improving the management of stormwater and waterways under the rubric of "enhancing a city's liveability".

Hager (2003) stressed the significance of safety risks associated with stormwater infrastructure in the United States of America. She reported that an adult drowned in a residential stormwater pond in 2000 following a car accident. This incident lead to a lawsuit which sought to find the developer partially responsible for the man's death. She also reported that some counties in the US have placed on hold plans for additional stormwater ponds in response to concerns over safety and vector control. In particular, concerns exist over the risk to children who live near these ponds.

Note that at least three cases of drowning involving children have occurred in Sydney since the 1980s in relation to urban lakes and/or stormwater ponds (Hunter, pers. comm., 2005).

The Department of Natural Resources (1986) in Maryland reported the following results from a survey of residents living near stormwater ponds:

- 60% of respondents thought that the ponds were associated with a drowning hazard for children.
- 16% of respondents thought the steepness of the ponds' banks created a safety hazard.
- 14% of respondents thought the ponds could lead to increased mosquitoes / insects.

3.3.5 Value of stormwater detention and the cost of nuisance flooding

Some stormwater management measures that are built primarily to treat stormwater can also provide value as detention systems (e.g. bioretention systems, constructed wetlands). However, the magnitude of this value is dependant on the detention-related objectives of a development. For example, if detention is required to maintain the post-development 1.5 year

ARI (average recurrence interval) peak flows to pre-development conditions, then best management practices for stormwater such as bioretention systems can *help* meet this objective, usually in combination with specialist detention measures.

If on the other hand, detention is required to mitigate the effects of extreme flooding (e.g. by maintaining the pre-development 10 and 100 year ARI peak flows), then common best management practices for *stormwater treatment* such as bioretention systems provide no significant detention value (Eadie, pers. comm., 2004). This is because such measures are typically designed to treat the 1 in 3 month ARI design storm, and are therefore quickly bypassed during larger storm events.

There are some examples however, where water sensitive urban design has resulted in significant reductions in stormwater runoff even during large, infrequent storm events, which could minimise the need for stormwater detention facilities downstream. For example, the Figtree Place development in Newcastle claims to be able to reduce approximately 83% stormwater runoff up to the 1 in 50 year ARI storm event and the Olympic development at Homebush Bay claims to be able to reduce all runoff up to the 1 in 100 year ARI storm event, albeit with some releases as environmental flows (Hatt *et al*., 2004). These developments are relatively unusual in Australia at present, as they not only treat stormwater, but they capture and reuse significant quantities of stormwater. Such developments are likely to become more common as increased efforts are made to reduce mains water use in Australia.

It has been estimated that the Figtree Place development in Newcastle provides a 1% cost saving (i.e. $960 per dwelling) in stormwater infrastructure. Research by the University of Newcastle has indicated that reuse of roofwater in new developments can *potentially* produce a 3% cost saving associated with a reduced need for stormwater pipes and downstream stormwater treatment devices (SIA, 2004).

Urban stormwater projects may aim to protect the value of nearby *natural* wetlands and in some cases, large natural wetlands are used as part of a region's stormwater management system. Under the ecosystem services approach to valuation, a natural wetland may be valued based on the services (or use values) it provides that would cost a known amount to provide via some other means (e.g. flood mitigation works). An example of where such as an approach could be used is the Bluebelt area around Staten Island, New York (see NRDC, 2001). In this area, natural wetlands are used as part of stormwater quantity and quality control. Even including the cost of acquiring large areas of wetlands (255 acres in total), New York City expects to save $50M (US) as the City was able to avoid the construction of traditional stormwater management infrastructure. This figure therefore represents the approximate value of the ecosystem service the natural wetlands in the Bluebelt area provides for flood mitigation and stormwater conveyance only (indirect use values). In Australia however, *natural* wetlands are rarely used to manage urban stormwater quality or quantity.

In theory, a dis-benefit or cost may be associated with the detention function of some stormwater treatment measures. For example, temporary ponding of water in roadside vegetated swales and bioretention systems may be seen as an inconvenience by some land owners, and be reflected in reduced property value. It is suggested however that good design can easily neutralise this potential cost. For example, a well-designed residential development with grassed swales and bioretention systems in Victoria (i.e. the Lynbrook Estate in South East Melbourne) was associated with faster sales than another stage of the development with 'traditional' stormwater designs and equivalent property prices.

3.3.6 Value of vegetation in stormwater treatment measures

Vegetation in stormwater treatment measures (e.g. constructed wetlands and urban forests) can provide benefits in terms of carbon sequestration, improvements in local air quality, urban cooling and aesthetics in addition to their stormwater treatment function. Some attempts have been made to value these additional benefits.

MacPherson *et al*. (1999) undertook a benefit-cost analysis of public street trees in the city of Modesto in California. This study sought to place a monetary value on the many services provided by the street trees. This study provides a broad indication of the values vegetation can provide in an urban environment. Such information may be relevant to stormwater projects that incorporate a large amount of vegetation (e.g. a urban forests). Overall, the study found that benefits that residents obtained from the city's 91,179 street trees exceed management costs by a factor of approximately two. The values placed on each category of benefit (in 1999 US dollars) were:

- savings in energy use due to shading ($10.97/tree);
- reductions in carbon dioxide ($4.93/tree);
- improvements in air quality ($15.82/tree);
- reduced stormwater runoff ($6.76/tree); and
- "aesthetic and other" benefits ($15.96/tree).

The total monetary benefit per street tree was estimated at $54.44 (in 1999 US dollars).

Feeney (2004) reported the results of a contingent valuation study that estimated the willingness to pay of New Zealand residents to avoid a 20% decline in their nations' 'urban tree estate'. The estimated willingness to pay per household when multiplied by the 833,333 households in New Zealand resulted in a total willingness to pay estimate of $116 million per annum over three years (in 2003 New Zealand dollars). The 95% confidence interval associated with this estimate was $85 million to $142 million.

American Forests (2000) undertook an analysis of the economic benefits associated with vegetated land within the District of Columbia in the US. Again, some of this information may be relevant to stormwater projects that incorporate a large amount of vegetation. The study found that forested land in the District of Columbia minimised air pollution and avoided health-related costs which were valued at approximately $109/ha per annum (in 1997 US dollars). This estimate represents the cost that the community would have to pay, in areas such as health care, if the vegetation did not remove air borne pollutants.

Healthy riparian vegetation and vegetated stormwater treatment measures (such as constructed wetlands and urban forests) can also provide carbon sequestration benefits (i.e. remove carbon dioxide from the atmosphere). For example, it is estimated that Australian forests in temperate climates trap approximately 1 to 10 tonnes of carbon/ha/year. This equates to approximately 4 to 37 tonnes of CO_2/ha/year. A market for trading ‘Carbon credits’ is not yet established in Australia, but some companies / organisations already have internal trading systems. For example, British Petroleum (BP) reportedly allocates approximately $11/tonne of CO_2 (Waterworth, 2001).

Pratt (2002) reported that the ExternE project estimated the costs associated with damage produced by every tonne of CO_2 (e.g. due to sea level rise, climate change, loss of habitat, etc.) as between $33 and $92. Pratt (2002) briefly reviewed the literature and suggested that $40/tonne of CO_2 should be used as an estimate of the damage that can be caused from CO_2 emissions.

If one assumes the costs associated with one tonne of CO_2 emissions is between $11 and $40 (based on 2001-02 estimates), an estimate of the value of healthy riparian vegetation or vegetation in a stormwater treatment measure from a carbon sequestration perspective in Australia is approximately $44 to $1,480/ha/year.

Costanza *et al*. (1997) estimated the value of vegetation from a carbon sequestration perspective to be approximately $88/ha/year (in 1994 US dollars). This figure represents a *global average* value of temperate forests for the ecological ecosystem service of “climate regulation”.

3.4 Non-use (intrinsic) values

Most valuation studies that determine ‘willingness to pay’ for waterway-related values that exist outside of a market (e.g. a waterway’s existence value), attempt to measure the *total value* of a waterway. Consequently, the willingness to pay results reflect *both* non-use (intrinsic) values and use values (e.g. recreational values). This is why Section 3.4 includes the results of several studies that report the approximate value of non-use *and* use values.

3.4.1 A word of caution about 'willingness to pay' studies

To estimate the importance of non-use social and ecological values, such as option, existence and bequest values, contingent valuation has been widely used as a valuation method[9]. Consequently, many of the values reported in Section 3.4 have been derived from this method. Due to the contentious nature of contingent valuation (see Appendix A), questions remain over the validity of, and uncertainty associated with, the values estimated by this method.

Note also that a study by Gramlich (1977) highlighted the importance of the affected community's *socio-economic profile* on their self-reported willingness to pay, as measured by methods such as contingent valuation. Gramlich studied people's willingness to pay for improved water quality in the Charles River, Boston. The income of surveyed residents was found to significantly affect their willingness to pay for water quality improvements, with a 10% increase in income causing a 5 to 6% increase in willingness to pay. Willingness to pay also increased with the residents' level of education, use of and proximity to the river, while it decreased with the residents' age. These general findings should be kept in mind when results from contingent valuation studies are being interpreted, or when they are being used in another context (e.g. using the 'benefit transfer' valuation method).

3.4.2 Relative importance of non-use values

Sanders *et al*. (1990) highlighted the relative importance of *non-use values* in a study that examined the willingness to pay (per household) for improved river protection in the Rocky Mountains of Colorado. The willingness to pay (per household, per year) results for protection of 15 of the most valuable wild and scenic rivers are given below (in 1983 US dollars):

- Recreational use value: $19.16 (approximately 19% of the total value, which was $101.12).
- Preservation (non-use) value: $81.96 (approximately 81% of the total value). This estimate can be broken down into 'option value' ($15.97 or approximately 16% of the total value), 'existence value' ($27.67 or approximately 27% of the total value) and 'bequest value' ($36.19 or approximately 36% of the total value).

In this example, use-values contribute less than a fifth of the total value of river systems that provide significant use and non-use values. Similar findings were reported by Clonts and Malone (1988), where recreational use accounted for only 14% of the total amount that residents of Alabama were willing to pay for the protection of 15 rivers in the State (note that the total value was approximately $57 per household per year in 1987 US dollars). In contrast, the option, existence and bequest value represented approximately 17%, 39% and 30% of the total value, respectively.

Kneese (1984) estimated the average willingness to pay to improve the water quality in US rivers to three broadly defined standards (i.e. boatable, fishable and swimmable). The average willingness to pay per household is summarised in Table C.6.

Table C.6 Estimated Value of Improving Water Quality in US Rivers

Water Quality Standard	Total Australian $ (1999)	Marginal Australian $ (1999)
Boatable	$361.90	$361.90
Fishable	$461.90	$100.00
Swimmable	$535.71	$73.81

Notes: **Source**: Kneese (1984)

- The 'total Australian dollars' column indicates the average willingness to pay (per household, per annum) to improve water quality from its current state to the standard specified in the table.
- The 'marginal Australian dollars' column indicates the willingness to pay to improve the water quality standard from one level to the next (e.g. the average willingness to improve water quality from fishable to swimmable is $73.81).

[9] A 'willingness to pay' study that invites surveyed respondents to nominate a monetary value for a service.

At first glance one could assume that the values in Table C.6 only relate to 'use values' (e.g. fishing). However, not all those who responded to the survey intended to *use* these rivers, so that some proportion of the value represents non-use values (i.e. their intrinsic value).

Kneese (1984) estimated willingness to pay for water quality improvements from people who recreated in US rivers as well as those who did not. Consequently, Kneese suggested the non-use value was about 45% of the total value to those involved with river recreation. For the sample as a whole, non-use value constituted approximately 55% of the value of the benefit derived from the water quality improvements. This study again highlights that non-use values can be significant.

Greenley *et al*. (1982) examined the willingness to pay to preserve the quality of receiving waters that were threatened from a mining development in the South Platte River Basin in the US. They reported for *users* of the water services, the willingness to preserve water quality per household per year (in 2002 Australian dollars) was:

- recreational value: $242.74 (i.e. approximately 39% of the total value);
- option value: $93.69 (i.e. approximately 15% of the total value);
- existence value: $144.80 (i.e. approximately 23% of the total value); and
- bequest value: $140.54 (i.e. approximately 23% of the total value).

Even in this study, which only surveyed people who benefited from use-values, the relative importance of non-use values was still high. Non-use values made up approximately 61% of the total estimated value of the waterways.

3.4.3 Value associated with reducing stormwater pollution in urban areas

In the mid 1990s, the CSIRO undertook a major, two part research study into urban stormwater management and in particular whether awareness campaigns and community participation programs can be used to effectively improve stormwater quality management (Nancarrow *et al*., 1995 and 1998). Stage one of this work examined the willingness to pay for stormwater pollution abatement measures to improve waterway health in urban areas. The results from surveys in Brisbane, Perth, Melbourne and Sydney are summarised in Table C.7.

Table C.7 Estimated Willingness to Pay for Stormwater Improvement Measures to Protect Waterway Health in Urban Areas

Statistic	Total (n = 1025)	Brisbane (n = 263)	Sydney (n = 252)	Melbourne (n = 249)	Perth (n = 261)
Mean*	$54.45	$55.67	$82.83	$32.15	$47.09
Standard error	3.97	6.15	12.84	4.95	4.98
95% confidence limits	$46.66 - 62.25	$43.58 - 67.78	$57.54 - 108.12	$22.40 - 41.90	$37.28 - 56.91
Median	$10.00	$20.00	$25.00	$0	$10.00

Source: Nancarrow *et al*. (1995).

Notes:

- * This data set contains some extreme bids. When these were removed from the data set the resulting means for Brisbane, Sydney, Melbourne and Perth were $52.07, $65.76, $32.15 and $47.09, respectively.
- Monetary figures are in 1995 dollars. These figures represent potential annual payments, per person (Nancarrow, pers. comm., 2003).
- The authors of the study 'scaled-up' these willingness to pay estimates to produce 'aggregate willingness to pay' values for each city. These are: $54.10M, $259.40M, $40.93M and $52.04M for Brisbane, Sydney, Melbourne and Perth, respectively.
- Only 52% of the surveyed population agreed to pay any amount.

While the results of the CSIRO's stage one willingness to pay survey were encouraging when viewed on a city-wide basis, their stage two work indicated that the community's willingness to pay can be significantly reduced when residents are presented with specific, local initiatives to improve stormwater quality even when such initiatives are explained in detail.

Resource and Environmental Management Limited (2001) undertook a willingness to pay study in 2000 involving water-related improvements in Waitakere City (New Zealand). These improvements related to flooding, stormwater treatment and reductions in wastewater overflows (Harwell and Welsh, 2003). The residents of Waitakere City indicated that they were prepared to pay on average \$44.6 million/year (in 2000 NZ dollars) in order to reduce stormwater pollution by approximately 50% over the next 10 years. This represents a very high willingness to pay per person, given the population of the city is approximately 169,000 (i.e. about \$264 NZ per person per year for 10 years).

Harwell and Welsh (2003) reported that approximately 15 to 60% of stormwater pollutant loads in Waitakere City were thought to be associated with road runoff. They concluded that the local community of Waitakere City would be willing to contribute approximately \$67 to \$268 million (in 2000 NZ dollars) over 10 years to treat stormwater runoff from roads (i.e. about \$396 to \$1,586 per person over 10 years).

3.4.4 Value of 'healthy waterways' (non-use and use values)

Van Bueren and Bennett (2000 and 2001) undertook an economic study to develop value estimates for generic environmental attributes using the choice modelling method that could be transferred across Australia with a reasonably high level of confidence. One of these attributes was "healthy waterways". This work was done to minimise the risks associated with transferring costs and benefits from one study context to another using the benefit transfer method. Relevant findings were:

- On a national basis there was a willingness to pay \$0.08 p.a. (mean) or \$0.04 to \$0.16 p.a. (95% confidence interval) per household as an environmental levy over 20 years to restore 10km of nearby waterways for fishing or swimming. These values represent year 2000 dollars. Thomas *et al*. (2002) reported that the value of \$0.008/km/household/yr is equivalent to an upfront lump-sum payment of \$0.15/km/household, using a real discount rate of 5% over a 50 year period.

  Note that although these values clearly relate to 'use values' (e.g. fishing and swimming), it is highly likely that they also include a significant 'non-use' component (e.g. the intrinsic value of having a healthy waterway nearby). Evidence was provided earlier in this section to support the claim that non-use values are often more significant than use values in willingness to pay studies involving waterway health and water quality.

- The national value given above should be scaled upwards for use in regional areas of Australia, as the study found that residents in regional Australia value waterway health more highly than the national average. The recommended scaling factor for the "healthy waterways" attribute was 20 to 25 times.

Bennett and Morrison (2001) sought to place approximate monetary values on some of the key environmental values of rivers in New South Wales. They selected five rivers for their analysis. They also considered five 'river health attributes', namely: water quality suitable for fishing (use value); water quality suitable for swimming (use value); healthy riverside vegetation and wetlands (non-use value); native fish species present (non-use value); and waterbirds and other fauna species present (non-use value).

The resulting value estimates for the three non-use river health attributes listed above on a *Statewide basis* (i.e. \$ per NSW household in 2001 dollars) were:

- \$4.23 (the value placed on an additional percentage of a river having healthy riverside vegetation and wetlands);

- $7.70 (the value of the presence of an additional species of native fish in a river); and
- $2.37 (the value of an additional species of waterbird or other fauna species).

Robinson *et al*. (2002) used a Citizens' Jury combined with the choice modelling valuation method to determine what residents of the Bremer River Catchment in South East Queensland would be willing to pay for improvements in waterway health. They firstly examined what residents would be willing to pay to improve riparian vegetation (non-use value), aquatic vegetation (non-use value) and visual amenity (indirect use value). Their willingness to pay results for non-use value are as follows (in 2002 Australian dollars, reported as per person per annum):

- To increase by 1% the total length of the streams and rivers in the catchment with riparian vegetation in moderate or better condition: $1.47.
- To increase by 1% the total length of the streams and rivers in the catchment with aquatic vegetation in moderate condition: $1.08.

Robinson *et al*. (2002) then used the above information on use and non-use values to calculate the willingness to pay for four catchment management scenarios that were designed to improve water quality in the Bremer River (and therefore waterway health). These results were (in 2002 Australian dollars, reported as per person per annum):

- Do nothing (current): $0.
- Minimal improvement: $21.
- Moderate improvement: $36.
- Substantial improvement: $87.

ACNeilsen Pty Ltd (1998) investigated the value that residents of the greater Sydney region place on protecting all the existing values of the Hawkesbury-Nepean River system (i.e. non-use and use values) from degradation using the contingent valuation method. Thomas *et al*. (2002) reported that the willingness to pay to avoid waterway degradation derived from the study was approximately $0.35/km/household/yr, which was broadly equivalent to a present value of $6.56/household/km as an upfront lump-sum payment, using a real discount rate of 5% over a period of 50 years.

Households in the Australian Capital Territory were surveyed to find out what each household was willing to pay as a once-off levy to improve the health of creeks and rivers in the area. The result was $133 - $155 per household (in 1998 dollars) which can be assumed to relate to non-use and use values (NSW EPA Envalue database, 2004).

A New South Wales study examined willingness to pay (WTP) a once-off tax increase for improved water quality in the Barwon-Darling river system. Prior to the study, this river system experienced severe blue-green algal blooms and many of the river's use and non-use values were impacted (e.g. the ability to swim and the ability to support a diverse ecosystem). The results in 1993 dollars were:

- Median WTP per household in Sydney (i.e. at a considerable distance from the river system): $20 to $118.
- Median WTP per household in the Darling River region: $105 to $153 (NSW EPA Envalue database, 2004).

Kerr and Sharp (2004) undertook a choice modelling study within two locations in the Auckland metropolitan region of New Zealand (i.e. the North Shore and South Auckland). This study estimated the value associated with changing a number of waterway health-related attributes of local streams. These attributes and results of this study are summarised in Table C.8.

Kerr *et al*. (2004) studied in-stream water values of two rivers in the Canterbury region of New Zealand (i.e. the Rakaia and Waimakariri rivers). The Waimakariri River study involved measuring non-use benefits associated with the protection of in-stream flows and the benefits from improved water quality (i.e. improvement from suitable for boating and fishing to suitable for swimming). For this river, Kerr *et al*. (2004) found:

Table C.8 Estimated Value of Incremental Changes in Waterway Health-related Attributes of Streams in Auckland, New Zealand

Type of Urban Stream	Attributes	Increments of Change	Value of Incremental Change (NZ$2003/household/year)*
Natural stream	Water clarity	Muddy, clear	$66** to $67**
	Native fish species	1, 3, 5 species	$11** to $5**
	Fish habitat	2 km, 3 km, 4 km of habitat	-$1 to -$3
	Moderate native vegetation	Little or none, moderate	$28 to $16
	Plentiful native vegetation	Moderate, plentiful	$21** to $41**
Degraded stream	Water clarity	Muddy, clear	$48** to $73**
	Native fish species	2, 3, 4 species	$4 to $0
	Fish habitat	1 km, 2 km, 3 km of habitat	$13** to $5
	Moderate native vegetation	Little or none, moderate	$21 to $36**
	Plentiful native vegetation	Moderate, plentiful	$20** to $55**
	Channel form	Straightened, natural	$58** to $42**

Source: Kerr and Sharp (2004).

Notes:

- * The range of values represent results from the two locations. The results from the North Shore region are given first and the results from the South Auckland region are given second.
- ** These results are considered by Kerr and Sharp (2004) to be significantly different from zero.

- The 'option price' (i.e. the sum of use, preservation and option values) to be $17.05 (in 2004 NZ dollars, expressed as a mean willingness to pay per household per year) for users and non-users of the river. The equivalent figure for just users of the river was $11.86, while for non-users of the river it was $21.45. The higher willingness to pay by non-users is a surprising result.
- The 'preservation value' (i.e. the sum of existence and bequest values) to be $27.34 (in 2004 NZ dollars, expressed as a mean willingness to pay per household per year) for users and non-users of the river. The equivalent figure for just users of the river was $15.69, while for non-users of the river it was $37.39. Again, there was a higher willingness to pay by non-users.
- The present value of preservation values to be approximately $11 to 30 million (in 2004 NZ dollars), depending on the data collection method.
- The present value of the option price to be approximately $4 to 8 million (in 2004 NZ dollars), depending on the data collection method.

Kerr (2000) reanalysed a New Zealand dichotomous choice contingent valuation study that measured the benefits of improving water quality in the lower Waimakariri River from a 'D' grade to a 'C' grade (i.e. from suitable for boating and fishing to suitable for swimming). The mean willingness to pay per household per year for this improvement was estimated to be $60 (in 1983 New Zealand dollars)[10].

[10] The figure of $60 is reported in Kerr *et al*. (2004), however the original Kerr (2000) reference appears to present a range of figures from $94 to $308 (depending on the economic model used), with most in the range of $100 to $125.

The Rakaia River study by Kerr *et al*. (2004) estimated recreational use benefits, the value of salmon management, and non-use benefits associated with the protection of in-stream flows. For this river, Kerr *et al*. (2004) found:

- The 'option price' to be $17.60 (in 2004 NZ dollars, expressed as a mean willingness to pay per household per year) for users and non-users of the river. The equivalent figure for just users of the river was $31.10, while for non-users of the river it was $10.08.
- The 'preservation value' to be $17.38 (in 2004 NZ dollars, expressed as a mean willingness to pay per household per year) for users and non-users of the river. The equivalent figure for just users of the river was $30.93, while for non-users of the river it was $10.07.
- The present value of preservation values to be approximately $19 million (in 2004 NZ dollars).
- The present value of the option price to be approximately $8 million (in 2004 NZ dollars).

Harris (1984) estimated the willingness to pay of residents in the vicinity of Waikato Basin, New Zealand to maintain improved ambient water quality in an urban area that was achieved as a result of point source regulation of industrial discharges over the previous two decades. The willingness to pay estimate was $35.56 (in 2002 Australian dollars) per person per year. Note however that some elements of the study's methodology are of concern (e.g. there were a significant number of 'zero responses' that were excluded from the data set to derive the willingness to pay estimate).

Loomis *et al*. (2000) undertook an economic study involving the degraded South Platte River in Denver, Colorado. They found that local residents were willing to pay, on average, approximately $78 (in 1998 Australian dollars) per month via increased water rates to improve river health. This result can be assumed to relate to non-use and use values.

Lant and Roberts (1990) undertook an economic study involving the mid west corn belt in Illinois and Iowa. They explored a range of willingness to pay scenarios involving intrinsic (non-use) values and recreational (use) values associated with improvements in river health. For example, they found that residents in the region were willing to pay, on average, approximately $89 (in 1998 Australian dollars) per household per year via an increase in the States' sales tax to achieve the non-use value associated with "fair to good" improvements in water quality.

AGB McNair Pty Ltd (1996) undertook a contingent valuation survey in relation to a proposed upgrade to a wastewater treatment plant that impacted the health of Berowra Creek in Sydney. The study generated willingness to pay estimates for improved waterway health per km of waterway (Thomas *et al*., 2002). Thomas *et al*. (2002) reported a willingness to pay estimate derived from the study as approximately $1.00/km/yr/household, which is broadly equivalent to a present value of $18.75/household/km as an upfront lump-sum payment using a real discount rate of 5% over a period of 50 years. This willingness to pay estimate is relevant to residents in the whole of the Sydney region and relates to non-use and use values.

Farber and Griner (2000) studied people's willingness to pay for waterway health improvements involving two streams within a degraded catchment in western Pennsylvania. Three levels of waterway health were characterised based on habitat quality (i.e. unpolluted, moderately polluted and severely polluted). The study found that persons living within 80 kilometres of the streams placed some positive value on improvements to local waterway health. The study produced the following willingness to pay estimates per household per year (over 5 years) in 2000 US dollars:

- Stream improvement from 'moderately polluted' to 'unpolluted' status: $26.63 to $51.35.
- Stream improvement from 'severely polluted' to 'moderately polluted' status: $35.90 to $67.64.
- Stream improvement from 'severely polluted' to 'unpolluted' status: $75.63 to $112.44.

These willingness to pay estimates can also be assumed to relate to non-use and use values.

3.4.5 Value of healthy estuaries (use and non-use values)

Le Goffe (1995) reported that residents of Brest Harbour in Brittany, France were prepared to pay 173FF p.a. to ensure a "good ecosystem" was protected from pollution. This value equates to approximately $30 per person, p.a., in 1998 Australian dollars (estimated from currency conversions reported in KPMG, 1998). This estimate can be assumed to relate to use and non-use values.

Visitors to, and residents that lived near, the Peel-Harvey Estuary in Western Australia were surveyed in 1984 to find their willingness to pay for improved water quality (and therefore enhanced use and non-use values). This survey followed a period where the estuary suffered from severe algal blooms. The survey indicated that visitors were prepared to pay $2.59 p.a. (in 1998 dollars) and residents were prepared to pay $49.54 p.a. (in 1998 dollars). These figures are thought to be underestimates (NSW EPA Envalue database, 2004).

A Norwegian study by Heiberg and Hem (1987) of local residents' willingness to pay for improved water quality of the Kristiansand Fjord derived a figure of approximately $73 (in 1998 Australian dollars) per household, p.a.. The equivalent figure expressed as a single, once off payment per taxpayer was approximately $165 (in 1998 Australian dollars). These estimates can be assumed to relate to non-use and use values.

A similar study by Heiberg and Hem (1988) for the Inner Oslo Fjord in Norway found that residents were willing to pay approximately $173 (in 1998 Australian dollars) per household, p.a. for improved water quality in the fjord (and therefore enhanced use and non-use values).

Paterson and Cole (1999) undertook an estimate of the total economic value of the direct and indirect use values associated with estuarine areas of New Zealand for the year 1994. Their estimate (for the one year) in 1999 New Zealand dollars was $39,980 per hectare (Harwell and Welsh, 2003).

3.4.6 Value of healthy catchments in or near urban areas (use and non-use values)

Johnston *et al*. (1999) examined the willingness to pay (via increased fees and charges) for improved catchment health in the Wood-Pawcatuck Catchment in Rhode Island. They found that people's willingness to pay increased if it could be *guaranteed* that money collected will be spent on the specified project. They also found that residents were willing to pay, on average, approximately $49.89 per household, per year (in 2002 Australian dollars) for improved surface water quality throughout the catchment (to an "average" standard). This estimate can be assumed to relate to non-use and use values.

A valuation study was undertaken for the urbanised portions of the Swan-Canning Catchment in Perth, Western Australia in 1998 (UWA, 1998). The study concluded that the average amount of *additional* tax that people were prepared to pay for improved management of the Swan-Canning system was $33 per household, p.a. (in 1998 dollars). This represents a willingness to pay to protect existing non-use and use values. Assuming an *additional* $30 per household was collected, it represents a city-wide value of $15M p.a.. It is noted that Briggs (1995) estimated that $12 to $26M p.a. was *already* collected by the State government in fees and charges associated with the use of the waterways in the Swan-Canning catchment in the mid 1990s.

3.4.7 Value of healthy wetlands (use and non-use values)

Healthy wetlands can provide a range of services that can make them very valuable natural assets (Boyer and Polasky, 2002). These services include providing flood mitigation benefits in urban areas, improving water quality, recharging groundwater, providing habitat for endangered species, providing opportunities for bird watching or other forms of passive recreation in urban centres and providing nursery grounds for commercial or recreational fisheries (i.e. use and non-use values). Some of these values are also provided by wetlands that are *constructed* for stormwater treatment.

Information on the economic value of wetlands in Australia has been reviewed by Read Sturgess and Associates (1998a). They reported that:

- Stone (1992) found the Barmah Forest Wetlands in Victoria were valued at approximately $3,000/ha. These are Ramsar listed wetlands[11]. This work considered direct use (e.g. recreation) and non-use values (e.g. the community's perception of its conservation value).
- Sappideen (1992) found the Sale Wetlands in Victoria to be valued at approximately $3,600/ha for recreational use only (i.e. only use values).
- McGregor *et al*. (1994) adopted a conservative figure of $1,000/ha for the approximate total value of wetlands with non-Ramsar characteristics.

Based on this information, Read Sturgess and Associates (1998a) recommended the following estimates as a guide to the value of wetlands in Australia (in 1998 Australian dollars):

- Wetlands of international and national significance = $3,000/ha.
- Wetlands of State significance = $2,000/ha.
- Wetlands of local significance = $1,000/ha.

Note that Read Sturgess and Associates (1998a) estimates above consider direct use values (e.g. recreation) and non-use values (e.g. a wetland's existence value), but do *not* include indirect use values (e.g. flood mitigation and pollution mitigation values). Jensen (1993) estimated that the indirect use value of studied wetlands for *flood control* were an order of magnitude greater than the non-use values[12]. The above estimates are therefore considered to be very conservative (Read Sturgess and Associates, 1998a).

Whitten and Bennett (2001) investigated the value of floodplain wetlands systems along the Murrumbidgee River between Wagga Wagga and Hay. Their study found that respondents in the Murrumbidgee region of New South Wales, Australian Capital Territory and Adelaide were, on average, willing to pay (per household as a once off payment), approximately:

- $11.39 for an extra 1,000 hectares of healthy wetlands;
- $0.55 for a 1% increase in the population of native wetlands and woodland birds; and
- $0.34 for a 1% increase in the population of native fish.

A meta-analysis of 39 wetland valuation studies by Woodward and Wui (2001) reported that the mean value of services provided by natural wetlands varied from $3/acre (in 1990 US dollars) for their amenity value to $1,212/acre for bird watching. These services included use and non-use values.

Heimlich *et al*. (1998) reviewed 33 wetland valuation studies in a US study looking at the benefits wetlands can provide, especially in relation to agriculture. They estimated the total wetland value to range between $0.06 to $22,050/acre (in 1998 US dollars). It is assumed that these estimates relate to use and non-use values.

Paterson and Cole (1999) undertook an estimate of the total economic value of the direct and indirect use values associated with all wetlands of New Zealand for the year 1994. The estimated annual value in 1999 New Zealand dollars was $34,163 (Harwell and Welsh, 2003).

Lant and Roberts (1990) used contingent valuation to estimate the value that wetlands provide in water quality improvement in the Illinois / Iowa border region to protect use and non-use values. The estimate was $37.61 to $47.16/acre/year (in 1987 US dollars).

Stevens *et al*. (1995) also used contingent valuation to estimate the value that wetlands provide in minimising

[11] Ramsar listed wetlands are sites of international significance. They have been designated by parties to the 'Ramsar Convention on Wetlands' for inclusion in the 'List of Wetlands of International Importance' because they meet one or more of the Ramsar Criteria. 'Ramsar' refers to a city in Iran, where the Convention on Wetlands was signed on 2 February 1971.

[12] For indirect use values such as the flood mitigation values of wetlands, this large value can be explained by the high costs associated with alternative flood mitigation measures (e.g. dams and drainage works).

flooding, protecting water supply and improving water quality (to protect use and non-use values) in the New England region of the US. The estimate was $77.15/acre/year (in 1993 US dollars).

3.5 Constructed asset values / costs

Costs typically included under this category of values are summarised in Table C.1. So-called ‘conventional costs’ (e.g. the cost of the stormwater asset and the land it occupies) are normally tracked as part of standard project cost accounting and are the dominant costs in this category of values / costs. Project managers should be able to estimate the likely magnitude of these costs for proposed stormwater improvement projects, based on previous experience, unit rates, quotations, information from the literature, land valuations and predictive life-cycle costing models.

For estimating the life-cycle cost and/or cost elements of common structural stormwater measures to improve urban waterway health, reference should be made to:

- The life-cycle costing module in the CRC for Catchment Hydrology’s MUSIC model (version 3 or later). This module allows users to predict the *likely* cost of proposed measures based on historical Australian costing data and is available at www.toolkit.net.au.
- The technical paper titled *‘Structural Stormwater Quality BMP Cost – Size Relationship Information From the Literature’* (Taylor, 2005) which provides basic costing information for a variety of stormwater measures (e.g. approximate relationships between a measure’s size and its cost). This paper is also available at www.toolkit.net.au and is supported by an introductory paper on life-cycle costing in a stormwater context (Taylor, 2003).

For urban stormwater projects involving non-structural measures that aim to improve waterway health, costing information from the literature is available in the publication titled *‘Non-structural Stormwater Quality Best Management Practices – A Literature Review of Their Value and Life Cycle Costs’* (Taylor and Wong, 2002a).

APPENDIX D

Objectives and Principles of Australia's National Strategy for Ecologically Sustainable Development

(Source: Department of Environment and Heritage, 1992)

1. Definition of Ecologically Sustainable Development (ESD)

In 1990 the Commonwealth Government suggested the following definition for ESD in Australia: "using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased".

Put more simply, ESD is development which aims to meet the needs of Australians today, while conserving our ecosystems for the benefit of future generations.

2. Australia's Goal, Core Objectives and Guiding Principles for ESD

The Goal is:

Development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.

The Core Objectives are:

- To enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations.
- To provide for equity within and between generations.
- To protect biological diversity and maintain essential ecological processes and life-support systems.

The Guiding Principles are:

- Decision making processes should effectively integrate both long and short-term economic, environmental, social and equity considerations.
- Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
- The global dimension of environmental impacts of actions and policies should be recognised and considered.
- The need to develop a strong, growing and diversified economy which can enhance the capacity for environmental protection should be recognised.
- The need to maintain and enhance international competitiveness in an environmentally sound manner should be recognised.
- Cost effective and flexible policy instruments should be adopted, such as improved valuation, pricing and incentive mechanisms.
- Decisions and actions should provide for broad community involvement on issues which affect them.

These guiding principles and core objectives need to be considered as a package. No objective or principle should predominate over the others[1]. A balanced approach is required that takes into account all these objectives and principles to pursue the goal of ESD.

[1] In the context of these guidelines this is interpreted as the three dimensions of the triple-bottom-line should be given equal weight, if the assessment process is seeking to determine the relative sustainability of a set of options (i.e. it uses criteria that are consistent with the above ESD objectives and principles).

APPENDIX E

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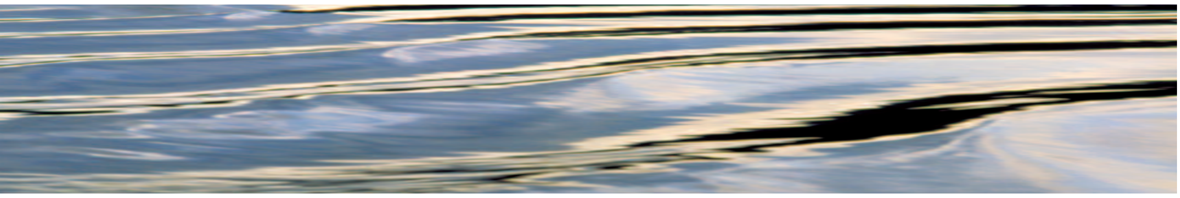

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