Stormwater management cost benefit framework

A report prepared for the South Australian Department for Environment and Water and Stormwater Management Authority | 4 September 2023

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Executive Summary

As South Australia's population grows, significant investment in stormwater infrastructure will be needed to meet the scale and pace of urban development and address these issues. Stormwater quality and quantity management infrastructure (including its land requirement) represents a major upfront cost for developers (and some local governments) and ongoing cost for local governments.

Stormwater and drainage management has traditionally been considered as a service provided by local governments to prevent damage to infrastructure and the community through flood mitigation with much stormwater infrastructure in urban areas is designed to rapidly channel water away from populated areas.

As reflected in South Australia's Water Sensitive Urban Design policy[1] and the Urban Water Directions Statement[2], there has been increasing recognition of evolving community expectations related to stormwater management to encompass broader issues of water security and climate resilience, community liveability related to open spaces, and the ecological health of our waterways and catchments. This has involved increasing acknowledgement that effective urban stormwater management is central to maximising the value of South Australia's waterways as a critical resource – essential for the sustainable supply of water for a range of users and of immense environmental, amenity, social and cultural value to South Australian's, including as an inalienable element of country.

Ensuring these objectives are achieved efficiently and effectively may involve an evolution in the boundaries of the sector and the interactions between different actors. This could include alternative models of urban design, stormwater governance, infrastructure solutions and funding of stormwater management as part of an integrated water cycle management approach (IWCM).

This presents both challenges and opportunities. Evidence from other jurisdictions suggests that several issues such as key accountability gaps for waterway and riparian health performance, chronic underinvestment in stormwater asset maintenance, and the lack of a coordinated, catchment-wide planning and investment approach adds to the cost and complexity of managing flooding, water security, amenity and waterway outcomes.

Getting this 'right' to manage urban growth efficiently and effectively in South Australia's requires:

- Collaborative approaches to identifying stormwater management and catchment objectives and expectations, involving a range of key stakeholders involved in urban planning and management of the water cycle.
- Sound governance arrangements that provide clarity and accountability related to the roles and responsibilities for planning (including the trade-offs between costs and benefits that can be challenging to measure) as well as delivery and monitoring of performance.

[1] Government of South Australia, Department for Environment, Water and Natural Resources, *Water sensitive urban design, Creating more liveable and water sensitive cities in South Australia*, https://cdn.environment.sa.gov.au/environment/docs/water-sensitive-urban-design-policy-gen.pdf

[2] Government of South Australia, Department for Environment and Water, *Urban Water Directions Statement*, https://cdn.environment.sa.gov.au/environment/docs/853934-DEW-Urban-Water-Directions-Statement-FIN3.pdf

- sound evidence and an adaptive analytical framework to identify the relative value of different interventions or approaches to stormwater management, the impactors and beneficiaries of these interventions, and potential sources of funding.
- sustainable funding arrangements that promote efficient decision-making related to the timing and location of development and the required stormwater infrastructure to support this development.

The Department for Environment and Water (DEW) and Stormwater Management Authority (SMA) have an important role to play in this transition. There is an opportunity for both DEW and the SMA to lead a concerted approach to the development of an analytical framework to ensure decision-making is holistic, evidence-based and aligned with the South Australian Government strategic objectives.

To support this, Frontier Economics and Alluvium were engaged by DEW and the SMA to assist in the development of a cost-benefit framework to support stormwater management decisions.

CBA is a standard and well-accepted tool for systematically assessing the economic, social and environmental costs and benefits that accrue *to the community* of options to address a business need or opportunity. It differs from traditional financial analysis which provides a narrow cash-flow focus to investment decision-making. CBA can also assist in identifying the distribution of this economic, social and environmental value *across the community,* which can assist in identifying beneficiaries to inform funding discussions.

CBA can be readily applied to stormwater management and broader IWCM decision-making. It doesn't necessarily need to be complex, detailed and resource intensive to undertake. This framework can be applied in a 'fit for purpose' way given the specifics of the business need, the potential options and their impact on the community. Even a simple CBA can be informative and cost-effectively support decision-making by requiring proponents to be clear about the objective, the potential options for achieving the objective and the transparent and objective evaluation process followed for comparing these options.

We hope this framework can enhance the consistency and quality of CBAs undertaken to support stormwater decision-making including funding arrangements. We have worked closely with key South Australia Government agencies including the SMAs and Department of Treasury and Finance to refine the scope of this guidance material and the right balance between the economic concepts, practical guidance and South Australian specific context.

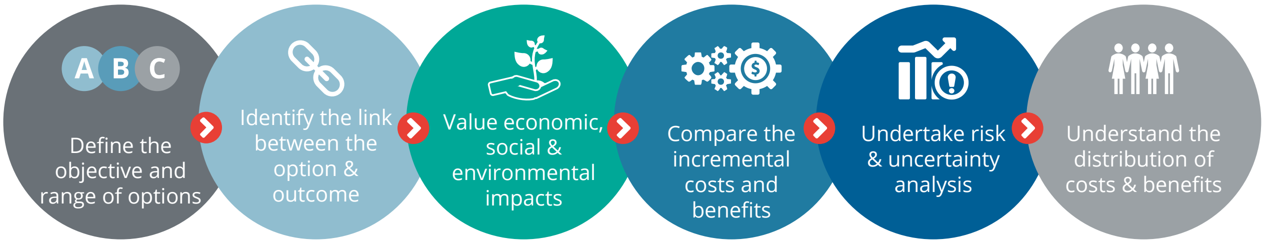
Over time there are other supporting actions that can be taken to enhance industry capacity to undertake CBA to support stormwater decision-making—including information collection and development of consistent assumptions and/or valuation methodologies. Actions to address industry capacity, governance and funding in concert will enhance the opportunities to manage urban growth efficiently and effectively and maximise the value of South Australia's waterways and riparian corridors.

Purpose

Frontier Economics and Alluvium were engaged by DEW and the SMA to assist in the development of guidance material to support the development of cost benefit analysis of stormwater management decisions across South Australia, consistent with best practice and relevant Australian Government and jurisdictional CBA guidelines. This material includes:

- a framework outlining the process for applying the six steps of CBA to identify the relative value of different approaches to stormwater management (see **Figure 1)** (this CBA framework document).
- worked examples (case studies), supported by an excel-based CBA model of the case studies.[3]

Figure 1: Six broad steps to CBA



Source: Frontier Economics

This framework introduces the steps involved in undertaking CBA of different approaches to stormwater management. Within each of these CBA steps the document covers the:

- key concepts and issues in applying CBA drawing on the standard principles and processes articulated in Australian Government and other jurisdictional CBA guidelines
- practical 'do and don't' tips as well as examples of valuation methodologies
- relevant case studies and worked examples
- check-list of steps and processes for user to consider prior to completion.

Audience

This framework seeks to support practitioners undertaking CBA to identify the relative value of different approaches to stormwater management. The framework can be applied to a range of decisions from urban design and/or development typology to stormwater governance to stormwater infrastructure solutions.

The framework is designed to accommodate a range of audiences including those looking for an accessible overview that may not regularly involved with CBA, through to those looking for guidance on specific expectations for CBA in developing, or reviewing, a CBA.

For this reason, the guidelines provide both a high level and detailed articulation of CBA to ensure the guidance is useful for the range of audiences. For example, if you are a:

- project director looking for a high-level understanding of CBA, see **Section 2**
- project manager looking to understand the key components of a CBA and the level of resourcing required including expert assistance, see **Section 2.2** and the checklist below (**Table 1**)

[3] Frontier Economics (2023), *2023-07-17 Framework for evaluating the costs & benefits of stormwater management-Case study model.*

- practitioner looking for a step-by-step guidance or 'instructions' how to undertake CBA (say local governments) or review CBA (say SMA), see the remainder of this document and the Excel-based CBA model workings for each case study.[4]

Summary of requirements

CBA can be used in variety of contexts to inform the evaluation of strategies and/or specific projects as well as government decision-making related to funding and prioritisation processes.

Table 1 provides a checklist to apply when undertaking CBA. The extent of analysis undertaken for each CBA to answer these questions should be matched to the size, complexity, level of risk and estimated cost on a case-by-case basis.

[4] Ibid.

Table 1: Economic analysis and distributional analysis checklist

Does the analysis:	Checklist
Clearly define the "problem" and objective of the project?	
Include a base and a range of options that achieve the objective?	
Consider the broad set of economic, social and environmental impacts across the community (including any impacts beyond the local community that may accrue to the broader South Australian community)?	
Forecast relevant economic, social and environmental costs and benefits (relative to the Base Case) across the community over an appropriate modelling or appraisal period?	
Evaluate the options from a consistent starting point and account for the project's full lifecycle over the modelling or appraisal period?[5]	
Use 7% discount rate as a central assumption?	
Account for impacts that cannot be quantified qualitatively?	
Include tools for assessing the impact of risk and uncertainty on the costs and benefits?	
Aggregate the incremental costs and benefits of the options into an overall measure of net benefits to the community (e.g. NPV and BCR)?	
Identify the high-level distribution of costs and benefits across the community including who bears costs and receives benefits?	
Appropriately document options considered, key assumptions (including sources or references), CBA results & limitations and potential next steps?	

Source: Frontier Economics

[5] If the modelling period is less than the asset life, there are techniques such as incorporating a residual value to account for the ongoing benefits that an asset provide beyond the still CBA modelling period. This could be because the asset is still producing benefits or because it can be resold.

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1 Introduction

Key points:

- Identifying the stormwater management approach(es) that deliver the best value for money to the South Australian community (i.e., maximise net benefits) in each situation requires a systematic approach to calculating and comparing the economic, social and environmental costs and benefits of the relevant options.
- Cost benefit analysis (CBA) is an important component of the decision-making process and aims to demonstrate that a proposed investment (or non-investment) option to address a business need or opportunity provides value for money from the South Australian community's perspective.
- CBA compares the economic, social and environmental costs and benefits of different options—converted to a single monetary (dollar) metric. It recognises the role that different approaches to stormwater management can have in meeting community expectations related to broader issues of water security and climate resilience, community liveability related to open spaces, and the ecological health of our waterways and catchments.
- The extent of analysis undertaken for a CBA should be matched to the size, complexity, level of risk and estimated cost on a case-by-case basis.
- The aim of this cost benefit framework is to provide an accessible and user-friendly set of 'instructions' for undertaking a CBA to demonstrate the relative value of different approaches to stormwater management.
- While the South Australian Treasury has broad investment evaluation guidelines[6] and Infrastructure SA provides high-level CBA guidance[7] , there is currently no detailed South Australian Government CBA material that provides 'step-by-step' guidance to practitioners seeking to use CBA to evaluate the value of investments. As a result, this CBA framework draws on the standard principles and processes for CBA articulated in Australian Government CBA and other jurisdictional CBA guidelines (such as NSW and Victorian Treasury CBA guidelines) and applies them to stormwater management in the SA context.

1.1 Background

Stormwater runoff is the result of either rainwater directly running off impervious surfaces (e.g. roofs and roads), or in large rain events from imperious *and* pervious surfaces such as parks and

[6] SA Department of Treasury and Finance, Guidelines for the evaluation of public sector initiatives, Part B: Investment Evaluation Process, July 2014. See website here: https://www.treasury.sa.gov.au/__data/assets/pdf_file/0007/515293/ti17-guidelines-part-b.pdf

[7] Infrastructure SA, *Impact Analysis Guide: Cost-Benefit Analysis*, April 2022. See website here: https://www.infrastructure.sa.gov.au/our-work/project-assurance/business-case-templates/Impact-Analysis-Guide.pdf

gardens. Stormwater runoff creates problems for people and the local environment that must be managed, including:

- **localised flooding.** Traditional stormwater management approaches (focused narrowly on drainage) have sought to manage by building drainage channels to divert flows away from populated areas.
- **degradation of waterway health.** This encompasses declines in water quality, waterway bank erosion and geomorphology issues, and others. As stormwater flows along urban areas, it picks up and carries pollutants to local waterways which degrade water quality. Large volumes of stormwater runoff can also cause erosion to waterways that can impact the ability of the waterway to serve as habitat.

As areas develop, stormwater runoff can threaten ecological, social, cultural and economic values and uses of waterways and surrounding developments (see for example **Box 1**). This in turn can impose significant economic, social and environmental costs on the community and our environments, including South Australia's waterways, wetlands and bays.

Box 1: South Australian context

The 2017 30-Year Plan for Greater Adelaide published by Plan SA has a target for 85 per cent of all new housing to be built within the existing urban footprint. Infill development helps to create walkable neighbourhoods, protect valuable farming and environmental land, and meet consumer demand for living close to jobs, shops, and services.

Currently, about 80% of Greater Adelaide's new housing growth is in these established suburbs with minor infill development contributing 40% of the increase in overall housing supply each year (AGD, 2020; DPTI, 2019). However, the bulk of minor infill development has generally not been adhering to WSUD objectives, resulting in up to 90% of minor infill developments constituting hard, impervious surfaces (Jensen 2011).

Infill development increases density which in-turn impacts stormwater runoff from urban areas by increasing peak flows, increasing the volume of runoff and increasing the exported load of pollutants to waterways. This in-turn may result in more frequent and more severe flooding, increased erosion and pollution and adverse impacts on economic, social and environmental values.

Source: Frontier Economics; BDO EconSearch, Options Analysis: Costs and Benefits of Stormwater Management Options for Minor Infill Development in the Planning and Design Code, September 2020

1.1.1 The role of stormwater management

Stormwater is a valuable resource that can enhance the liveability, sustainability and resilience of communities. However, it needs to be planned and managed effectively to minimise potential for flooding, facilitate reuse, maintain natural drainage patterns, and protect ecological health, including the quality of our waterways – all while balancing the upfront and ongoing costs to the community of doing so. This requires:

- Collaborative approaches to identifying stormwater management and catchment objectives and expectations involving a range of key stakeholders involved in urban planning and management of the water cycle.
- Sound governance arrangements that provide clarity and accountability related to the roles and responsibilities for planning, delivery and monitoring of performance.
- Sound evidence and an adaptive analytical framework to identify the relative value of different interventions or approaches to stormwater management, the impactors and beneficiaries of these interventions, and potential sources of funding.
- Sustainable funding arrangements that promote efficient decision-making related to the timing and location of development and the required stormwater infrastructure to support this development.

Stormwater management often involves the use of structural (e.g. physical infrastructure, drainage channels, and treatment techniques) and non-structural (e.g. education programs, monitoring, and flood preparedness) measures to both improve water quality, mitigate excessive flows, minimise damage from flooding, or achieve other goals such as water reuse through stormwater harvesting. This includes the use of:

- Rainwater harvesting which involves collecting, storing and reusing rainwater captured from roofs. This water can then be used as an alternative supply for non-potable demands.
- Stormwater harvesting, which involves collecting, treating and storing stormwater from urban catchments, etc. (rather than rainwater from roofs), which can be used as an alternative supply for non-potable demands.

Importantly, traditional stormwater management does not typically extend further ‘upstream’ in terms of management of land-use or the urban form (such as reducing ‘hard’ surfaces and increasing ‘soft’ surface areas across a catchment) which significantly impacts the amount of stormwater to be managed—as this goes to the heart of a range of policy and planning functions (where will people live and how many) as well as commercial factors and community expectations (what type of dwelling and community do people value).

Rather, historically the aim of stormwater management was to prevent damage to infrastructure and the community through flood mitigation and, as a result, the majority of the stormwater infrastructure in cities is designed to rapidly channel water away from urban areas.

However, in recent years there has been a gradual shift in community objectives and expectations related to climate resilience, community liveability related to open spaces, and the ecological health of our catchments. This in turn has prompted greater consideration of how different approaches to stormwater management, as part of an integrated water cycle management approach (IWCM) could be used to achieve these community objectives while also providing the value for money to the community (see **Box 2**).

Box 2: Why is it important for approaches to stormwater management offer 'value for money'?

It is important to focus on the net benefits or overall value that different approaches to stormwater management provide for the community. This is because while different approaches to stormwater management (for example, nature-based solutions rather than traditional drainage approaches) can offer significant benefits, they can be costly both from a financial perspective as well as a broader community perspective.

For example, in some circumstances specific forms of stormwater management can lower the cost of managing waterway health (say by improving catchment wide coordination) and improve the quality-of-service outcomes relative to other solutions. It may also offer a range of other often 'non-market' social or environmental benefits. In these cases, the approach to stormwater management may be considered value for money as it is net beneficial (i.e., positive NPV).

However, this is not necessarily the case: in some circumstances, specific forms of stormwater management (say in brownfield areas) may not be possible or relative to other approaches involve higher upfront costs (including infrastructure and/or land requirements) and/or ongoing costs to achieve the outcomes sought by the community relative to other solutions. In these cases, the approach to stormwater management is not considered to provide value for money as it imposes net costs on the community (i.e., negative NPV).

Source: Frontier Economics

This shift to ICWM has included increasing consideration of alternative forms of stormwater management related to:

- **stormwater governance** to improve coordination and maximise opportunities for efficiencies in planning and delivery of infrastructure
- **urban design or development typology** to influence the level of stormwater run-off from development (e.g., to enhance opportunities for permeable surfaces and urban canopy) and the natural capacity of the urban form to mitigate runoff and flooding related risk
- **stormwater infrastructure** solutions to move beyond traditional localised 'grey' solutions to include use of 'blue-green' infrastructure (such as green roofs, distributed gardens etc) and catchment-wide solutions that extend beyond local government boundaries

While these inter-related issues are often considered by different agencies, identifying the stormwater management approach(es) that delivers the best value for money to the community in each situation requires a systematic approach to calculating and comparing the economic, social and environmental costs and benefits of the relevant options.

Figure 2: **Key inter-related set of urban stormwater-related decisions**

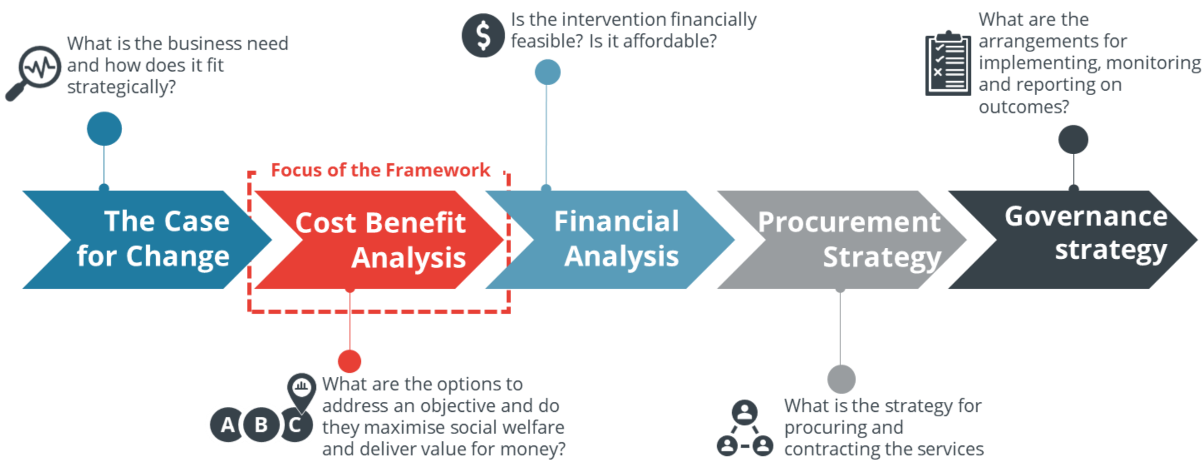
Source: Frontier Economics

1.1.2 The need for cost benefit analysis of stormwater management interventions

Cost Benefit Analysis (CBA) is a standard and well-accepted tool for systematically assessing the costs and benefits of a range of options available to address a business need or opportunity (identified in the 'case for change'). A CBA identifies in monetary terms the option that maximises value from the perspective of the community—the relevant community in this CBA framework being the entire South Australian (SA) community.

As shown in **Figure 3**, CBA is a key component of the business case process. But even in instances where a business case is not required, CBA can provide valuable insight into the value delivered by a proposed option to address a business need or opportunity.

Figure 3: **Business case process**



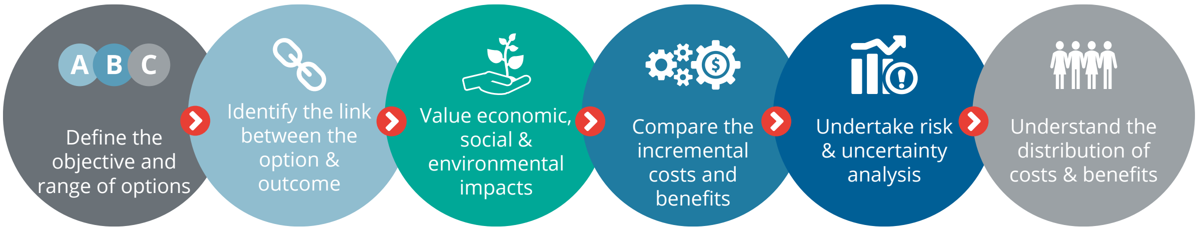
Source: Frontier Economics

1.2 Purpose of this CBA framework

Frontier Economics and Alluvium were engaged by the Department for Environment and Water (DEW) and the Stormwater Management Authority (SMA) to develop a framework for evaluating the costs and benefits of stormwater management (the CBA framework). This CBA framework includes:

- guidance on the process for applying the six steps of CBA to stormwater management initiatives in South Australia (see **Figure 4**)
- illustrative examples or case studies, supported by an excel-based CBA model with the workings for each case study[8]

Figure 4: **Six broad steps to CBA**



Source: Frontier Economics

The CBA framework is designed for those who are new to or not regularly involved with CBA and aims to provide a practical and accessible set of 'instructions' to undertaking a CBA to support users' involved in CBA processes.

The CBA framework is designed to be applicable to the broad-range of stormwater-related decisions shown in **Figure 2**, including decisions around:

- the level of service or standard of stormwater and flood management to be provided (*what outcomes are to be achieved?)*
- the stormwater governance arrangement (*who is responsible for doing what?)*
- the urban design and stormwater infrastructure solution (*how should it be achieved?*).

The Department of Treasury and Finance is available to provide further assistance and advice on request to agencies regarding CBA before a submission is lodged for Cabinet.[9]

1.2.1 Approach to developing this CBA framework

The CBA framework introduces the steps involved in undertaking a CBA of stormwater management. Within each of these CBA steps the framework covers the:

- key concepts and issues in applying CBA to stormwater decisions
- practical 'do and don't' tips as well as examples of valuation methodologies
- relevant case studies and worked examples (see **Box 1**)
- check-list of steps and processes for user to consider prior to completion (Appendix A)

8 Frontier Economics (2023), *2023-07-17 Framework for evaluating the costs & benefits of stormwater management-Case study model*

9 https://www.dpc.sa.gov.au/resources-and-publications/Better-Regulation-Handbook.pdf, p. 31.

This CBA framework does not provide a catalogue or repository of all key assumptions that could be used in CBA. Using this CBA framework may require users to source site or project specific information related to the stormwater interventions being evaluated.

Box 1: Case studies in this CBA framework

To enhance the accessibility of this CBA framework, ***three*** indicative examples or case studies have been developed covering a broad range of potential approaches to stormwater management in different contexts across South Australia:

1. **Case Study A** – *Additional investment in stormwater treatment in a brownfield metropolitan area* (see Appendix E). This case study is designed to highlight the benefits of investing in vegetated stormwater treatment (i.e. raingardens) to improve stormwater quality in existing urban areas. The Base Case is essentially a '*do minimum*' option, where investment is provided for like-for-like replacement of grey infrastructure to maintain current level of service for flood protection and no investment is provided for stormwater quality improvement. Options 1 and 2 both explore the benefits of additional investment in WSUD, albeit at different rates. This allows for a comparison of the costs and benefits of 'slow' (Option 1) and 'fast' (Option 2) investment in stormwater quality improvements;
2. **Case Study B** – *Alternative governance arrangements in a greenfield development* (see Appendix F). This case study is designed to value the trade-off between the costs of catchment wide governance solutions (including a regional entity providing stormwater reuse through centralised non-potable third-pipe reticulation network) and the benefits of avoided upstream potable water supply costs, the consolidation of assets to reduce the total infrastructure footprint and upfront and ongoing scheme costs;
3. **Case Study C** – *Alternative infrastructure renewal options in a regional coastal centre* (see Appendix G). This case study is designed to value the trade-off between the additional costs of more expensive renewal programs (e.g., WSUD solutions including naturalisation of a stormwater channel and irrigation of tree canopy) and the benefits of enhanced waterway health, amenity and recreation outcomes and reduced urban heat.

For each of these case studies:

- This CBA framework sets out the application of the CBA steps, including problem definition and CBA objective, options definition and valuation of costs and benefits, presentation of results and supporting risk and uncertainty analysis, as well as distributional analysis; and
- A supporting excel-based CBA model is available that sets out the workings.[10]

It is important to note these are indicative and for illustration purposes only. Users of this CBA framework will need to consider the appropriate analytical effort and documentation requirements for their specific projects depending on the specific scale, risk and community impact.

Source: Frontier Economics

[10] Frontier Economics (2023), *2023-07-17 Framework for evaluating the costs & benefits of stormwater management-Case study model*

1.3 What's involved in cost benefit analysis?

As discussed above, CBA is a standard and well-accepted tool for systematically assessing the costs and benefits that accrue to the community of a range of options in a given situation to address a business need or opportunity (identified in the 'case for change').

A CBA identifies in monetary terms the option that maximises value for money from the perspective of the community by identifying, valuing and comparing the incremental benefits and costs (i.e. compared to a Base Case) of a single or set of potential investment (or non-investment) options to address a business need or opportunity. CBA considers of a broad range of costs and benefits that affect the community, including:

- **Economic costs and benefits,** such as costs and cost-savings associated with the provision of stormwater and flood management services (for example, the capital and operating expenditure required to build a pipe network).
- **Social (or liveability-related) costs and benefits,** such as improved amenity and liveability outcomes through the provision of stormwater management services (for example, the recreational benefits of providing cycling opportunities along a stormwater wetland).
- **Environmental and cultural costs and benefits**, such as improved waterway health, improved protection of cultural sites and / or improved air quality/ carbon emissions arising from improvements in stormwater management (for example, the value of increased number of species in waterways).

CBA has some key differences to the financial analysis in the business case (see **Box 3**).

Box 3: Cost benefit analysis (CBA) vs financial analysis

CBA is the principal tool of economic analysis, which provides a holistic community or societal approach to investment decision-making. It compares economic, social and environmental benefits and costs that ***accrue to the South Australian community***—converted to a single discounted metric using the social discount rate.

Financial Analysis provides a cash-flow focus to investment decision-making. It compares the revenues and financial costs that ***accrue to a single entity such as a council or a State Government agency***—converted to a single discounted metric using the entity's cost of capital discount rate. This is central to the 'Financial Analysis' of the business case.

	Focus of the Framework **Economic analysis**	**Financial analysis**
Overview	• Explores the value for money of options through identifying the option that maximises the net benefits from the perspective of the SA community.	• Explores the affordability of options interventions through identifying the financial impacts of the options on the agency (& potentially Government budget)
Detail	• **Cost-benefit analysis (**CBA): Compares in monetary terms the economic, social and environmental costs & benefits of options to meet the objectives. • **Risk and resilience analysis:** Focuses on variability of CBA results under various states of the world from simple scenario analysis to complex real options analysis. • **Distributional analysis** – An extension to CBA that sets out the distribution of costs & benefits across the community	• **Funding analysis** – Drawing on distributional analysis it identifies potential sources of funding considering both impactor and beneficiary pays frameworks. • **Financial appraisal-** evaluates whether based on the funding analysis, the proposed project is financially viable from the perspective of the investor.
Example	• Captures economic and social value created by reducing stormwater infrastructure 'footprint' which increases opportunities for other uses of land.	• Captures the financial transfers incl. cash 'outflows' from the cost of infrastructure, land acquisition & tax as well as cash 'inflows' from rates and charges.

Source: Frontier Economics

To compare the incremental economic, social and environmental costs and benefits that accrue to the South Australian community over time, CBA:

- as much as practical, converts each cost or benefit to a monetary (dollar) value, without any double-counting
- compares these values to the Base Case to identify the 'incremental value' to the community from 'moving away' from the Base Case (which can be a 'do nothing' or 'do minimum')
- discounts these values using a social discount rate to a single metric – presented in:
  - ***net present value*** (NPV) terms – present value of economic, social and environmental benefits *minus* present value of economic, social and environmental benefits costs over the period

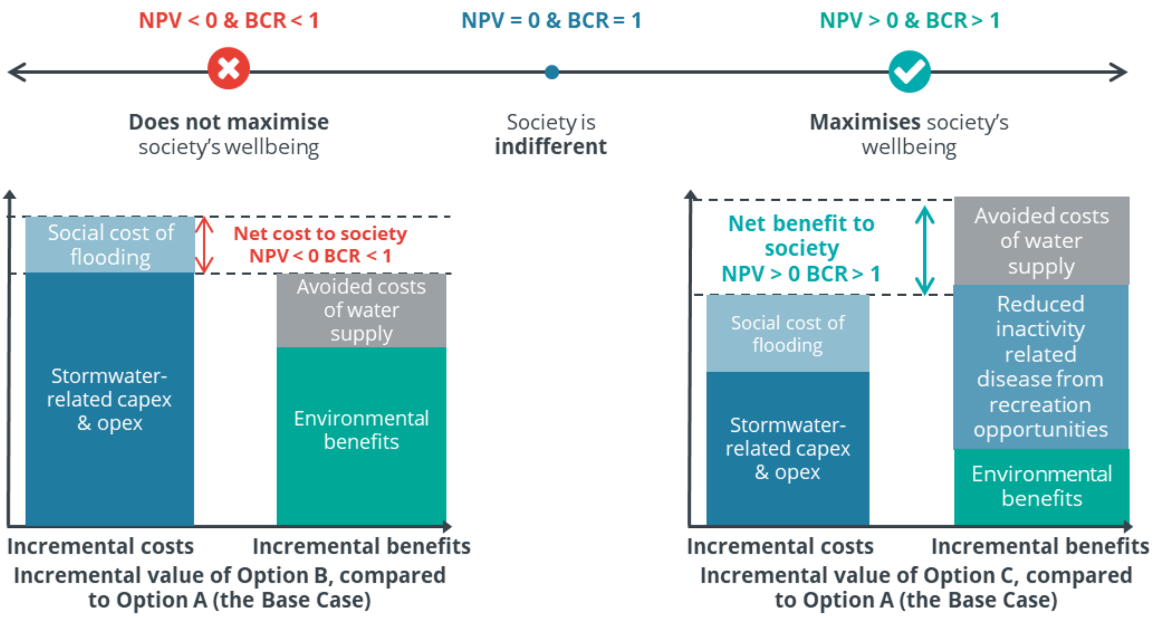
- *benefit-cost ratio* (BCR) terms –present value of economic, social and environmental benefits *divided* by present value of economic, social and environmental benefits costs over the period

- qualitatively includes impacts that cannot be quantified and monetised.[11] This qualitative assessment should include decision of the likely direction of impact and significance, without formal weightings.

As shown in **Figure 5**, the option with the largest NPV and BCR generates the largest incremental benefit to the community (compared to the Base Case). In particular:

- **NPV > 0 and BCR > 1 indicates that the option results in a net benefit** to the community relative to the Base Case (i.e. incremental benefits of the option exceed incremental costs).
- **NPV = 0 and BCR = 1 indicates that the incremental benefit of the option exactly equal its incremental costs.**
- **NPV < 0 and BCR < 1 indicates that the option results in a net cost** to the community relative to the Base Case (i.e. incremental costs of the option exceed incremental benefits).

Figure 5: CBA involves considering which options generate the highest community net benefits – an illustrative example



Source: Frontier Economics

1.3.1 When is cost benefit analysis required?

CBA is typically the preferred approach for the evaluation of all policy, regulatory decisions and/or investment decisions. This could include the broad-range of stormwater-related decisions shown in **Figure 2**. However, **the extent of analysis undertaken for a CBA should be matched**

11 CBA does not require all costs and benefits to be quantified and monetised.

to the size, complexity, level of risk and estimated cost on a case-by-case basis—that is, they should be 'fit for purpose' given the proposed option.

CBA doesn't necessarily need to be complex, detailed and expensive to undertake. Even a simple CBA can be informative and can cost-effectively support decision-making. This is because a CBA 'framework' is primarily a process for organising the available information in a logical and methodical way to support decision-making. It requires proponents to be clear about the objective (i.e. what are we seeking to identify), the potential options for achieving the objective and the transparent and objective evaluation process followed for comparing these options and identifying potential risks.

As discussed in more detail below, a simple CBA may be appropriate in cases where it may not be necessary or feasible to quantify and monetise all economic, social and environment outcomes of a proposed investment.

However, in some cases, the need or objective and the size and scope of the investment or (non-investment) options may warrant a more detailed CBA. If so, you may require further technical guidance and specific supporting expertise to assist in developing or reviewing key aspects of the CBA. Examples of projects that could be supported by a complex CBA include:

- changes in governance arrangements relating to stormwater and waterways, such as a movement from council-by-council approach to a regional approach
- assessment of alternative options (including managed aquifer recharge) to address water security

Importantly, as discussed in more detail below, there is likely to be a range of effort required dependent on the relative scale of the investments and community interest.

2 Getting started

Getting started – tips and tricks

- **DO** focus on being clear about the need, objective or driver for the decision, and broad spectrum of options to achieve this need.
- **DON'T** focus on whether final detailed cost information on the options or any non-monetary social and/or environmental values are available.

Source: Frontier Economics

2.1 What are the key steps involved in a CBA?

While in recent years there have been developments in analytical techniques used to monetise social and environmental outcomes and evolving expectations relating to consideration of risk and resilience in stormwater planning, the key concepts and steps involved in a CBA remain broadly unchanged and utilised throughout the water industry and beyond. These include setting out the objective or business need for the investments (or non-investments), the range of potential options for achieving this objective and the transparent and objective process for valuing and ultimately comparing these options.

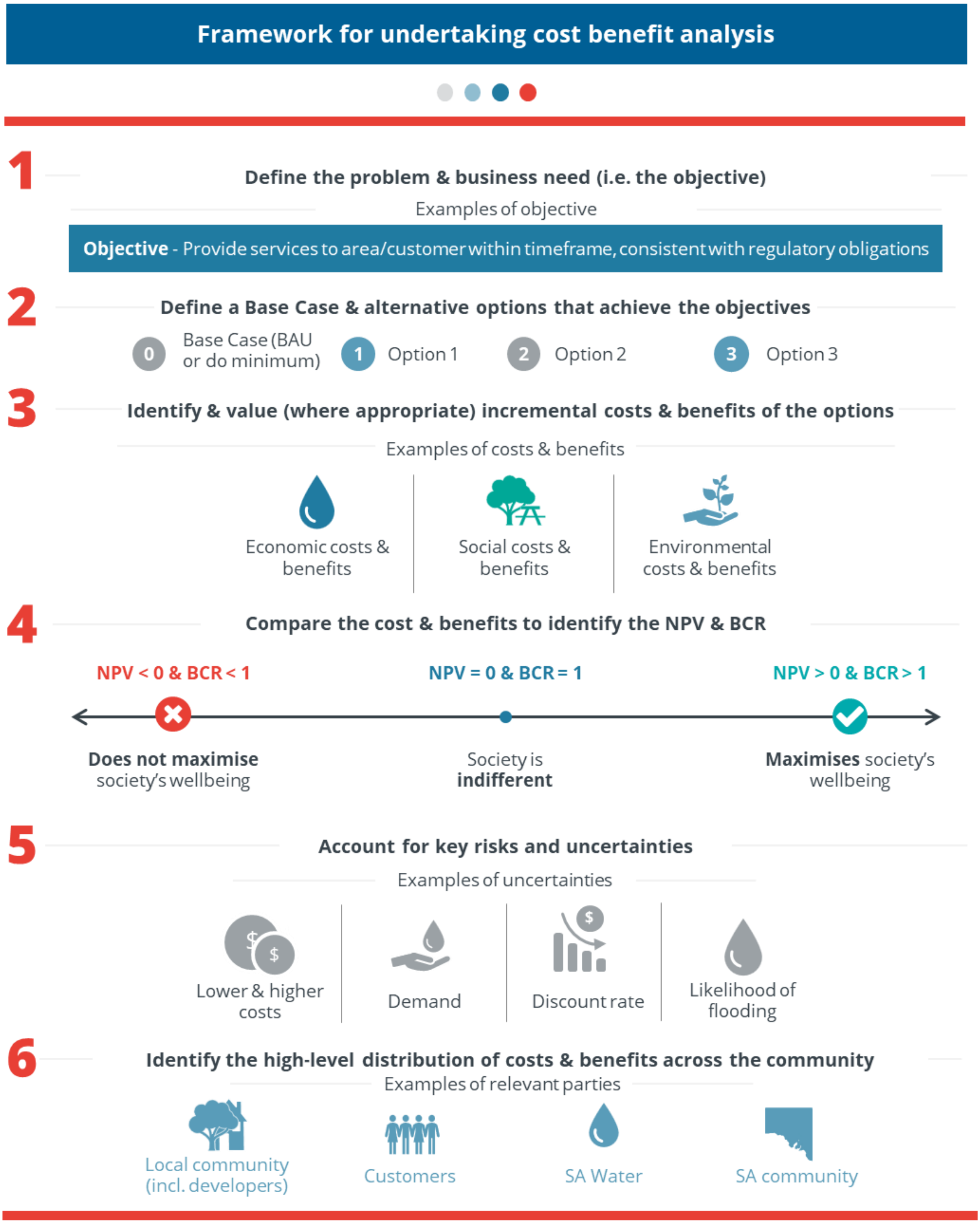
To do this there are **six** key steps or mandatory processes for users undertaking CBA of approaches to stormwater management. As shown in **Figure 6** undertaking a CBA involves the following steps:

- **Step #1:** Define the problem or business need (i.e. the objective)
- **Step #2:** Define a Base Case and at least two alternative options (in most cases the Base Case and options should achieve the objective)
- **Step #3:** Identify and value (where appropriate) the incremental economic, social, and environmental costs and benefits of the options (i.e. relative to the Base Case)
- **Step #4:** Compare the costs and benefits of the options (compared to the Base Case) to identify the NPV and BCR using a social discount rate of 7% for the central scenario
- **Step #5:** Account for key risks and uncertainties that could impact the economic, environmental and social costs and benefits of the options
- **Step #6:** Identifying the high-level distribution of costs and benefits across the community

This framework is consistent with best practice approaches to undertaking CBA and draws on a range of Australian Government and jurisdictional CBA guidelines. [12]

[12] See for example: Infrastructure Australia (2021), *Guide to economic appraisal, Technical guide of the Assessment Framework*;

Figure 6: Key steps in a CBA



Source: Frontier Economics

2.2 What level of resourcing and effort is required?

While CBA is the preferred approach for evaluation of all decisions, the valuation of costs and benefits requires resources, time and effort. The appropriate degree of analysis will vary from one project to another and should be matched to the size, complexity, level of risk and estimated cost on a case-by-case basis.

While proponents have flexibility in making assumptions that draw on the best evidence available, the 'rules' about which benefits and costs to include in a CBA and approaches to valuing them are, on the whole, straightforward and well established.

As discussed in more detail below, in many cases, the decision and choice of option will have limited differential impact on the community (i.e. many options may result in the same social or environmental outcomes) or may be of limited interest to our stakeholders. If so, a simple CBA (similar to a cost effectiveness analysis (CEA)) may be appropriate (see **Box 4**).

In other cases, the scale and significance of the project(s) to one or more parties may warrant a more detailed CBA. If so, you may require further technical guidance and specific supporting expertise to assist in developing or reviewing key aspects of the CBA.

Box 4: Cost benefit analysis vs cost effectiveness analysis

Cost effectiveness analysis (CEA) aims to identify the option that achieves the specified outcome(s) at least cost (**Figure 7**). In this example, it is clearly option A (Base Case), as options B to E all involve additional costs to the Base Case (i.e. positive incremental costs).

CEA involves undertaking many similar sets of steps, applying similar principles, and using some similar evidence as CBA, except that non-market costs and benefits are typically not quantified and valued as it is assumed the same outcomes are being achieved. Unlike CBA, CEA identifies the least cost option and cannot indicate whether the preferred option provides 'value for money' to the community. Rather **Figure 8** shows that in this example when accounting for other costs and benefits option C delivers value for money.

Figure 7: CEA identifies option A (Base Case) as least cost

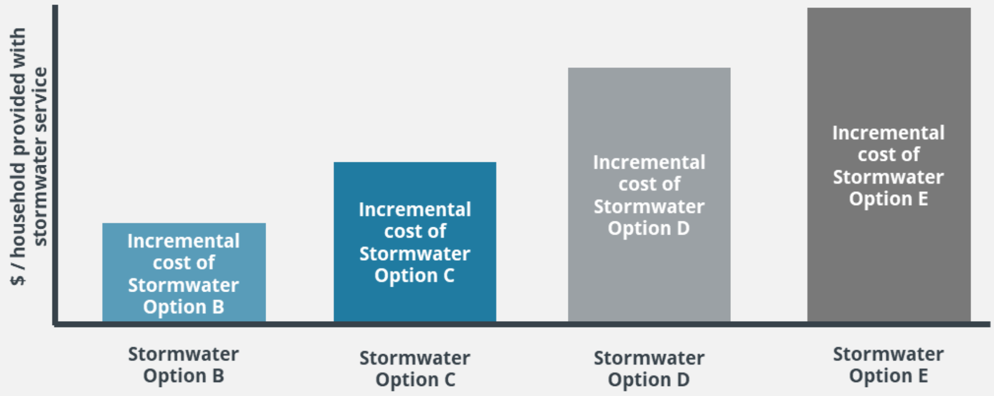
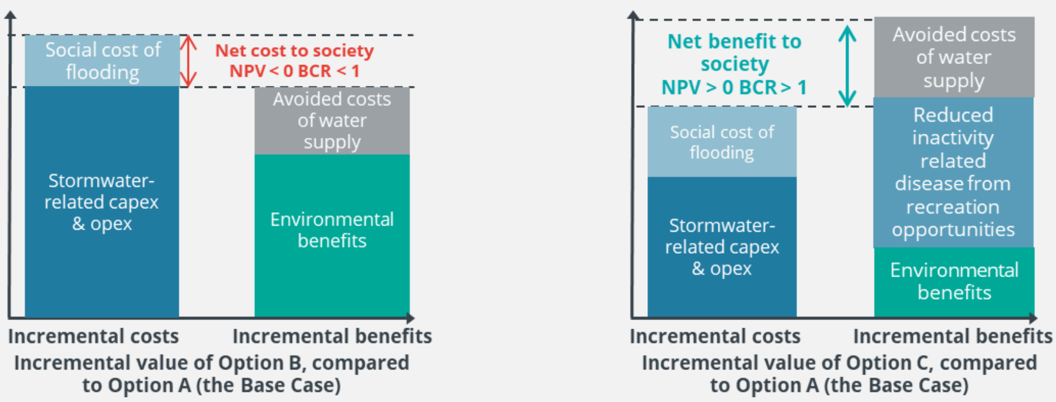


Figure 8: CBA identifies option C as achieving the specified objective in a way that maximises welfare or value for money for the community



Source: Frontier Economics

Table 2 and **Table 3** provide guidance whether the scale and significance of the project(s) warrants a more detailed analytical effort in different circumstances. **In short, answering 'yes' indicates that elements of a detailed CBA may be warranted**.

While there may not be always be a clear distinction in practice, common sense should guide the degree of analysis—that is, the extent to which a simple or detailed CBA is warranted—particularly when assessing benefits or costs that are difficult to quantify, and the level of risk and resilience analysis required.

Table 2: Getting started: Identifying the analytical effort required for a detailed CBA

Guiding principle	Implication	Example	Effort and resourcing required
Is the project associated with significant non-monetary impacts?	May be significant environmental or social impacts	Impact on waterway health from stormwater runoff	May require gathering and valuing site-specific outcomes
Would the project impose significant financial costs to the South Australian community?	May involve lifecycle expenditure over $10m	Retrofitting Water Sensitive Urban Design (WSUD) across urban areas	May require more complex risk and resilience analysis and distributional analysis
Is the project subject to significant risk and uncertainty?	Community value may differ significantly depending on future states of the world	Implementation of infrastructure solutions which have effects on uncertain outcomes such as climate change and flooding	May require more complex risk and resilience analysis, such as expected NPV or real options analysis
Is the project subject to cost-recovery risk and/or require co-funding?	May need to demonstrate value and distribution of benefits to sections of community (e.g. to identify beneficiaries for co-funding discussions)	Moving to a regional approach to stormwater governance	May require, more complex risk and resilience analysis and distributional analysis
Is the project of significant community interest?	May need to demonstrate value and distribution of benefits to sections of community	Revitalising an existing concrete channel	May require gathering and valuing site-specific outcomes and distributional analysis

Source: Frontier Economics

Table 3: Getting started: Practical differences in level of effort and resourcing required

Step	Simple CBA		Detailed CBA		Key differences
	Summary	Example	Summary	Example	
1. Defining the business need and objective (that all options must achieve)	Objectives are typically the set of outcomes to be achieved, although CBA can also be used to determine the value of different levels of service or performance (i.e. different outcomes).	Deliver stormwater management services to the community, consistent with the minimum flooding standards.	**As per simple CBA**	**As per simple CBA**	**n/a** (both involve identifying the objective that all options must achieve)
2. Defining options (including a Base Case and at least two alternative options)	Identifies the range of possible options to achieving the objective. A 'do nothing' Base Case nothing will only be appropriate in some (but not all) circumstances.	Business as usual approach to stormwater management (Base Case) compared to WSUD alternatives.	**As per simple CBA**	**As per simple CBA**	**n/a** (both involve identifying options (including a Base Case) that achieve the objective

Step	Simple CBA Summary	Simple CBA Example	Detailed CBA Summary	Detailed CBA Example	Key differences
3. Identifying and valuing benefit and costs	Likely to only include economic costs (expressed in financial dollar terms), and so won't require valuing non-monetary social and environmental impacts.	Lifecycle costs of new infrastructure in new developments, including land acquisition costs; or Operating costs and renewal costs of an existing stormwater channel in a single council LGA.	Likely to involve valuing broader economic, social and environmental outcomes (some of which are non-monetary), using site specific information.	Benefit to the community of improvements in ocean health from reduced stormwater runoff.	Detailed CBAs are more likely to involve the valuation of broader economic, social and environmental costs and benefits that accrue to broader community.
4. Comparing the value of the options	Calculates NPV and BCR to compare economic costs across the options.	Similar to least-cost analysis (also known as cost effectiveness analysis).[13]	Calculates NPV and BCR to compare economic, social and environmental costs and benefits across the options.	Detailed CBA that values the broader economic, social and environmental outcomes.	While both involve calculating the NPV and BCR, simple CBA is more likely to resemble a least-cost analysis / CEA.

13 Cost effectiveness analysis assumes all options deliver the same benefits and seeks to identify the least financial cost approach to deliver those benefits. As it does not assess the net impact on social welfare, CEA should only be used as a supplementary approach to CBA. For more detail see Infrastructure Australia (2021), *Guide to economic appraisal, Technical guide of the Assessment Framework*.

Step	Simple CBA		Detailed CBA		Key differences
	Summary	Example	Summary	Example	
5. Accounting for risks and resilience of options	Likely to involve simple sensitivity analysis of key assumptions (at least 9 combinations of sensitivities).	3 discount rates combined with 3 cost scenarios (low, central and high).	Likely to involve more detailed sensitivity, scenario analysis and/or real options analysis.	The use of real options analysis to identify the value of adaptive decision making in response to a flood event.	Simple CBA is likely to involve much simpler sensitivity analysis (e.g. varying a few key assumptions).
6. Identifying high-level distribution of costs and benefits	Likely to have few broader impacts (impacted parties are likely to be those in a single development). Likely to be qualitative.	Renewal of an existing stormwater channel in a single council LGA.	Likely to involve more detailed distributional analysis (broader range of impacted parties) to inform potential co-funding discussions. Likely to be quantitative.	Moving towards a regional governance approach to stormwater management rather than council-by-council approach.	Simple CBA is likely to have a smaller range of impacted parties and likely to be qualitative.

Source: Frontier Economics

2.3 What information do I need and where is it available?

Regardless of the resources, time and effort available, all CBAs will follow a basic 'framework' or process for organising the available information in a logical and methodical way to support decision-making.

There is a minimum amount of information required to get started on a CBA (see **Table 4**). However, CBA is an iterative process, so if more information becomes available this can be introduced into the CBA over time. It is common for the analysis to evolve as more information becomes available about the nature of the decision and the available options, the associated costs and benefits and the risks and uncertainties. **The trick is to find a 'way into the problem' without getting 'stuck' on whether all potential options have been identified, or final cost information and/or other detailed site specific assumptions are available**.

Importantly, **all assumptions adopted as part of the CBA should be appropriately documented and justified**.

Table 4: Getting started: CBA information requirements

Information required	How the information is used	Where I can find this information?	Example
Need and objective and driver of the decision	To ensure all options meet the same minimum standard (an "apples with apples" comparison)	**Step #1** (Section 3) **Related business case** (outside this CBA framework)	Providing stormwater and flood management services in a way that meets obligations and expectations (for example, water quantity and quality targets).
Base Case and at least two alternative options	To compare the broad range of options to achieve the objective	**Step #2** (Section 4)	BAU approach to renewing an existing stormwater asset, compared to WSUD-led approach and WSUD with stormwater harvesting.
Modelling period	For calculating the stream of costs and benefits	**Step #3** (Section 5)	30 years
Lifecycle costs	For stream of costs and benefits	**Step #3** (Section 5)	Land acquisition, capital costs, operating and maintenance costs (including any share of overheads), renewals.
Information on site specific outcomes	For measuring the change in economic, social and	**Step #3** (Section 5)	Volume of stormwater harvesting that offsets potable water, 'brown/green' energy

Information required	How the information is used	Where I can find this information?	Example
	environmental outcomes		demand, volume of stormwater discharged to local waterways.
Information on values from project site or a similar site	For valuing the change in economic, social and environmental outcomes	**Step #3** (Section 5)	Long run marginal cost (LRMC) of water supply, carbon price, willingness to pay for improved waterway health.
Information on valuation methodologies	For valuing the change in economic, social and environmental outcomes	**Step #3** (Section 5) **Appendices B, C and D**	Calculating the value of avoided potable water demand[14] by multiplying the LRMC of water by the volume of water saved.
CBA model	To calculate NPVs and BCRs to compare the value of options	**Step #4** (Section 6)	NA
Discount rate	To compare costs and benefits over time	**Step #4** (Section 6)	7%
Information on how outcomes change under alternative states of the world	For comparing the value of options under uncertainty	**Step #5** (Section 7)	Say 27 scenarios involving 3 discount rates combined with 3 population growth rates, combined with low, central and high lifecycle cost estimates.
Impacted parties (i.e. who benefits)	To understand the high-level distribution of costs and benefits across the community	**Step #6** (Section 8)	The local community (e.g. people living and working in local community), developers, nearby councils and the broader SA community.

Source: Frontier Economics

[14] Or supply from centralised water supply system

3 Step #1: Defining the problem, business need and CBA objective

The first step in a CBA is to clearly define the problem and the specific policy, regulatory or investment need or opportunity (i.e. why is this decision being sought) and the resulting project objective that responds to this need (i.e. what outcome are we seeking).

This instances where a business case is being developed, this step typically draws on previous work done in the 'strategic case for change' stage of the business case.

Step 1: Defining the problem, business need and CBA objective - Tips and tricks

- **DO** focus on the immediate drivers (i.e., service expectations and compliance obligations) and measurable (ideally customer focused) outcomes in setting the CBA objective.
- **DON'T** express the objective in terms of stormwater harvesting volumes to be delivered or insufficient rainwater tanks. Stormwater harvesting and rainwater tanks are a means to an end (e.g. to manage stormwater volumes or deliver water security) rather than an objective in and of itself.
- **DON'T** include overly broad drivers or ill-defined outcomes (i.e. promotion of circular economy or net zero greenhouse objectives) that could be achieved by a very broad set of options and may not assist in focusing on the core objectives being sought. The extent to which different approaches to stormwater management contribute to other economic, environmental and social outcomes can still be captured as part of **Step #3**.
- **DON'T** include prescriptive inputs within the objective unless necessary (for example, compliance with a strict regulatory obligation that requires specific actions) as this could preclude a solution being considered. This is consistent with best practice outcomes and risk-based regulation.

Source: Frontier Economics

3.1 Defining the problem and business need or opportunity

Typically, a problem and business need or opportunity could relate to several interrelated drivers, including the need to:

- **Meet existing service obligation** – such as providing stormwater and flood management services to a new or existing area in a way that meets obligations and expectations. For example, ensuring stormwater infrastructure in a new development can meet water quality and, where appropriate, quantity targets (noting these are output based targets rather than customer focused outcomes).

- **Consider governance arrangements –** such as considering whether there is an opportunity to amend the way stormwater management is planned, delivered and monitored to deliver better outcomes and/or services at lower cost.
- **Evaluate the appropriate 'level' of service or form of new or existing standards including licence or compliance requirements** – such as level of service that could cover flood risk, waterway health and environment outcomes, recreational outcomes and potable water security (in the case of large-scale stormwater harvesting or managed aquifer recharge using stormwater.

3.1.1 The challenge of answering multiple questions at once

Often a decision on stormwater management (commonly supported by a business case) will be responding to more than one of these needs, with multiple potential decisions being sought—say the level of service / standards and the interventions to meet this agreed level of service. For example, as part of setting standards or targets, decisions are often sort on the level of the flow targets and on the appropriate infrastructure to deliver that target.

At times there may be multiple drivers with multiple potential decisions being sought. However, this can create the risk that the CBA will be seeking to optimise across too many variables creating analytical challenges i.e., there are too many drivers and moving variables that the options could address (see **Step #2)** and making it more challenging to interpret results.

If this is the case, one pathway may be to undertake a sequential analytical process whereby the:

- **Level of service is firstly analysed** (i.e., what level of service or level of outcomes maximises net benefits to the community – say what level of community outcomes are best delivered in terms of healthy waterways or if defined in output terms the level of nitrogen, phosphorus and total suspended solids discharged into key waterways.
- **The interventions to achieve this level of service are analysed** (i.e., what set of interventions designed to meet this set of outcomes maximises the value for money or net benefits to the community).

The clearer the need and resulting CBA objective, the more the CBA can be targeted to answering the 'right' questions in the 'right' order.

3.2 Establishing the CBA objective

The related step is then to define a clear outcome that each of the project options will need to achieve—and the CBA objective.

This is a critical step—and worthy of close consideration before proceeding to the next steps—given business case reviews often raise concerns with how the objectives have been defined. Getting the CBA objective 'right' can reduce the risk of undertaking an evaluation of options that may not be identifying the 'best' (i.e., largest net benefit) intervention.

For this reason, a range of principles can be used to help guide the selection of the problem/opportunity and objective. These include the objective being:

- Clearly stated in terms of welfare outcomes i.e., ends rather than means, and in terms of what the community values not in terms of the completion of a process (or what is to be built or delivered i.e. inputs).

- Broad enough to allow a range of innovative alternatives to be explored, but specific enough ensure the analysis reveals reliable and relevant information to decision-making.
- Separable, unless several interdependent outcomes are being addressed through a single initiative i.e., where there are synergies between projects.

The standard SMART (i.e. specific, measurable, achievable, relevant and timely) principles should also be applied when establishing the CBA objective.

Application of the Framework – Objective Definition

For example, the CBA objectives of the case studies undertaken include:

- **Case Study A: t**o deliver renewal of ageing and inadequate infrastructure across the region to ensure the infrastructure continues to meet performance standards related to flood risk and to provide additional investment in stormwater pollution reduction to deliver waterway health improvement.
- **Case study B**: Provision of stormwater solutions for the greenfield development of 10,000 homes, that meets timing of development growth and performance standards related to waterway health & water quality and flood risk. The receiving waterways include an ecologically sensitive estuarine environment.
- **Case study C**: To deliver renewal of specific aging stormwater channels to meet performance standards related to waterway health & water quality and flood risk.

More detail on the case studies is provided in **Appendices E, F and G**.

4 Step #2: Defining the options

A CBA is a comparison between a Base Case option and an alternative set of options. The second step in a CBA is to clearly define the credible set of options (including a Base Case) that could achieve the objective. In instances where a business case is being developed, this step typically draws on previous work done in the 'strategic case' stage of the business case.

Step 2: Defining the Base Case and options - Tips and tricks:

- **DO** ensure the Base Case represents what is realistically likely to happen *without* the specific project or investment (often but not always a 'business as usual' situation). This can include charges or adaptive measures that would be expected to occur over time.
- **DON'T** define a Base Case or options based on whether funding is already available or is (or isn't) committed given that in many circumstances it may not be credible to assume there will not be investment in new stormwater infrastructure.
- **DO** consider a 'do nothing' Base Case when evaluating policy or regulatory changes to stormwater management.
- **DO** consider a 'business as usual' or 'do minimum' Base Case when evaluating alternative stormwater infrastructure solutions.
- **DO** ensure the Base Case and options are forward looking and consider the costs and benefits with and without the intervention.
- **DO** consider a broad range of technically-feasible options to achieve the objective—policy, regulatory, investment. For example, these could include:
  - "Build" and "non-build" solutions - such as construction of an asset or changes to policy settings.
  - Different combinations of capital and operating expenditure.
  - Refurbishment or replacement of infrastructure.
  - Staging / sequencing of options in terms of timing and scale.
  - Varying locations or site options.
  - Early intervention or prevention strategies.
- **DON'T** rule out feasible options as part of the long-listing process on the basis of broader considerations that should be captured as part of the CBA. For example, a conventional drainage approach to managing stormwater should not be ruled out because it imposes environmental costs that a WSUD does not impose. Rather, these environmental costs should be incorporated in the CBA and compared to the associated costs.

Source: Frontier Economics

4.1 Defining the Base Case option

The Base Case is the comparator or counter-factual against which the benefits and costs of all alternative options are calculated, i.e., incremental to the Base Case.

The Base Case consists of a 'real world assessment' of what would occur in the absence of alternative options being implemented. The Base Case is the state of the world if none of the alternative options proceed i.e. *without* the alternative options—not before and after. The Base Case may represent a:

- ***'do nothing' case*** if this is sufficient to achieve the objective
- ***'do minimum' case*** if this is sufficient to achieve the objective
- ***'business-as-usual' case*** where there is an existing pathway or paradigm for achieving the objective

When evaluating alternative stormwater infrastructure solutions, a 'do minimum' or 'business as usual' Base Case may be most appropriate. This is because there is often a clear compliance, service or customer expectation to be met.

However, **when evaluating policy or regulatory changes to stormwater management a 'do nothing' Base Case** may be most appropriate. For example, where there are genuine, realistic options for do 'nothing'—say by potentially taking on additional risk from poor performance and/or not meeting expectations—or when evaluating different targets or standards (i.e. objective is to set optimal level of service), and the objective is still met, then a 'do nothing' case may be appropriate.

Alongside **Step #1**, a well-established Base Case is critical to a robust and informative CBA as it provides the foundation for identifying the incremental value of alternative options or project cases. Getting the Base Case 'right' reduces the risk of misreporting the incremental value of alternative options or project cases.

4.2 Identifying alternative options

Following the definition of the Base Case, a range of realistic alternative stormwater management or governance options that achieve the objective need to be identified and documented.

As discussed above, stormwater management can involve the use of structural (e.g. physical infrastructure, drainage channels, and treatment techniques) and non-structural (e.g. policy and governance change, education programs, monitoring, and flood preparedness) measures to both improve water quality, mitigate excessive flows, minimise damage from flooding, or achieve other goals such as water reuse through stormwater harvesting. As shown in **Figure 9**, this includes:

- the planning and delivery of 'infrastructure, including 'natural assets' (or 'green and blue infrastructure', such retention and filtration lakes or basins, tree canopy, waterways, vegetation)
- the operation and maintenance of that infrastructure, this includes replacement of assets
- monitoring of water quality and ecosystem health to assess effectiveness of stormwater management

- monitoring of flows in drains and creeks to assess effectiveness of flow management (flood) controls
- managing relationships with, and the expectations of, the communities served by the above infrastructure and natural assets
- emergency management activities related to flood hazard
- administrative and corporate support for all of the above activities, including inter-agency coordination given the range of organisations with roles and responsibilities in this area
- changes to urban form or management of land-use (such as reducing 'hard' surfaces and increasing 'soft' surfaces across the catchment)
- changes to stormwater governance arrangements

Figure 9: Stormwater management activities

Source: Frontier Economics

The appropriateness of a stormwater management activity or initiative (and therefore, whether it should be included as an option in the CBA) will depend on the objective of the CBA and the range of options available to a decision-maker. For example, in many instances, changes to urban form and/or governance are not feasible options. In these cases, feasible stormwater management options may be restricted to infrastructure solutions or education programs, for example.

Application of the Framework – Case Study B: Base Case & Options Definition

For example, the appropriate Base Case and alternative options for **Case Study A**, involve:

- **Base Case**: The Base Case identified in Case Study A is that Council will design, invest and build traditional 'pits and pipes' grey infrastructure. This Base Case is an example of a 'do minimum' Base Case, as council is undertaking the minimum level of investment to meet regulatory obligations.
- **Option 1** consists of Council designing, investing and building a combination of traditional grey-infrastructure and green infrastructure, including 'on-site' water-sensitive urban design.
- As per Option 1, **Option 2** consists of Council designing, investing and building a combination of traditional grey-infrastructure and green infrastructure, including 'on-site' water-sensitive urban design. The key difference between the two options is the timing of investments, where Option 2 brings forward investment in grey and green infrastructure to improve amenity and environmental outcomes.

More detail on Case Study B is provided in **Appendix E**.

4.2.1 When the option involves a number of stormwater management initiatives

In some cases, a single measure or investment (say rainwater tanks), may not be sufficient to achieve the objective (say manage stormwater volumes). In this case, the measures should be packaged into a combination or portfolio of actions. The **CBA will compare different combinations (or portfolios) of these individual measures**.

4.3 Identifying the Base Case and alternative options

The options and the Base Case should meet a range of principles (see **Table 5**) including being forward looking (i.e., as we can only change future action) and being defined in a way that enables measurement of costs and benefits 'with and without' the intervention.

Table 5: Step 2: Defining the project options for inclusion in a CBA - Key principles

Guiding principle	Why?	Example	Potential issues
Do the options achieve the CBA objective?	Enables 'apples with apples' comparison.	If the aim of the project is to provide stormwater services to the catchment area it is not appropriate to include an option that does not achieve that objective.	Care should be taken when undertaking projects aimed at setting the standard/level of service and identifying the preferred option to achieve that standard. As discussed in Step #1, in this case, one option may be to undertake a sequential analytical process whereby the CBA is used to set the level of service first and then consider options.
Do the options consider the feasible range of approaches to achieving the objective?	Ensures 'all options are on the table' to identify the option that delivers the greatest benefit to the community.	If the aim of the project is to provide a stormwater service to a development, it is not appropriate to only consider specific or a subset of options (say WSUD only options) (i.e. not considering traditional drainage options).	Care should be taken to consider the broad range of policy, regulatory and build or non-build investment options, rather than focusing on a subset of potential solutions (i.e. predetermining the solution before the analysis has been complete).
Are the options technically feasible?	Ensures all options can be implemented in practice, and therefore achieve the objective.	New technologies that have not been tested in practice, or not consistent with policy, regulatory or community expectations, are unlikely to deliver the objective.	Care should be taken to balance considering the broad range of options with ensuring they represent practical solutions.

Guiding principle	Why?	Example	Potential issues
Are the options forward looking?	Ensures changes that can be reasonably expected in policy, regulatory or market factors are captured.	The options (and Base Case) should not assume nothing will change over time – changes that can be reasonably expected (e.g. increase in population and urbanisation and the resulting impact on stormwater volumes) should be incorporated.	This requires considering how things will change in future (e.g. forecasting how demand will change over time), which can be challenging, especially in the case of biophysical changes.
Do the options enable identification of the counter-factual?	Enables identifying the value of intervention by comparing what would happen in the absence of the project (i.e. compare the state of the world with and without the project).	A project that involves potentially moving to a regional governance approach to stormwater management should compare a Base Case that involves no change ('do nothing') in the governance of stormwater (remaining with a council-led approach), rather than a Base Case of no stormwater management at all.	This requires understanding what would happen in the absence of the option (i.e. the causal link between the option and outcomes), which can be challenging, especially for options that involve multiple steps in the causal chain.

Source: Frontier Economics

4.3.1 Identifying the appropriate number of options

While it will depend on the objective and decision being sought, as well as the level of risk and uncertainty, typically between ***2-4*** **alternative options to the Base Case should be short-listed** for inclusion in the CBA.

The process for short-listing these options is a key component of the CBA and broader business case (see **Box 5**). For example, if the CBA is supporting an 'early' business case focused on strategic need for intervention, where the decision relates to potential pathways or business directions, then a larger number of broad options may be appropriate. If the CBA is supporting a 'later' business case, where there is an investment and/or procurement decision, then a smaller set of options may be appropriate (say covering differences in scope, timing, size, location of investment etc).

It is critical that feasible options are not ruled out as part of the short-listing process, on the basis of broader considerations that should be captured as part of the CBA. For example, a conventional drainage approach to stormwater management should not be ruled out (unless it would conflict with a licence requirement) because it imposes additional environmental costs.

Rather, these environmental costs should be incorporated in the CBA and compared to the associated costs.

Box 5: Short-listing options for inclusion in the CBA

It is best practice to articulate the process for short-listing the options, such as:

- The long list of potential policy, regulatory and build and non-build solutions, and a high-level discussion of:
  - the intended outcome and resources required. In the early stages of identifying options, only summary data may be required. Later in the process and before significant funds are committed, the confidence required increases and additional detail should be included
  - how, where and when these resources will be used
  - how the intended outcome meets the needs of the community
  - broader considerations (including social and environmental impacts)
  - any risks
- A short list which includes a Base Case and typically between 2-4 alternative options.
- The criteria used to short-list the options for example: the long list of options was assessed based on whether they met a range of criteria, including:
  - the capacity of the options to meet the stormwater and flooding needs of the growing population (the key objective)
  - the capacity of the options to contribute to a range of other objectives
  - the feasibility of the options in practice
  - the consistency of the options with broader long-term planning and regulation
  - the extent to which solutions represented a least cost approach to servicing customers, consistent with obligations

Source: Frontier Economics

5 Step #3: Identifying and valuing key incremental costs and benefits

The third step in a CBA is to identify the types of economic, social and environmental outcomes that accrue to the South Australian community from the options, and to then forecast and value in monetary terms (i.e. monetising by converting to a dollar basis) over the modelling period those outcomes most likely to materially differ between the Base Case and the alternative options ('the key incremental costs and benefits').

This cost and benefit valuation step can often be the most resource, time and effort intensive and where there may be key differences between a simple and complex CBA. The appropriate degree of analysis in this valuation step will vary from one business case to another and should be matched to the size, complexity, level of risk and community interest on a case-by-case basis.

Step #3: Identify and value key incremental costs and benefits - Tips and tricks:

- **DO** focus on incremental changes in SA community outcomes that directly result from the alternative options (i.e. that result from 'moving away' from the Base Case).
- **DON'T** focus only the customers, users of the CBA framework, or the decision-maker themselves (e.g. local council or SA Government). The reference group is the SA community.
- **DON'T** be concerned whether an incremental difference in community welfare resulting from the alternative options should be labelled a change in economic, social or environmental outcomes or impacts.
- **DO** consider the existing methodologies or approaches outlined in this CBA framework for valuing key impacts in monetary terms. Review the Appendices for further detail on specific valuation methodologies or consider specific supporting expertise to assist in applying existing (or if necessary, amended or new) methodologies for monetising key impacts. This includes:
    - **Appendix B** – further detail on valuing economic costs and benefits of stormwater management.
    - **Appendix C**– further detail on valuing social costs and benefits of stormwater management.
    - **Appendix D**– further detail on valuing environmental costs and benefits of stormwater management.

Source: Frontier Economics

5.1 Identifying categories of costs and benefits

CBA captures economic, social and environmental outcomes or impacts on community welfare. These are outcomes that accrue to the SA community rather than only to customers, users of the CBA framework, or the decision-maker themselves.

- **Benefits relate to any *improvements* in economic, social and environmental outcomes, relative to the Base Case, as a result of the options**—say a $10m economic saving in the form of avoided or deferred capital expenditure or a $10m environmental saving in avoided waterway health impacts or greenhouse emissions. Both outcomes form part of the benefit side of the CBA 'ledger' (see **Step #4** on incorporating these benefits into the BCR calculation and NPV calculation).
- **Costs relate to any *deterioration* in economic, social and environmental outcomes, relative to the Base Case as a result of the options**—say $10m in additional operating expenditure or $10m in reduced amenity or environmental benefits from a deterioration in waterway health. Both outcomes form part of the costs side of the CBA 'ledger' (see Step #4 on incorporating these costs into the BCR calculation and NPV calculation).

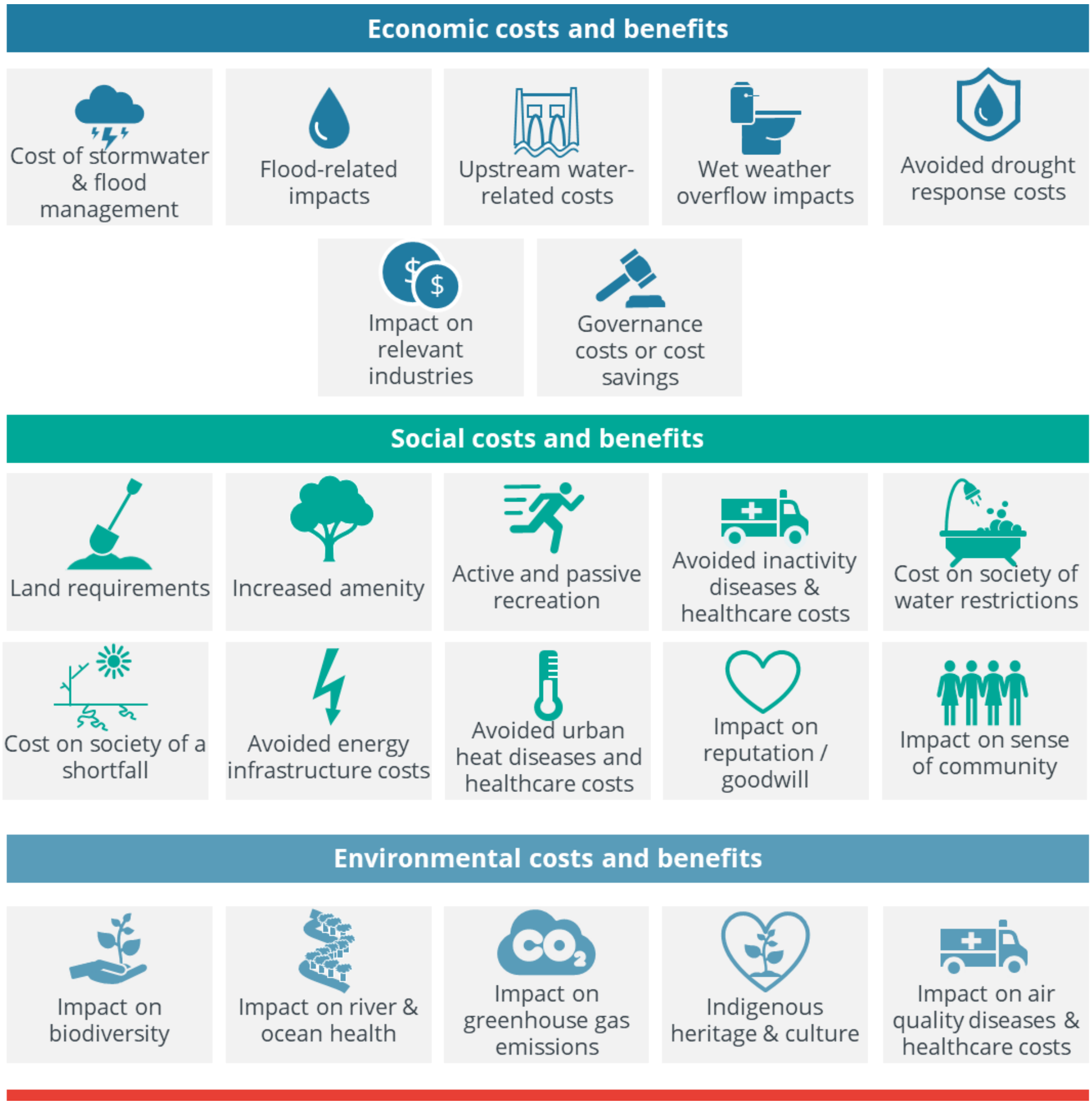
Ultimately it **does not matter whether an *improvement (or deterioration)* in community welfare is in the form of changes to economic, social or environmental outcomes** (i.e., don't overly focus on classifying into these categories). Unlike an MCA where weights are attached to certain outcomes, key changes in community welfare are valued in monetary terms (i.e. converted to a dollar basis) and summed over the modelling period. For this reason, **a $10m economic, social or environmental benefit provides the same value to the SA community**.

5.1.1 Overview of common costs and benefits of stormwater management

Figure 10 below sets out some common categories of costs and benefits of stormwater management that may be relevant to the CBA of stormwater-related decisions. These costs and benefits include:

- **Economic costs and benefits** such as:
  - the cost of managing stormwater
  - cost of managing flooding
  - the impact on upstream water systems
  - governance costs or cost savings
- **Social costs and benefits,** such as:
  - amenity and recreation benefits arising from greater availability of irrigated open space and the resulting recreation-related health impacts
  - impact on availability of land (opportunity cost of land) arising from alternative land footprint or location requirements
  - urban heat-related benefits from the provision of irrigation, such as reduced energy distribution and generation infrastructure costs and reduced urban-heat related diseases
- **Environmental costs and benefits**, such as:
  - impact on river and ocean health arising from stormwater and wastewater discharge and wet weather overflows
  - impact on greenhouse gas emissions

Figure 10: Overview of commonly identified costs and benefits of stormwater-related decisions



Source: Frontier Economics

Importantly, this list is a ‘conversation starter’ rather than a ‘menu’ to choose from as ultimately any relevant costs and benefits incorporated into the CBA need to meet the following key principles:

- **Costs and benefits should represent changes in ‘resource’ outcomes** from the perspective of the SA community, rather than financial costs and benefits from the perspective of the user.
- **Costs and benefits should directly result from the option with a clear and documented ‘causal link’** between the intervention and the outcome. A ‘logic model’ approach can be useful to establish and document these causal links.

- **Costs and benefits should be measured on an incremental basis to the Base Case** (i.e. changes in SA community outcomes that result from 'moving away' from the Base Case).

Application of the Framework – Case Study C: Identifying Relevant Costs & Benefits

For example, the range of relevant costs and benefits of Case Study C include:

- **Additional stormwater management costs:** Ensuring that stormwater and flooding is managed consistent with policy, standards and regulations will require investment in stormwater and flooding management. As the options involve alternative approaches to managing stormwater and flooding, they will be associated with differing levels of capital and operating expenditure.
- **Additional upstream water-related costs:** Option 1 involves increased water demand associated with the irrigation of the new tree canopy (under Option 2 this irrigation demand is met by stormwater harvesting). This will increase the demand for potable water, compared to the Base Case, and in turn, bring forward the need to augment the potable water system.
- **Additional cost of the infrastructure footprint:** as the options involve alternative approaches to managing stormwater and flooding, they will require a different footprint of land to deliver the services. To the extent that this land would have been used for an alternative use (e.g. development, recreation, industrial land, biodiversity), delivery of these stormwater management measures reduces the availability of land for these other uses.
- **Increased amenity:** as the alternative options involve the provision of irrigated tree canopy and a naturalised stormwater channel, they create additional usable open space and healthier waterways. Greater proximity to usable open space delivers amenity benefits.
- **Avoided urban heat diseases and healthcare costs:** As discussed above, the increased amount of irrigated tree canopy under the alternative options can reduce urban heat. This in turn can reduce the risk of mortality and morbidity associated with urban heat related diseases. Reduced mortality and morbidity reduces the strain on the public health sector.
- **Avoided energy infrastructure costs:** The alternative options involve the provision of additional irrigated tree canopy. This increased tree canopy can reduce urban heat, which in turn, can reduce energy demand and peak demand associated with cooling (and potentially increase heating requirements). Assuming the impact on cooling demand outweighs the impact of heating demand, reduced energy demand can defer or avoid the need to upgrade energy network and generation infrastructure.
- **Impact on air quality diseases and healthcare costs:** As discussed above, the alternative options involve the provision of increased tree canopy. Canopy planting can remove pollutants in the air (including carbon dioxide), leading to improvements in air quality. This in turn could reduce mortality and morbidity associated with diseases related to air quality.

More detail on Case Study C is provided in **Appendix G**.

5.1.2 Identifying the causal link between the option and the outcomes

A key principle of CBA is that there is a clear causal link from:

- the interventions (inputs and actions) in the Base Case and alternative options to
- the products and services provided (intermediate outputs) to
- the changes in community welfare (economic, social and environment outcomes).

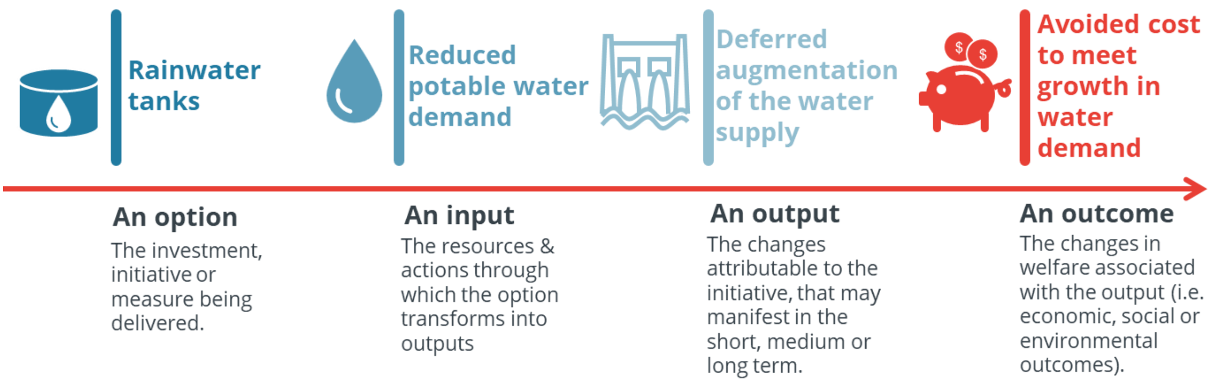
This ensures there is a clear explanation of how an option will meet the CBA objective.

A 'logic map' is a tool to ensure there is a clear causal link underpinning the CBA. It describes the links from an initiative's objective to the inputs, to the outcomes and to the ultimate benefit it will produce. Logic models can act as an evidence base and assist in identifying the data required to forecast and monetise economic, social and environment outcomes and ensure that any business case can provide a clear explanation of how an option will meet the CBA objective. The extent of analysis should be matched to the size, complexity, level of risk and estimated cost on a case-by-case basis.

As shown in **Figure 11**, identifying the causal link using a logic map involves identifying the link between an option, inputs, outputs and outcomes, where:

- **an option** - the investment, initiative or measure being delivered
- **an input** - the resources and actions through which the option transforms into outputs
- **an output** - the changes attributable to the initiative, that may manifest in the short, medium or long term
- **an outcome** - the changes in welfare associated with the output (i.e. the change in economic, social or environmental outcomes)

Figure 11: Identifying the causal link is critical



Source: Frontier Economics adapted from NSW Treasury

Table 6 outlines some examples of common inputs, outputs and outcomes.

Table 6: Examples of common inputs, outputs and benefits

Option	Input	Outputs	Outcomes
Investment in stormwater harvesting or rainwater tanks	Investment in stormwater harvesting or rainwater tanks	Increased opportunity for regular irrigation of open space	Amenity benefit
Investment in stormwater harvesting or rainwater tanks	Investment in stormwater harvesting or rainwater tanks	Reduced household potable water demand	Avoided upstream water costs
Water sensitive urban design	Investment in wetlands	Reduced volume and flow of stormwater discharged into waterways	Improved waterway health
Investment in stormwater harvesting or rainwater tanks	Investment in rainwater tanks	Reduced likelihood of wet weather overflow	Reduced cost to manage wet weather overflows
Regional governance approach to stormwater management	Regional entity adopts responsibility for aspects of stormwater management	Regional approach to the planning and delivery of stormwater infrastructure	Lower cost of stormwater management

Source: Frontier Economics

However, it can be challenging to identify and articulate the causal link between the investment and the associated economic, social and environmental costs and benefits valued by the community. This is because it involves answering a number of difficult questions, such as:

- **What degree of incremental or marginal change is caused by the investment and not by other factors?** This can be especially difficult for social and environmental outcomes which often involve a multi-step, causal chain.
- **What is the change in outcomes over long periods of time?** As some investments are often long-lived, outcomes may emerge and compound only into the longer term. This inevitably makes accurate measurement difficult as certainty reduces with time elapsed.
- **Which indicators or attribute variables should be measured to best capture the change in outcomes?** The variables chosen should be the best possible indicators of incremental changes in real social resources that arise because of the investment. See below for an indicative sample of biophysical indicators that have been used to measure the incremental changes in outcomes.

- **What dataset is needed and available to link the investment to the outcome and quantify the impacts of the investment?** Baseline scientific data to measure changes in outcomes due to the investment is essential. Without this, there is no baseline measure to convert to a dollar figure. In the best-case scenario, original research is undertaken as part of the investment evaluation project with the research parameters and scope tailored to the project at hand. In reality, this happens only rarely due to time and resourcing constraints.

5.2 Determining the appraisal period

Key costs and benefits should be forecast over a period of time ('appraisal period'). This appraisal period defines the start and end dates of the CBA and enables a robust comparison of the economic, social and environmental outcomes of the options—some of which may not occur until many years into the future.

Typically, the appraisal period is ***30 years***,[15] however the choice of appraisal period will depend on several factors including:

- **Nature of the intervention** including the economic life of any investments. In general, the longer the asset life, the longer the appraisal period, but where options involve differing assets and/or interventions, the appraisal period can include the use of:
  - **a 'residual value'—**representing the additional value provided by the investment beyond the appraisal period—say where a stormwater channel has an asset life of 80-100 years which is beyond the 30 years appraisal period, or a specific option requires additional investment towards the end of the appraisal period.
  - **a 'renewal value'**—representing the cost of renewal and replacement of assets with a shorter economic life —say IT systems which typically provide greater flexibility and/or lower level of risks than large long-lived investments.
- **Ability to forecast key costs and benefits** over this period. This includes consideration of key factors that might influence outcomes over this period including population and demand, technological changes, climate change and rainfall etc. In general, the more certainty regarding forecast key costs and benefits, the longer the appraisal period. However, where there are uncertainties impacting forecasts these can be addressed through:
  - simple sensitivity analysis
  - more complex real options or adaptive pathway analysis (see **Step #5**).

As the stream of costs and benefits are discounted in **Step #4**, the 'importance' attached to outcomes diminishes in the later years of the appraisal period (i.e. the extent to which they drive the CBA results diminishes). For this reason, **the choice of appraisal period will be a balance between time, effort and resourcing required to compile reasonable estimates of costs and benefits over the period, and additional value obtained** —in terms of differentiating the options—from a longer period.

Importantly:

- **The same appraisal period should be adopted for all options** (including the Base Case).

[15] This is consistent Government of South Australia Department of Treasury and Finance (2014), *Guidelines for the evaluation of public sector initiatives*, which states that an appraisal period should generally be no greater than 30 years.

- **The life of the asset and the appraisal period should not influence the valuation approach**. For example, the value of a kilolitre of water saved in year one as a result of a stormwater harvesting project with a life of five years, should be the same as if the same kilolitre of water was saved as a result of a project with a life of twenty years (see **Box 6**).

Box 6: The difference between appraisal period and the value of water saved

Critically, the life of the asset and the appraisal period should not influence the valuation approach. In other words, under the same hydrological conditions a kilolitre of water saved in year 1 should have the same value whether the modelling period is 5 years or 30 years.

For example, let's assume that there are two stormwater harvesting projects being considered: Project 1 and Project 2. Both projects save 5ML of water per year. The only difference is that Project 1 lasts five years, while Project 2 lasts 20 years. There also maybe different costs but that is not the focus here.

Given both projects save 5ML per year in the first 5 years of the modelling period (under the same hydrological conditions), it can be assumed that both projects provide the same value of water saved in the first five years of their lives.

Table 7: **The value of water: Project 1 – an example of a project with a 5 year life**

Years	1	2	3	4	5	6	…	20
Volume of water saved	5ML	5ML	5ML	5ML	5ML	0	…	0
Value of water saved ('true value')	$0.5m	$1m	$2.5m	$1.5	$1m	0	…	0

Table 8: **The value of water: Project 2 – an example of a project with a 20 year life**

Years	1	2	3	4	5	6	…	20
Volume of water saved	5ML	5ML	5ML	5ML	5ML	5ML	…	5ML
Value of water saved	$0.5m	$1m	$2.5m	$1.5	$1m	$0.5m		$0.5m

Source: Frontier Economics

Note: These values are indicative only.

5.3 Valuing costs and benefits over the appraisal period

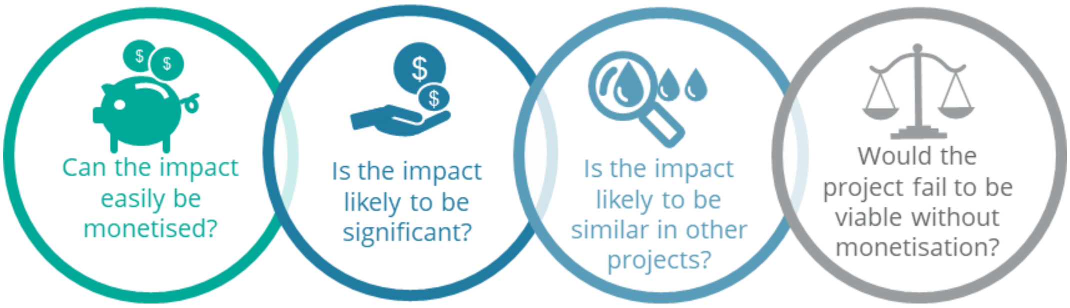
Forecasting and valuing in monetary terms the key incremental outcomes over the modelling period can be resource, time and effort intensive process. This is typically in Australian dollars in real terms (i.e. excluding inflation).

Importantly, a **CBA does not require the valuation of <u>all</u> relevant impacts**.

Some of these forecasts may be straightforward as they are already expressed in dollar terms (such as the cost of additional stormwater infrastructure opex or capex, or the benefit of any avoided opex or capex) and for many simple CBAs these costs may be the key differentiating factor between the options and the focus of the CBA. Where this is the case, or where the size and scope of the project does not justify the work entailed in quantifying other social and/or environmental costs and benefits,[16] a simple CBA may be similar to a CEA (see **Section 1.3**). In this context, proponents should be confident that other key economic, social and environmental outcomes are equivalent across the options or that valuing and including these non-market social or environmental outcomes would not materially impact the CBA or business decision.

As shown in **Figure 12**, where there are material social or environmental outcomes that could differentiate the options, there may be value in developing a forecasting and valuation method. This may involve additional analytical effort, require input from specialists (including environmental, hydrology or economic experts), and potentially additional stakeholder consultation.

Figure 12: **Principles for identifying the appropriate degree of monetisation**



Source: Frontier Economics

Whether it is forecasting and valuing the additional infrastructure costs to manage growth, the benefit of deferred infrastructure augmentation (i.e. avoided cost), or avoiding pollution in a waterway or air, valuing these outcomes typically requires the same key stages for each of the specific actions or inputs within the option:

1. **Forecasting the change in likelihood of events from each option (ΔL)** – say the reduction in likelihood of flooding or irrigation of green space following the implementation of WSUD measures. In many cases there will be no changes in likelihood of events and this step can be skipped.
2. **Forecasting the change in outcomes from each option (ΔQ)** i.e. the forecast quantity or volume change in outcome that we are trying to value —say the reduction in stormwater volumes discharged to a waterway (measured in kL), reduction in brown energy demand or greenhouse emissions (measured in MWh or tonne CO_2) or availability of land for recreation (measured in hectares of land and percent of the time it is available). This is often expressed as the 'change in quantity' term in the valuation formula.
3. **Applying a monetisation technique to value this biophysical change** (**P**) – say the value of water conserved as a result of using stormwater harvesting rather than potable water to meet

16 The cost and time involved in benefit valuation and data collection are not consistent with the scale or scope of the options being evaluated.

demand ($/kL). This is often expressed as the 'price' term in the valuation formula. The key valuation principle is that outcomes are valued at the dollar amounts that individuals or businesses are willing to pay for them. These techniques can typically be classified as:

- ***market valuations:*** where market prices reflect the value of the resources in alternative uses. This could include using estimates of labour and other unit costs associated with delivering stormwater infrastructure derived from market contracts for these services.
- ***non-market valuations such as:***
  - ***primary approaches—***which could use original data from a revealed preference study, stated preference survey or hedonic pricing analysis from the project site or context to derive a monetary value for some quantified change in outcomes caused by an option (i.e. what are people prepared to pay for a certain outcome); or
  - ***secondary approaches***, which takes values from a pre-existing study, project, or piece of research and applies it to a new project or context (known as such as benefit-transfer).

Box 7: Benefit transfer

Benefit transfer is relatively cheap and quick to undertake, relative to primary valuation studies. However, it relies on the existence of a bank of suitable primary nonmarket valuation studies from which unit values can be drawn. The less similar the study site is from the policy site, the more questionable is the use of benefit transfer. In particular, for benefit transfer to be suitable:

- The source study must be based on adequate data, sound economic methodology and correct empirical techniques.
- The magnitude of the change in the relevant variables measured and valued in the source study must be similar to the magnitude of the change at the target site.
- The policy context and characteristics of the source and target site should be similar. In general, South Australian studies are preferred, and if a relevant South Australian study is unavailable, Australian studies are always preferred to international studies.
- The market or households of the source and target site must have similar socio-economic characteristics.
- The relevant outcome at the policy site (i.e. the biophysical indicator or outcome to be valued) should be the same as the outcome of the study site.

Even where there are significant similarities between a study site and policy site, benefit transfer requires considerable judgment on how to transfer the study site values (for example, the appropriate method of truncating a value from another study).

In every case, the choice of study should be appropriately justified.

Source: Frontier Economics and Gillespie Economics

5.3.1 Identifying the appropriate monetisation technique

In simple terms, the steps above can be thought of as multiplying change in likelihood (**ΔL**) by a change in outcomes (**ΔQ**) and an appropriate value (**P**) (see **Figure 13**).

Figure 13: Valuing economic, social and environmental costs and benefits

Source: Frontier Economics

Table 9 provides examples of relevant **P, ΔQ** and **ΔL** for a range of benefits of stormwater management. For some costs and benefits, the likelihood of the impact occurring does not change, and therefore, likelihood is not a relevant input into the valuation formula (marked with an N/A).

Table 9: Valuing key costs and benefits – information requirements

Cost or benefit	Change in outcomes (ΔQ)	Price (P)	Change in likelihood (ΔL)
Value of avoided water demand	Change in demand / volume of stormwater harvesting	Long run marginal cost (LRMC) of water supply	N/A
Avoided costs of a flood	Change in flood related outcomes	Avoided cost of a flood event[17]	Change in likelihood of flood inundation
Improved health of vegetation	Kilometres or hectares of protected vegetation	Community willingness to pay (WTP) for protected vegetation	N/A
Improved waterway health	Kilometres of swimmable waterway	Community WTP for swimmable rivers	N/A
Recreation opportunities	Hectares of irrigated or unirrigated open space / visitors to open space / water based recreation	Community WTP to engage in recreation (e.g. walk, run)	N/A
Avoided cost of water restrictions	Duration of water restrictions and size of restricted demand (in kL)	Community WTP to avoid water restrictions	Likelihood of different stages of water restrictions

Source: Frontier Economics

The relevant P, ΔQ and ΔL all depend on the cost or benefit of interest, which in turn, depend on the information available as part of the CBA. This is because, in practice, a given change in outcomes that the community values (for example, changes in waterway health) can often be valued in multiple different ways.

For example, to value quantitative changes in waterway health arising from reduced stormwater discharge from the use of rainwater tanks, users may have access to information related to either outputs or certain outcomes that provide some insight into the change in community welfare, such as:

- the volume of nutrients discharged into the river (output)

17 The cost of a flood event will depend on the location and duration of the flood event, but possible economic, social and environmental costs can include costs of rebuilding after a flood event, costs of disruption to planned events, mental health costs and reduced social cohesion from the flood and environmental costs associated with polluted runoff.

- the presence of indicator species (proxy for outcome)
- the length of waterway in good health, swimmable days lost or gained etc (outcomes the community values)

While each of these metrics seek to estimate the change in the environmental outcomes related to waterway health, they use very different but potentially overlapping information on changes in biophysical outcomes. As discussed in **Box 8**, care should be taken to avoid double-counting.

Box 8: Avoiding double counting

Double-counting which can occur when:

- **Valuing and monetising both an output and an outcome**[18] which can occur when outcomes are imprecise and difficult to measure. For example, WSUD solutions can lead to increased tree canopy and reduced urban heat. However, a benefit of increased tree canopy is reduced urban temperature. In other words, urban heat is an **output** of increased tree canopy (an input). This means that is inappropriate to value both the benefit of a tree (which would include its urban cooling benefits) and the benefits of reduced urban heat without acknowledging the risks of double-counting (see **Figure 14**).
- Valuing multiple outcomes from the set of interventions. Another example relates to amenity benefits and environmental outcomes. Often studies will estimate the value of improvements in amenity by looking at changes in house prices of dwellings in close proximity to open space or healthy waterways. But depending on the characteristics of the study, this change in house prices can capture both improvements in visual amenity (often categorised as a social benefit) and improvements in waterway health (an environmental benefit). In this case, it would be inappropriate to value both the benefits of waterway health and this change in amenity.

Figure 14: Example of a logic map

Source: Frontier Economics

This framework has sought to identify a methodology to value each cost and benefit identified. However, users may be constrained by the data available to them and therefore in some cases may choose to use different metrics based on the data available.

For large-scale projects, users may have access to a wide range of information, including multiple metrics that value the same outcome. In cases such as these, users should seek to adopt the

18 The NZ evaluation guidelines provides further examples of the need to define inputs, outputs and outcomes. See for example, Social Policy Evaluation and Research Unit (2017), *Making sense of evaluation: a handbook for everyone*, p.23.

metric that matches the best available study (for example, one that meets as many of the principles of benefit transfer as possible).

In many instances (for example, smaller-scale projects), users may only have information on a single metric for each outcome of interest. In these cases, the choice of the appropriate price will be driven by the available information. For example, if the proponent only has information on *time to catch a bass*, the appropriate price must be based on a study that estimates the community's *willingness to pay for a reduction in time to catch a bass*.

In some cases, this study may not be based on the specific area of interest. In these cases, users should clearly document their assumptions (including why this specific study was adopted) and include sensitivity and scenario analysis to test how sensitive the results are to the benefit value applied.

Critically, CBA is an iterative process so if more information becomes available, this can be introduced into the CBA. It is common for the analysis to evolve as more information becomes available about the nature of the business need and the available options, the associated costs and benefits and the risks and uncertainties. The trick is to find a 'way into the problem' without getting 'stuck' on whether all potential options have been identified, or final cost information and/or other detailed assumptions are available.

5.4 Applying the monetisation technique

The Appendices provide further detail on valuation methodologies to value the key costs and benefits of stormwater management:

- **Appendix B** – further detail on valuing economic costs and benefits of stormwater management, including valuing the cost of low probability, high cost events such as flooding.
- **Appendix C** – further detail on valuing social costs and benefits of stormwater management.
- **Appendix D**– further detail on valuing environmental costs and benefits of stormwater management.

Whether it is economic, social or environmental outcomes being forecast and valued, where possible they should:

- **Be expressed on an annual basis**
- **Utilise well accepted tools and techniques**
- **Be derived from best available information and utilise common planning assumptions** (where relevant)
- **Be expressed in real dollars** (for example, $FY23 without the impact of inflation)

For example, as discussed in **Box 9** (and applied in Case Study B), the value of reduced potable water demand from the use of stormwater harvesting or rainwater tanks can be estimated by multiplying together the LRMC of potable water by the change in potable water demand.[19]

More detail on Case Study B is provided in **Appendix E**.

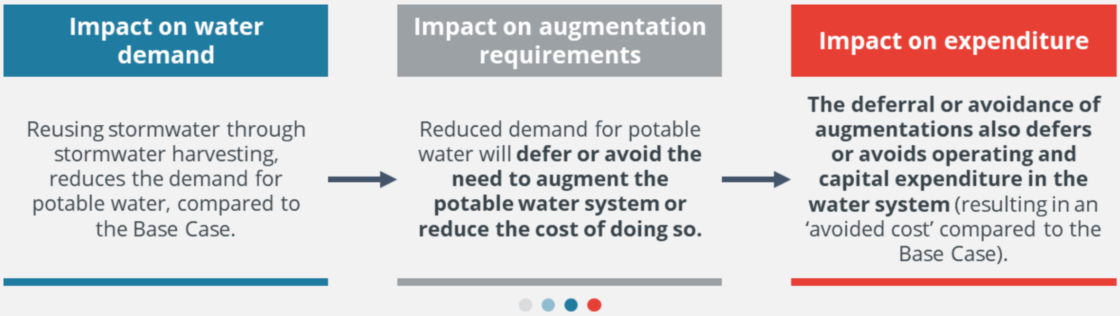
19 In this example, there is no change in the likelihood of an event, so L does not appear in the formula.

Box 9: Example of valuing broader costs and benefits – deferred or avoided water costs

Differences in the approach to stormwater management can lead to differences in the costs of water-related services beyond those directly incurred to service specific developments in a given region of South Australia.

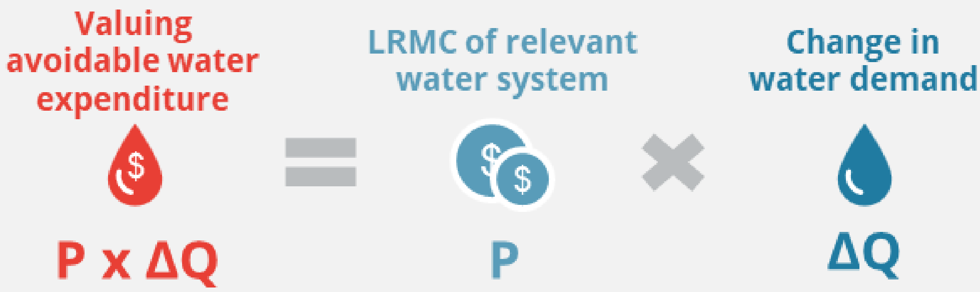
For example, the use of rainwater tanks or stormwater harvesting can reduce the demand for water from the potable water system. In turn, this can defer or avoid the need to augment and/or operate key water supply assets that would otherwise be required to meet growth in water demand.

The deferral of this expenditure represents an economic cost saving for the community (an 'avoidable cost' benefit) relative to a Base Case.



The present value of this upstream water operating expenditure and capital expenditure cost savings can be calculated by multiplying together for each year of the modelling period the:

- The Long Run Marginal Cost (LRMC) of water supply ('P')
- The change in water demand ('Q') in each year over the modelling period.



Source: Frontier Economics

6 Step #4: Comparing the costs and benefits to identify the NBV and BCR

The fourth step in the CBA involves comparing the costs and benefits to report the overall net benefit to the community.

Step #4: Comparing the costs and benefits – tips and tricks

- **DO** categorise all monetised 'positive' impacts (i.e., enhancements in society or community outcomes relative to the Base Case) as benefits (including avoided costs) whether they are economic, social or environmental.
- **DO** categorise all monetised 'negative' impacts (i.e., deterioration in society or community outcomes relative to the Base Case) as costs whether they are economic, social or environmental.
- **DON'T** assume only additional capital and/or operating expenditure are the only costs (unless satisfied that a simple CBA akin to a cost effectiveness analysis is warranted – see **Box 4** in **Section 1.2.1** for more detail on CEA's and the differences with CBA's).
- **DO** calculate both the BCR and NPV of the options using the social discount rate of 7% for the central scenario, consistent with Infrastructure SA CBA guidance.

Source: Frontier Economics

6.1 Calculating BCR and NPV

The purpose of CBA is to compare the economic, social and environmental costs and benefits of different options to achieve the business need or opportunity (CBA objective). To achieve this, the incremental costs and benefits (i.e. relative to the Base Case) that accrue over the modelling period are aggregated into an overall single measure of net social benefit. The two measures that are used to compare the overall measure of social benefit are:

- **Net Present Value (NPV)** – equal to the present value of incremental economic social and environmental benefits ***minus*** present value of incremental economic social and environmental costs over the period (**Figure 15**). This provides an estimate of community value for money of the options in ***absolute*** terms.
- **Benefit Cost Ratio (BCR)** – equal to the present value of incremental economic social and environmental benefits ***divided*** by present value of incremental economic social and environmental costs over the period (**Figure 16**). This provides an estimate of community value for money of the options in ***relative*** terms.

Critically, both BCR and NPV use the same information – the present value of incremental benefits and the present value of incremental costs – and provide important insights as to the value for money of the options.

Figure 15: Calculating Net Present Value

Source: Frontier Economics

Figure 16: Calculating Benefit Cost Ratio

Source: Frontier Economics

6.1.1 Categorising costs and benefits

As both NPV and BCR metrics are ways of identifying the size or ratio of the incremental benefits to the costs, a key step is to ensure that costs and benefits have been categorised correctly i.e., have we got them on the correct side of the CBA 'ledger'.

This is because, as discussed above, a BCR should represent the present value of all benefits (including avoided costs) divided by the present value of all costs (including disbenefits), while the NPV represents the difference between the costs (including disbenefits) and benefits (including avoided costs). For example:

- **An incremental cost to society represents any economic, social or environmental change that represents a deterioration in community welfare relative to the Base Case** i.e. a disbenefit—whether it is $10m in incremental capital expenditure or $10m in additional greenhouse emissions. **They form part of the denominator in the BCR calculation and the second term in the NPV calculation**.
- Similarly, a $10m saving in the form of avoided or deferred capital expenditure should be treated in the same way as $10m in avoided greenhouse emissions—**they both represent an improvement in community welfare relative to the Base Case i.e. a benefit. They form part of the numerator in the BCR calculation and the first term in the NPV calculation.**

It is a common mistake to include any changes in infrastructure costs (i.e., whether it is an increase in expenditure or an avoided expenditure) as costs i.e. denominator in the BCR calculation.

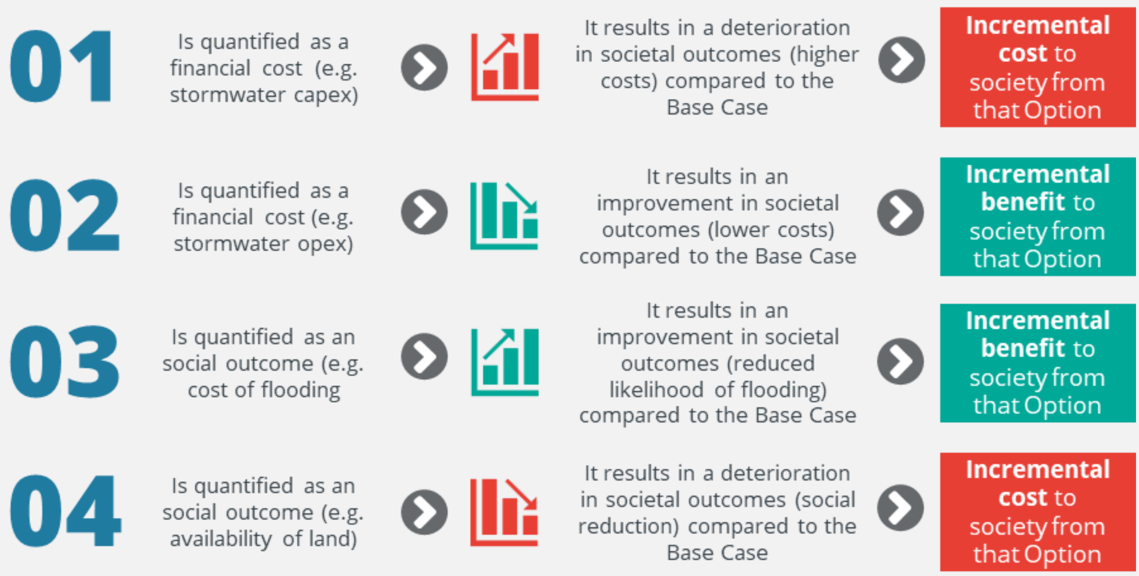
Box 10 provides a simple example of categorising monetised costs and benefits.

Box 10: Investment in WSUD stormwater systems: Simple example of allocation of impacts to cost and benefit categories

Take the example of an investment WSUD systems to provide high amenity and flood-resilience which creates four possible pathways for a given economic, social or environmental outcome. In the example below, compared to the Base Case:

- **Capital costs are an example of #1 (an incremental cost to the community)**, as WSUD is likely to involve additional capital costs, compared to the Base Case.
- **Operating costs are an example of #2 (an incremental cost saving or benefit to the community)**, as this WSUD solution involves reduced operating costs, compared to the Base Case.
- **Cost of flooding is an example of #3 (an incremental improvement in societal outcomes / benefit to the community)**, as the WSUD option is likely to reduce the likelihood of flooding, and therefore, the community cost of flooding.
- **Opportunity cost of land is an example of #4 (an incremental reduction in societal outcomes / cost to the community)**, as the WSUD option requires an increased land footprint (i.e. loss in alternative use of land).

The overall net present value outcome of a given portfolio is determined by the **sum of #2 and #3, less the sum of #1 and #4** (incremental benefits less incremental costs). A net beneficial portfolio is one where the sum of #2 and #3 exceeds the sum of #1 and #4.



Source: Frontier Economics

6.2 Discounting costs and benefits

As discussed below, to compare costs and benefits that occur over different time periods, the costs and benefits must be discounted to current period dollars.

Box 11: Why do we discount costs and benefits?

Discounting means that costs and benefits that occur in the future are given less weight than costs or benefits which occur sooner.

An intuitive justification for discounting is that there is a time value of money: we prefer to receive one dollar today than one dollar in a year's time.

To value a future cost or benefit in today's terms we discount the future cost or benefit using a discount rate, to determine the present value. Present values allow for decisions to be made in the present about initiatives that have different costs and benefits in the future. It also allows for comparisons of interventions that may have a different sequence and/or timeframe of costs and benefits over the same modelling or appraisal period.

Source: Frontier Economics

The Infrastructure SA Impact Analysis Guide to Cost-Benefit Analysis states:

"ISA recommends that appraisal summary results be presented for the following real discount rates:

- *4% per annum (low)*
- ***7% per annum (central case)***
- *10% per annum (high)"*[20]

This discount rate can be different to the Weighted Average Cost of Capital (WACC) of the user. The WACC may be used when the user is undertaking a financial analysis, separate to the CBA.

6.3 Reporting and interpreting the CBA results

The results should be presented in NPV and BCR terms.

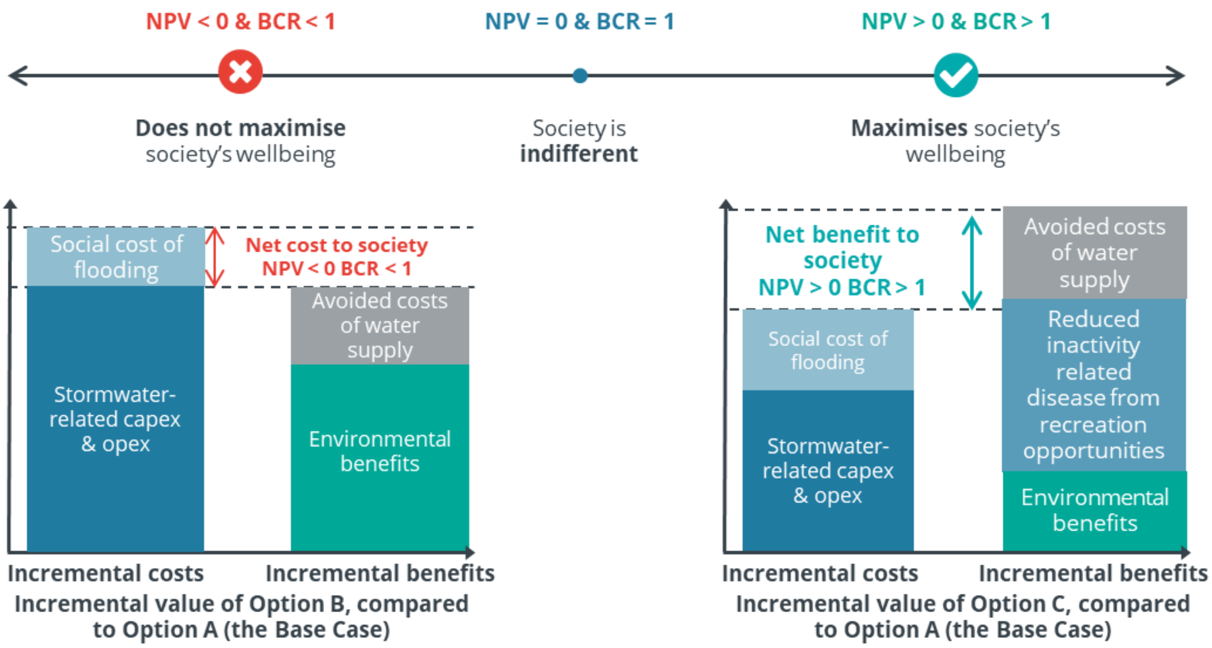
As shown in **Figure 17**, the option with the largest NPV and BCR generates the largest incremental benefit to the community (compared to the Base Case). In particular:

- **NPV > 0 and BCR > 1 indicates that the option results in a net benefit** to the community relative to the Base Case (i.e. incremental benefits of the option exceed incremental costs).
- **NPV = 0 or BCR = 1** indicates that the incremental benefit of the option exactly equal its incremental costs.
- **NPV < 0 and BCR < 1 indicates that the option results in a net cost** to the community relative to the Base Case (i.e. incremental costs of the option exceed incremental benefits).

Both BCR and NPV provide important insights as to the value for money of the options. A BCR provides insights as to the value for money of the options in ***relative*** terms (i.e. for every dollar of costs), whereas NPV provides this insight in absolute terms.

20 Infrastructure South Australia (2022), *ISA Impact Analysis Guide – Cost Benefit Analysis*, p.12.

Figure 17: CBA involves considering which options generate the highest net benefits – an example



Source: Frontier Economics

6.4 Considering qualitative costs and benefits

The quantifiable costs and benefits are the main part of a CBA but in some cases quantification may not be practical. Impacts that cannot be quantified should be accounted for qualitatively.

A list of qualitative factors should be included in the CBA to inform decision makers. This list should also include the anticipated direction of impact and likely significance and presented without subjective formal weightings. Even though these impacts may not be quantified or monetised, the same principles apply relating to establishing a clear causal link from the interventions (inputs and actions) to the products and services provided (intermediate outputs) to the changes in community welfare (economic, social and environment outcomes).

Costs and benefits should be addressed qualitatively where the best available evidence for valuation or monetisation is not reasonably robust or unavailable. That is, a cost or benefit should be considered qualitatively if one or more of the following is **not** possible:

- A thorough literature review has been undertaken that identifies and supports the best valuation, monetisation or benefit transfer methodology possible given the best available data.
- Parameters and techniques from the literature review are able to be used accurately and appropriately in the context of application.
- The key risks and uncertainties in the final results stemming from valuation challenges are clearly communicated and defensible.

Table 10 provides an example of undertaking qualitative analysis for Case Study B. More detail on Case Study B is provided in **Appendix E**.

Table 10: Including qualitative factors in the CBA – an example from Case Study B

Impact	Summary	Likely materiality
Economic costs and benefits		
Governance cost savings	The alternative governance arrangement involves moving responsibility for the planning and provision of some stormwater services from councils to a regional entity. Changing governance arrangements are likely to reduce council's governance / administration costs. However, given information availability on cost savings to local government, we have sought to include this impact qualitatively.	Minor benefit
Additional regulatory burden on ESCOSA	The creation or expansion of an entity is likely to increase the regulatory burden on ESCOSA (given the new or expanded entity is likely to be subject to economic regulation). However, this cost is likely to be minor, compared to the benefits of reform.	Minor cost
Social costs and benefits		
Increased amenity arising from improvements in waterway health:	As the alternative governance arrangement reduces the volume of runoff and pollutant loads, it will improve the health of the ecologically sensitive estuarine environment. Improved health of waterways, increases the likelihood that dwellings will be in close proximity to healthy waterways. Greater proximity to healthy waterways delivers amenity benefits. However, to ensure we avoid double counting with the benefits of improved waterway health, we have included this impact qualitatively.	Minor benefit
Environmental costs and benefits		

Greenhouse emissions	The alternative option involves the treatment and transportation of stormwater for use in stormwater harvesting but reduced potable water demand. The treatment and transportation of stormwater or potable water requires energy (from either renewable or brown energy sources). While this analysis has quantified the change in greenhouse emissions associated with increased treatment and transportation of stormwater, given lack of information regarding the change in energy demand from reduced potable water demand, we have included this impact qualitatively. Depending on whether the increase in energy demand from treatment and transportation of stormwater outweighs the energy demand from treatment and transportation of potable water, greenhouse emissions may increase or decrease.	Unclear impact

Source: Frontier Economics

7 Step #5: Account for key risks and resilience of options in the CBA

Step #5: Accounting for risk and resilience of options – tips and tricks

- **DO** include a form of risk analysis that is proportionate to the size of the project. Sensitivity analysis that varies key assumptions (such cost, timing or discount rate assumptions) may be appropriate for simple CBA, whereas more complex forms such as real options Analysis (ROA) which consider the resilience of the options to these risks may be more appropriate for detailed CBA.
- **DO** consider grouping combinations of risks and uncertainties into a global/book-end *high* and *low*. While it may be unlikely in practice, it can be helpful for decision-makers to understand the best and worst-case outcomes from an option.
- **DON'T** try to include every combination of risks and uncertainties. The focus should be to quantitively address uncertainties which are likely to have the most material impact on the value of the options/investments, and qualitatively including others.

Source: Frontier Economics

7.1 The need to consider key risks and the uncertainty in the CBA results

The result of a CBA is often a single estimate of the difference between benefits and costs. However, the size or level of costs and benefits will be driven by a range of uncertainties. For example, population growth and/or actual capital cost of an investment might be higher or lower than forecast or be incurred earlier or later in the appraisal period. This means that the estimate of the net benefit of certain options may be volatile, and potentially higher or lower than the Base Case.

Some commonly identified risks and uncertainties of stormwater management decisions. These include:

- Population growth and urban design which can influence the timing of investment requirements.
- Future community expectations and/or environmental and health regulation, which drive the cost of complying with regulation (e.g. managing stormwater volumes consistent with environmental regulation).
- Capital and operating cost estimates.
- Climate change impacts on rainfall and consequent flooding risk and water supply availability.
- Discount rates (as discussed above Infrastructure SA guidelines require sensitivity analysis be undertaken on the discount rate).

- Customer willingness to pay (WTP) for social and environmental outcomes, such as WTP to protect waterway health, manage biodiversity or avoid water restrictions.
- Avoidable water costs, which impact the size of the benefits from using stormwater volumes to offset potable water demand.

It isn't possible to analyse all risks nor whether there are opportunities in the design of the options to manage these risks. **The focus should be on quantitatively addressing (see below for techniques) the uncertainties which are likely to have the most material impact on the value of an option**, and qualitatively including other relevant uncertainties.

7.2 Overview of approaches to account for risk

To ensure an accurate comparison of costs and benefits across potential options in a world of uncertainty, robust CBA should include tools for assessing and managing risk. (**Figure 18**).

Figure 18: **Summary of techniques to account for risk**

Sensitivity analysis	Scenario analysis	Expected NPV	Adaptive Pathways / Real options analysis
Estimates how sensitive the value is to assumptions made about some of all key variables	Estimates how sensitive the NPV is to changes in technical, economic, political factors	Estimates the expected NPV of a project by taking account of the likelihood (or risk) of different impacts occurring	Values the benefit of flexible decisions to respond to risk and uncertainty (e.g. the flexibility to defer decision-making until the future is more certain)

← Lower — **Complexity of risk assessment** — Higher →

Source: Frontier Economics

The techniques are briefly discussed below.

7.2.1 Sensitivity analysis

Sensitivity analysis can provide information about how changes in different variables will affect the overall costs and benefits of the project options, as well as the distribution of the costs and benefits. It can be a useful tool to manage the inherent uncertainty over future costs and benefits of project options, particularly for those parameters that may be material to the project evaluation.

The complexity of senility analysis is likely to vary with the detail of the CBA. For example, undertaking sensitivity analysis for:

- a simple CBA could involve between 9 - 27 combinations of sensitivities such as:

- 3 discount rates (i.e. 10%, 7% and 4% consistent with Infrastructure SA guidelines[21]); combined with
- 3 forecast population growth scenarios (i.e., high, medium and low demand); combined with
- 3 forecast lifecycle cost estimates (low, medium and high lifecycle cost estimates).

- a complex CBA is likely to involve more than 27 combinations of sensitivities and/or real-options analysis.

7.2.2 Scenario analysis

Scenario analysis tests how sensitive estimates of net present value are to key technical, economic, political or other uncertainties that could affect the success of a project. Scenario analysis does not involve forecasts, but rather, seeks to describe 'what if' situations that might occur over the medium to long term.

Scenarios usually consist of descriptions of the alternative future environments which differ in crucial respects, usually in terms of significant or 'big picture' factors. For example, this could involve grouping together assumptions into a "worse-case" scenario which represents the lowest value delivered by an alternative option and a "best-case" scenario which represents the upper bound of value delivered by an alternative option. Examples of uncertainties included in a worst-case scenario and best-case scenario are shown in **Table 11**.

Table 11: Assumptions underpinning worst case and best case scenario analysis – an example

Uncertainty	Worst-case	Central estimate	Best-case
Costs	High estimate of costs	Central estimate of costs	Low estimate of costs
Discount rate	10%	7%	4%
Volume of water saved	Lower bound estimate of volume saved	Central estimate of volume saved	Upper bound estimate of volume saved
Value of avoidable potable water costs	Low LRMC	Central estimate	High LRMC
Value of avoidable wastewater costs	Low LRMC	Central estimate	High LRMC

Source: Frontier Economics

21 Infrastructure SA (2022), *ISA Impact Analysis Guide – Cost Benefit Analysis*, p.12.

It should be noted that this is an example only, in practice, whether specific variables form part of the worst-case scenario or best case scenario will depend on the characteristics of the investment. For example:

- If the costs of the project are upfront, while the benefits are spread across time, a low discount rate will increase the value of the alternative option, and therefore form part of the "best case" scenario.
- In contrast, if the costs of the project are spread across time, while the benefits are delivered upfront, a low discount rate will reduce the value of the alternative option, and therefore form part of the "worst case" scenario.

It is best undertaken in conjunction with (or taking into account the assumptions tested in) sensitivity analysis. This is because sensitivity analysis occurs within a particular state of the world whereas scenario planning explores different states of the worlds.

7.2.3 Expected net present value

The performance of options can depend significantly on the likelihood and consequence of events occurring. Where there is reasonable information to support estimates of the likelihood and consequence of key risks or events, incorporating them into the quantification of costs and benefits by calculating the expected net present value (ENPV) (multiplying the likelihood (%) by the consequence ($) of an event occurring) should be undertaken.

That is, estimating ENPV requires the assignment of a probability of occurrence to a defined set of discrete potential events. The ENPV can then be calculated by multiplying the NPV of a given intervention under each event by the estimated probability of the event occurring (and summing the subsequent results).

Probabilities can be 'calculated' or 'backed-out' utilising a range of resources, including historical data, expert opinion or other sources of information. The sources and methodology used for the estimation of probabilities as well as any associated limitations should be clearly documented in the CBA.

The ENPV should be used in situations where costs and benefits are highly dependent on the probability of uncertain events in the future, for example, as part of valuing resilience to flooding. Flooding frequency and severity is an inherently uncertain variable, however historical data can be used to construct probability distributions to inform estimates with respect to flooding frequency (and severity) in a given area for the purposes of calculating costs and benefits. For example, assume a stormwater solution is built in an area that is subject to flooding 10% of the time. As shown in **Figure 19,** the value of this solution will be equal to:

- the likelihood of flooding (10%) multiplied by the NPV of the option under the flood scenario (-$1m) and
- the likelihood of no flooding (90%) multiplied by the NPV of the option under the no flood scenario ($10m)

Figure 19. Expected net present value – an example of flooding

Source: Frontier Economics

Failure to calculate ENPV in situations such as these is likely to inaccurately estimate the value of the options, potentially imposing additional economic, social and environmental costs on the community.

Expected net present value is most useful where:

- **The value of the options depends significantly on uncertainty**. For example, the value of flood resilient stormwater infrastructure depends on the likelihood of a flood.
- **There is no opportunity to respond to the uncertainty** (as would occur in adaptive pathways or real options analysis).

7.2.4 Real options analysis (ROA) or adaptive pathways analysis

Some projects (and their inherent uncertainties) can be managed in a dynamic way in response to new information. This can reduce the likelihood of investment 'regret'.

Where there may be material benefit from deferring the investment decision or pursuing smaller or shorter-lived investments until new information becomes available, ROA can be used as a quantitative tool to value this flexibility. It does this by modelling the prospective cash flows which result from responding to new information in the future (when uncertainty is likely to be resolved) and identifying the pathway that maximises the expected payoff.

Real options analysis or adaptive pathways analysis is most useful for more complex CBA and decision making where there are credible opportunities to alter the inputs or actions over time as new information becomes available.

In the presence of significant risk, standard CBA won't identify the approach that generates the highest benefit-cost ratio, as it assumes a fixed investment strategy that remains unchanged as circumstances change (i.e. it ignores the flexibility to respond to new information and does not account for the fact that achieving the outcomes in practice may be uncertain). If the impact of risks and value of flexibility in decision-making is large, standard CBA will understate the value of the project.

In contrast, ROA or adaptive pathways analysis recognises upfront that:

- there is uncertainty about future outcomes (e.g. demand, community acceptance)
- this uncertainty may be resolved as new information emerges over time

- the investment can, in certain circumstances, be adapted in response to the new information (say investments can be broken down into multiple stages, or where some stages are irreversible
- this flexibility to adjust the investment can be valuable, as it can be used to exploit beneficial outcomes, while avoiding negative outcomes

The steps in undertaking real options analysis involves:

- **Identifying key sources of uncertainty** – uncertainties may be future drought or flooding.
- **Identifying options to respond to that uncertainty** – in the case of flooding, there are likely a range of infrastructure and governance measures that can be implemented to address uncertainty.
- **Building a decision tree that maps the key uncertainties and options** – Given the range of outcomes, incorporating every possible response is likely to be difficult to map, let alone model. Focus should be placed on the most material.
- **Calculating the expected present value of each branch** – this will depend on the NPV of each scenario and the probability of outcomes occurring.

7.3 Identifying the appropriate approach to manage risk and uncertainty

In general, **the approach taken to identifying risk and resilience of the options should be proportionate to the size of the project, key risks and impacts on the community**.

For example, simple sensitivity analysis that varies key assumptions (such as discount rate) may be appropriate for simple CBA. It can be undertaken relatively easily and can provide an indication of whether there are key risks that decision-makers need to consider in interpreting the CBA results.

In contrast, ROA may be more appropriate for detailed CBA where options are subject to a range of key risks and/or there are opportunities to build 'real-options' into the interventions. While the value of flexibility in decision-making should be considered early in the options development stage, real-options analysis can be complex and time consuming to implement and may require specific supporting expertise.

8 Step #6: Identify the distribution of costs and benefits across the community

The final step is to assess the distribution of costs and benefits across the community. This distributional analysis disaggregates the overall impacts of the options in a CBA by key groups of interest (such as beneficiaries) or other categories that are relevant. It is designed to complement the CBA and forms part of the evidence-based presented to decision-makers.

Step #6: Identify the high-level distribution of costs and benefits– tips and tricks

- **DO** consider the distribution of costs and benefits across the broad SA community, rather than just focusing on those who live in a given development or who are the direct recipients of the stormwater management initiative.
- **DO** consider financial payments including the relevant funding arrangements in recovering costs.

Source: Frontier Economics

The distribution of gains and losses across the community is an important aspect of any decision. The success of some decisions can hinge on having a robust understanding of the equity impacts as well as appropriate strategies to manage any equity concerns.

As discussed in **Box 12**, distributional analysis disaggregates the overall impacts of the options in a CBA by groups of beneficiaries and losers – for example, by institutional sector (households, private business and government), geographic areas (LGA, region, State) or other relevant categories. This can be analysed qualitatively or quantitatively and may draw on stakeholder feedback.

The steps involved in undertaking a distributional analysis are outlined in **Box 12** and discussed in more detail in this section.

Importantly, understanding the final distribution of costs and benefits for detailed CBAs projects may require a detailed understanding the approach to funding the investment and any financial impacts i.e. how to developers and/or local governments recover costs related to stormwater infrastructure. This requires complementing this initial analysis around identification of relevant parties with a separate (but related) financial and funding analysis.

Box 12: Steps in distributional analysis

1. Identify the key groups of interest in the relevant community, for example, the local community, developers, and the broader South Australian community.
2. Allocate all costs and benefits identified in the CBA to one or more of these groups and consider any unquantified effects and whether these are likely to impact significantly on any of the identified groups. Allocating infrastructure costs (or cost savings) should have regard to market and/or regulatory funding arrangements.
3. Understand the distribution of costs and benefits across the community. Importantly, the level of detail in the 3rd step is likely to vary depending on the detail of the CBA:
   a. For simple CBAs, a qualitative distributional analysis (that lists the parties and how they benefit) may be sufficient.
   b. For more detailed CBAs, a quantitative distribution (which identifies the size of the costs and benefits borne by each party) may be required.

Source: Frontier Economics

8.1 Identifying the key groups of interest

The first step in distributional analysis is to identify the key groups of interest arising from the costs and benefits identified in the CBA. There are two broad categories of relevant parties:

- **Impactors** – the party that created the need to incur the cost, such as those living and working in a development that create the need for stormwater and flooding management services within that development.
- **Beneficiaries** – the party that benefits from an action, but don't necessarily drive the cost of the service.[22] This may include:
  - direct beneficiaries – those who derive a private benefit from the activity, such as local residents receiving stormwater or flooding management services
  - indirect beneficiaries – those who derive an indirect benefit, such as the broader community which benefits from improved waterway health and/or health outcomes and avoided health costs from enhanced urban amenity and recreation opportunities

Within these two broad categories, relevant parties can also vary across institutions and geographic area. While the exact relevant groups of interest will vary project, depending on the relevant impacts and affected parties identified, examples of relevant parties are outlined in **Figure 20**, such as:

- **Local community** (including residents and businesses).
- **Developers**, for example, those who are responsible for the provision of some stormwater infrastructure.

22 Impactors are often also beneficiaries, but beneficiaries are not exclusively impactors.

- **Local councils,** for example, those who are responsible for maintenance of some stormwater infrastructure.
- **Surrounding councils and broader community,** for example, those that are impacted by stormwater management actions upstream.
- **SA Water and customers,** for example, those who benefit from reduced potable water infrastructure requirements as result of the use of stormwater harvesting.
- **Other communities and organisations**, such as SA Health who benefit from reduced urban heat related healthcare costs.
- **State Government**.

There is no fixed number of parties of interest. In general, more complex investments and those with a larger geographic scope would be expected to have more relevant groups of interest. Distributional analysis doesn't necessarily need to be geographic based, for example, it could be income and demographics, however these categories are typically less relevant for the evaluation of stormwater related initiatives.

Figure 20: **Example of key groups of interest**

Source: Frontier Economics

We note that the dispersed nature of the costs and benefits of stormwater management means it can be challenging to identify, quantify and monetise changes in outcomes. This in turn presents challenges in identifying impacted parties and, ultimately identifying, engaging and ultimately charging these broader 'impactors' or 'beneficiaries' in line with the costs they impose or benefits they receive (see **Box 13**).

Care should be taken to ensure that the distribution of costs and benefits is considered across the broad SA community, rather than just those who live in close proximity to the area.

Box 13: The distribution of costs and benefits

In Greater Adelaide as well as South Australia more broadly, local government is generally responsible for the construction, maintenance and upgrade of stormwater management systems within their jurisdictional boundaries. However, catchment boundaries, and therefore, the benefits of catchment-wide stormwater solutions, do not generally align with council boundaries.

For instance, an intervention may generate substantial overall economic benefit, but impose significant costs on some members of the community (e.g. the cost of stormwater harvesting may be much larger than a traditional BAU approach to stormwater management but provide avoided potable supply benefits to the broader community) and/or significant positive impacts on other members of the community (e.g. improved health of receiving waterways downstream from the development).

Conversely, failure to invest in adequate stormwater services in one region may have immediate, ongoing or future negative spill-over effects for other regions. For example, failure to invest in adequate stormwater infrastructure that then exacerbates the impacts of a flooding event, or the volume of pollution discharged into waterways in one region will likely impact surrounding regions as well.

Consequently, the distribution of costs and benefits, and ultimately, the funding burden for street-scale stormwater infrastructure works is generally borne by the wider community via council rates.

Source: Frontier Economics

8.1.1 Identifying key groups of interest to guide funding decisions and/or transfer payments

There is a well-established funding hierarchy that can be used to inform the potential funding of stormwater related investments. This framework is consistent with the National Water Initiative Pricing Principles and has been used by a range of governments and economic regulators. As shown in Figure 21, under this hierarchy:

- Preferably, the party (or parties) that created the need to incur the cost (the impactor or cost bearers) should pay in the first instance.
- If that is not possible, the party that benefits (the beneficiary) should pay.
- In cases where it is not feasible to charge either impactors or beneficiaries (for example, because of an administrative or legislative impracticality of charging or equity concerns), the government (taxpayers) should pay on behalf of the broader community.

Figure 21: Overview of the funding hierarchy – the role of beneficiaries and impactors

Overview of the funding hierarchy		
Impactor pays *The party that creates the need to incur the cost (the impactor)*	• E.g. those living in a development create the need for stormwater management services.	• E.g. upfront or ongoing **user charges** to fund infrastructure and ongoing service delivery.
Beneficiary pays *The party that derives value from provision of a service (but not necessarily use of that service)*	• E.g. Water users outside the new development benefit from deferred augmentation of the water system as result of using stormwater harvesting to meet water demand.	• E.g. **utilise an 'avoided cost' framework** for stormwater which allows sharing of costs between stormwater customers and the broader water customer base.
Government(s) pay *Government(s) pay on basis of efficiency or equity on behalf of community*	• E.g. Costs of water supply in are shared between users and SA Government	• E.g. **using Government consolidated revenue** to fund infrastructure and ongoing service delivery.

Source: Frontier Economics

Under this hierarchy, costs are recovered from individuals or groups in proportion to their contribution to the need to incur the expenditure or the benefits they receive from the expenditure. In principle, an impactor pays approach is preferred in the first instance, as it promotes efficient decisions by those who create the need to incur the cost.

Practical limitations or equity concerns often mean that a blend of impactor pays, beneficiary pays, and government pays funding is adopted across a range of sectors. For example, government may opt to contribute on behalf of impactors if there is a view that, given equity concerns, impactors are unable to contribute in line with the costs they impose.

Another example is contribution from the broader water and wastewater customer base to new stormwater infrastructure/services in a given development to enable uptake of economically efficient stormwater infrastructure/services which would otherwise not be pursued (as funding from stormwater customers alone is not sufficient).

8.2 Allocating impacts to groups

Following identifying the relevant groups of interest, costs and benefits should be allocated to these groups. Some costs and benefits can be easily allocated to an individual group while others need some thinking to split between multiple groups.

- Direct costs and benefits, including the costs of dedicated assets and activities/operations and the benefits that flow from these, can relatively easily be allocated to specific group. The key principle is to ensure there is a clear identification of the characteristics of the cost/benefit item that associate it uniquely with a particular group. For example, visitors to a naturalised stormwater channel and local park benefit from this provision.
- Common costs and benefits are incurred in the supply of more than one service or to more than one group but may not easily be attributed to any single service or customer. For example, air quality benefits impacted by green infrastructure investments are not easily attributable to any specific development or to any specific customer.

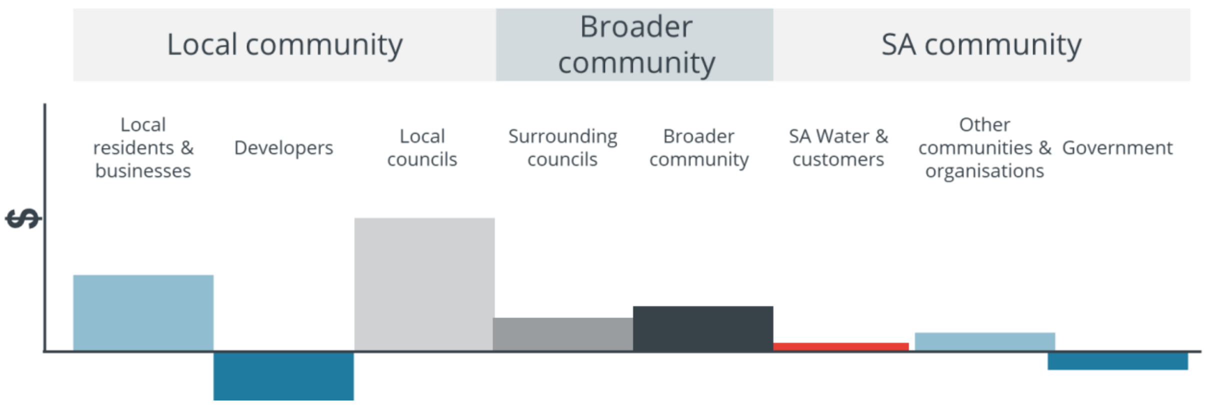
In some cases, allocating costs and benefits for detailed CBAs requires understanding the ultimate approach to funding the investment. This requires complementing this initial distributional analysis with a separate (but related) financial and funding analysis (which is not the subject of this CBA framework).

8.3 Understanding the high-level distribution of costs and benefits across the community

The final step in the distributional analysis is to identify and report on the distribution of costs and benefits across the community, based on the allocation of costs and benefits. As discussed above, the detail of the distributional analysis is likely to vary depending on the detail of the CBA:

- **Simple CBA** – is likely to involve a qualitative distributional analysis (which lists the groups and discusses how they benefit). For example, the beneficiaries of an investment in stormwater harvesting that reduces potable water demand are SA Water customers.
- **Detailed CBA** – is likely to involve a quantitative distributional analysis, which estimates the size of the costs and benefits borne by each group of interest and calculates the ultimate distribution across the community (as shown in the indicative example in **Figure 22**). For example:
  - the surrounding communities benefit from the naturalisation of an existing stormwater channel (its assumed visitors come from the surrounding community)
  - SA community benefits from the health benefits of reduced urban heat arising from the presence of water in the landscape and passively irrigated tree canopy
  - local community gains open space benefit from improved irrigation of open space enabled by using stormwater harvesting (i.e. ability to irrigate even during periods of restrictions)

Figure 22: **Quantitative distribution of costs and benefits across the community – an example**



Source: Frontier Economics

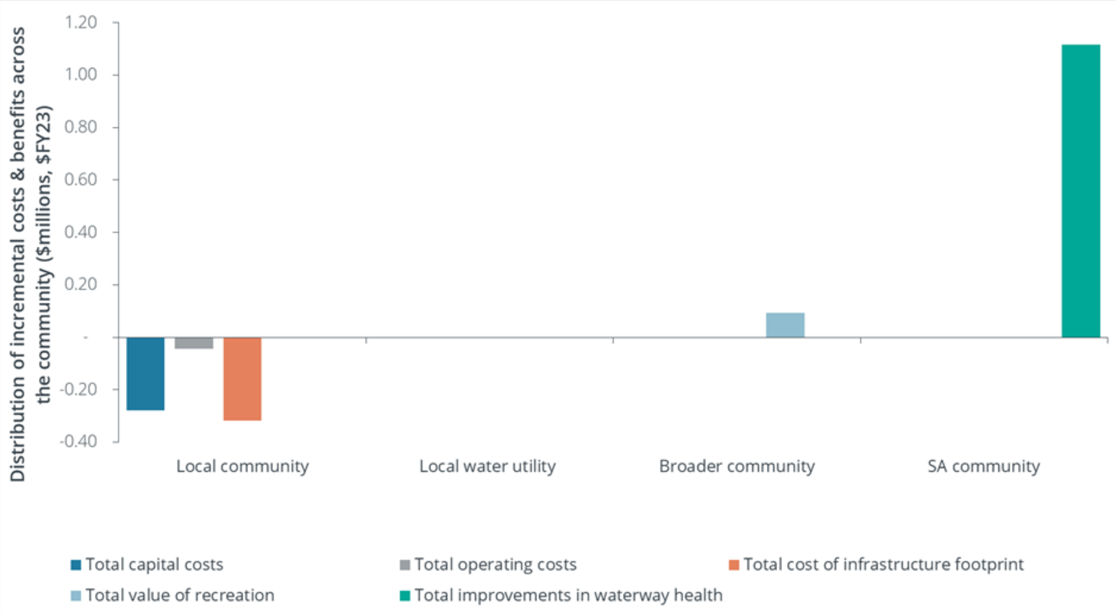
Application of the Framework – Case Study A: Identifying the Distribution of Costs and Benefits

As Option 1 is the preferred option from a CBA perspective (i.e. the option that delivers the greatest next benefit to the community) this analysis has focused on the distribution of the incremental costs and benefits of Option 1, compared to the Base Case.

The indicative distributional analysis captured in **Figure 64** illustrates that:

- the majority of the benefits (in the form of improved waterway health) are received by the broader community, while
- the majority of the costs associated with the provision of stormwater infrastructure (including capital and operating costs and the cost of the infrastructure footprint) are borne by the local community given the funding arrangements for this infrastructure.[23]

This suggests that there may be a role for co-funding from the SA community in line with the benefits they receive.



Source: Frontier Economics; Alluvium

More detail on Case Study A is provided in **Appendix E**.

23 Noting financial transfers between entities within South Australia should be included in distributional analysis, but not in CBA results.

A Glossary of key terms and concepts

Table 12: Glossary

Term	Definition
Analysis period	Time period over which a project or initiative is assessed, i.e. the period for which costs and benefits are estimated.
Alternative options	Alternative regulatory, project, policy or program proposals (i.e. compared to the Base Case).
Avoidable costs	The cost a business would avoid over the long run if it no longer provided a defined service.
Base Case	The project or initiative which alternative options are compared with, which shows the baseline projections of costs and benefits 'without' the alternative options. Depending on the objective of the project, the Base Case may represent do nothing or do minimal.
Benefits	Any improvements in economic, social or environmental outcomes as a result of the alternative options.
Benefit Cost Ratio	The ratio of the present value of any incremental economic, social and environmental benefits to the present value of any incremental economic, social and environmental costs.
Cost Benefit Analysis	CBA provides a holistic community or societal approach to investment decision-making. It compares a range of benefits and costs that accrue to the SA community—converted to a single discounted metric using the social discount. CBA is the preferred approach for all business cases.
Cost Effectiveness Analysis	Aims to identify the option that achieve specified outcome(s) at least cost.
Contingent valuation	A survey method to place a value on a non-market good, contingent on it being available. Willingness to pay for (or willingness to accept payment for damage to or reduction of) a good or service is treated as a proxy of the value of the good or service.
Costs	Any deterioration in economic, social or environmental outcomes as a result of the alternative options.
Distributional analysis	Identification of how the costs and benefits are distributed across the community. It can be qualitative or quantitative depending on the detail of the CBA.

Term	Definition
Discount rate	The rate used to convert future streams of costs and benefits into today's dollar value (present value).
Financial Appraisal	Appraisal of the cash flows of a project or program.
Liveability	The extent to which a place meets the social, environmental and economic needs of its inhabitants.
Long-run marginal cost	The cost of meeting an incremental change in demand assuming all factors of production can be varied.
Net present value	The difference between the present value of any incremental economic, social and environmental costs and the present value of any incremental economic, social and environmental benefits.
Non-market benefits	Benefits conferred on parties outside of the market (e.g. cleaner waterways, healthier communities, reduced ocean outfall discharges and liveability).
Non-potable water	Water that has not been treated such that it is safe for drinking, but may still be used for other purposes.
Postage stamp pricing	A system of pricing where customers are charged the same price for the service across a defined area regardless of differences in cost of supplying water and/or wastewater services to customers in different locations on the network.
Transfers	Where the benefits to one group are offset by costs to other groups (i.e., no change in use of economic resources).
Willingness to pay	The maximum price at or below which a consumer will buy one unit of a product or service.

Source: Frontier Economics

Table 13: Acronyms

Acronym	Definition
ACCU	Australian Carbon Credit Unit
BCR	Benefit Cost Ratio
CBA	Cost Benefit Analysis
CEA	Cost Effectiveness Analysis
CO_2	Carbon Dioxide
DALY	Disability-Adjusted Life Year
DEW	Department of Environment and Water (South Australia)
DTF	Department of Treasury and Finance (South Australia)
ENPV	Expected Net Present Value
IWCM	Integrated Water Cycle Management
KL	Kilolitre
LGA	Local Government Area
LRMC	Long-Run Marginal Cost
MWh	Megawatt-hour
NPV	Net Present Value
ROA	Real Options Analysis
SA	South Australia
WACC	Weighted Average Cost of Capital
WSUD	Water Sensitive Urban Design
WTP	Willingness to Pay
YLD	Years Lived with Disability
YLL	Years of Life Lost

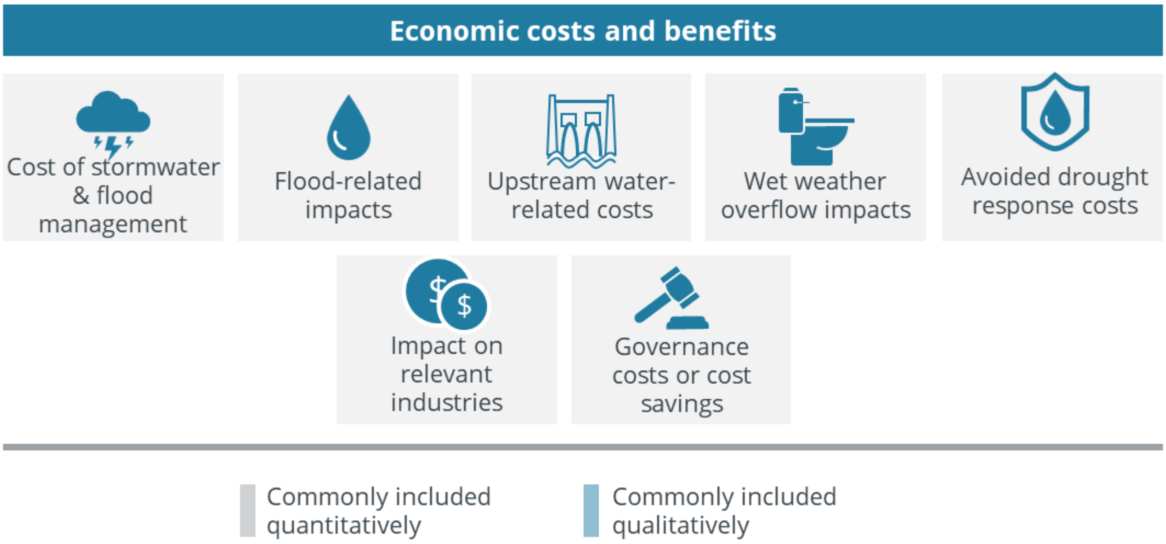
Source: Frontier Economics

B Approaches to valuing key economic costs and benefits

This section provides further detail on the approach to valuing key economic costs and benefits of stormwater decisions. As shown in **Figure 23**, these include:

- The cost of stormwater and flood management.
- Flood-related impacts (i.e. the costs incurred in the event of a flood).
- Upstream water-related costs and avoidable costs (bulk and non-bulk water).
- Wet weather overflow impacts.
- Avoided cost of a drought response.
- Impact on industries that rely on healthy watercourses and coasts.
- Governance costs, or cost savings.

Figure 23: Overview of key economic costs and benefits



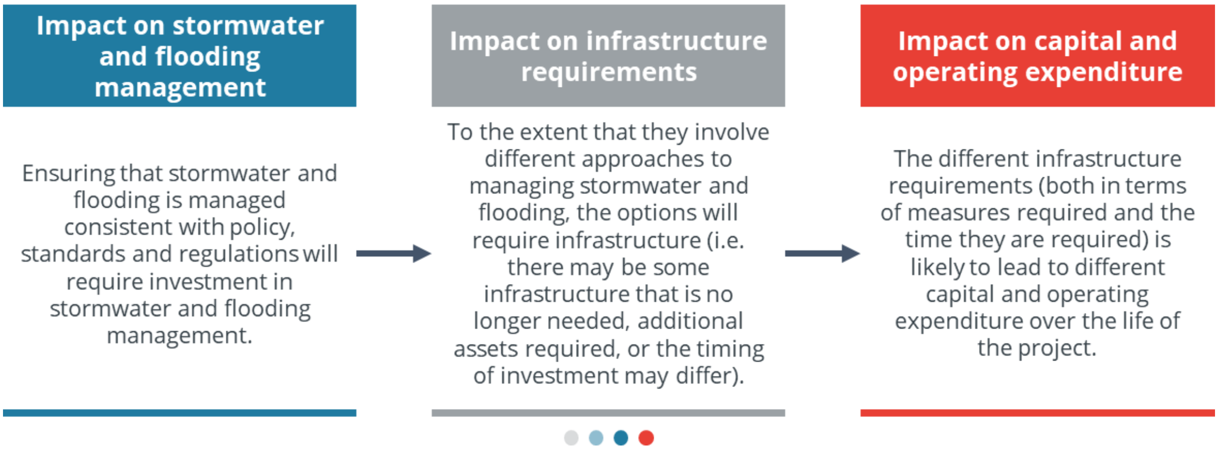
Source: Frontier Economics

The methodology to value each cost and benefit is discussed below.

Approach to valuing the cost of stormwater and flood management

Different approaches to stormwater and flood management will have a different profile of capital and operating expenditure, driven by differences in the timing and type of infrastructure or service delivered (see **Figure 24**). For example, a concrete channel may involve comparatively large capital expenditure, but relatively low operating expenditure. In contrast, naturalised stormwater channels may have much higher ongoing expenditure (associated with the ongoing maintenance of the blue and green infrastructure).

Figure 24: Link between stormwater and flooding management and capital and operating expenditure



Source: Frontier Economics

The costs of stormwater and flood management should reflect the costs required to deliver services consistent with standards or obligations. As shown in **Figure 25**, the costs of stormwater solutions can include:

- **Capital costs:** includes costs associated with planning (research, concept and design etc) and non–recurring manufacturing, construction or purchase and installation costs.
- **Operation and maintenance:** includes ongoing operation and maintenance of equipment and facilities, such as energy, chemicals, routine maintenance, major programmed maintenance and breakdown maintenance.
- **Replacement, renewal, disposal and/or upgrade costs.**
- **Residual or salvage value:** includes the value of the asset at the completion of the lifecycle or the period of analysis (see **Box 14**).[24]

Figure 25: **Valuing the costs of stormwater management**

Source: Frontier Economics

24 Adapted from Government of Western Australia, Department of Sport and Recreation, 2005. "Life Cycle Cost Guidelines: Sport and Recreation Facilities". P. 21 Available at: https://www.dlgsc.wa.gov.au/docs/default-source/sport-and-recreation/life-cycle-cost-guidelines.pdf?sfvrsn=b90a3037_1

Box 14: Calculating residual value

Residual value must be estimated whenever the project life is:

- shorter than the asset's useful life and the business intends to dispose of the asset; or
- greater than the appraisal period and a residual / terminal value needs to be included in the final year of the appraisal, in recognition that the asset provides value beyond the modelling period.

The residual value of an asset can be based on its value in place or its resale or scrap value less the costs of disposal (which can include expenses such as disassembly and removal, recycling or safe disposal, and/or site remediation).

Source: Frontier Economics adapted from NSW Treasury

Importantly, in cases where the CBA evaluates the costs and benefits of changes to stormwater governance arrangements, care must be taken to avoid double counting between:

- Valuing the cost of stormwater management (i.e. the infrastructure solution), which may include cost savings associated with a more efficient approach to providing stormwater services on a large scale.[25]
- Valuing the governance costs of stormwater management, such as the administration costs associated with expanding an existing entity's role.

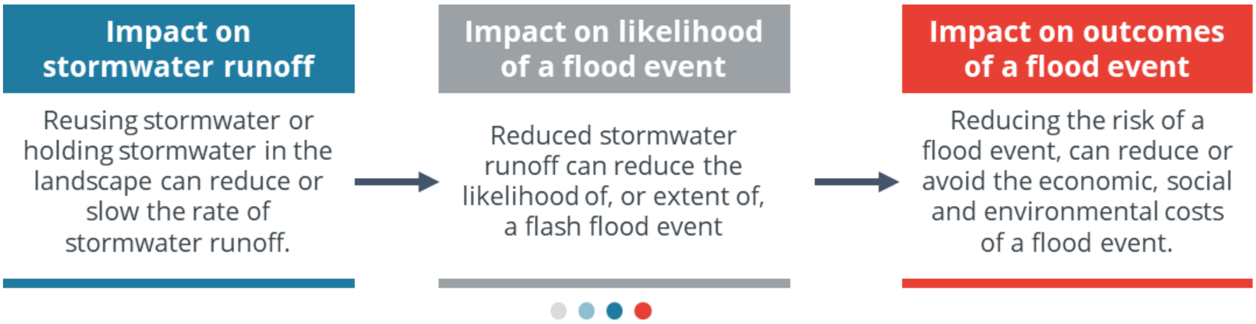
Approach to valuing flood-related impacts

While all options should ensure that the standards around the likelihood of flooding are met, alternative approaches to stormwater and flood management can lead to differences in the likelihood of flooding (e.g. reduce the likelihood below the minimum standard).

For example, as shown in **Figure 26**, interventions that reduce the volume, or slow the rate, of stormwater runoff can reduce the likelihood of a flood event. This in turn can reduce the likelihood of, or extent of, incurring the economic, social and environmental costs of a flood event. As shown in **Box 15**, these costs can include the cost of rebuilding after a flood event or the social cost of a cancelled event.

[25] In some cases, councils may only pursue smaller scale (often more expensive) stormwater works that can be completed and managed within their own jurisdiction. Larger scale works that cross LGA borders could be the superior solution, but these are often not considered.

Figure 26: The link between stormwater and flood management and flood-related impacts



Source: Frontier Economics

In other words, the benefit of options that reduce the risk of flooding is the value of reducing the likelihood (L), or extent of (Q), these economic, social and environmental outcomes.

Box 15: Potential costs of a flood event

The cost of a flood event will depend on the location and duration of the flood event, but possible economic, social and environmental costs can include:

- costs of rebuilding infrastructure after a flood event
- costs of disruption to planned events, such as schooling (if a school is flooded)
- costs of additional travel time and associated productivity impacts, if the community is forced to travel further to avoid the flood event
- mental health costs and reduced social cohesion from the flood
- environmental costs associated with polluted runoff
- additional cost of landfill to dispose of material damaged during the flood
- additional greenhouse emissions associated with additional travel time

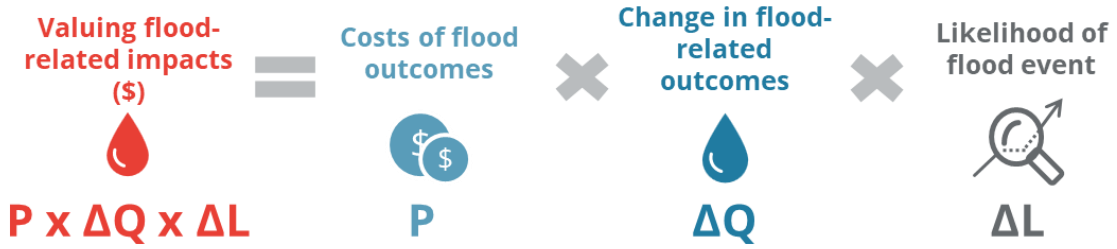
The benefit of options that reduce the risk of flooding is the **value of reducing the likelihood, or extent** of, these economic, social and environmental outcomes.

Source: Frontier Economics

As shown in **Figure 27**, at a high level, the cost of a flood event can be estimated by multiplying together:

- the cost of the relevant flood outcome, for example, the cost of rebuilding infrastructure after a flood (see **Box 15** for other examples) (**'P'**)
- the change in flood-related outcomes, for example, if a smaller number of playing fields or streets are affected after a flood event **('ΔQ')**
- the change in the likelihood of the flood event **('ΔL')**

Figure 27: Valuing flood-related impacts



Source: Frontier Economics

Importantly, the final methodology for valuing the costs of flooding will depend on the relevant costs of the flood event, which in turn, depends on the characteristics of the affected area. For example, if the affected area includes a school, likely costs could include:

- the cost of missed schooling during and immediately after a flood event (i.e. before alternative education arrangements have been organised)
- the cost of additional travel time associated with moving students to an alternative school
- the additional greenhouse emissions associated with additional travel time

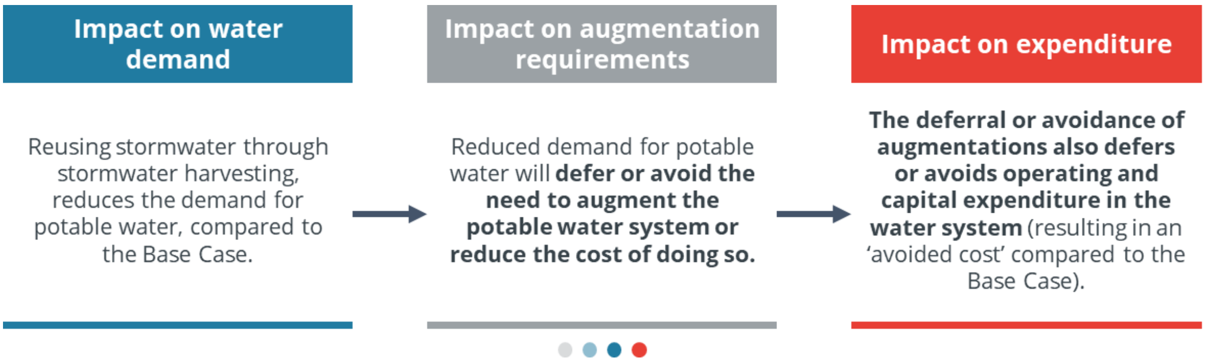
Approach to valuing upstream water-related avoidable costs

Differences in the approach to stormwater management can lead to differences in the costs of water-related services beyond those directly incurred to service specific developments in a given region of South Australia.

For example, as shown in **Figure 28**, the use of rainwater tanks or stormwater harvesting can reduce the demand for water from the potable water system. In turn, this can defer or avoid the need to augment and/or operate key water supply assets that would otherwise be required to meet growth in water demand.

The deferral of this expenditure represents an economic cost saving for the community (an 'avoidable cost' benefit) relative to a Base Case.

Figure 28: The link between stormwater management approaches to upstream water costs

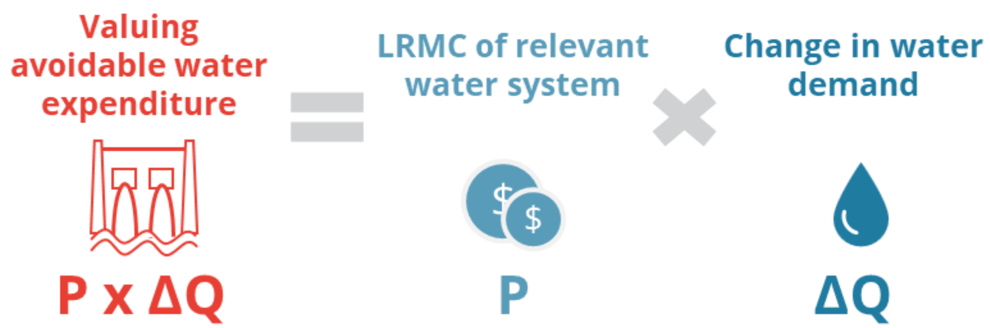


Source: Frontier Economics

As shown in **Figure 29**, the present value of this upstream water cost savings can be calculated by can be calculated by multiplying together:

- the Long Run Marginal Cost (LRMC) of water supply **('P')** (ideally covering bulk and the appropriate non-bulk water supply)
- the change in water demand **('ΔQ')** over the modelling period

Figure 29: Valuing avoided bulk and non-bulk water expenditure

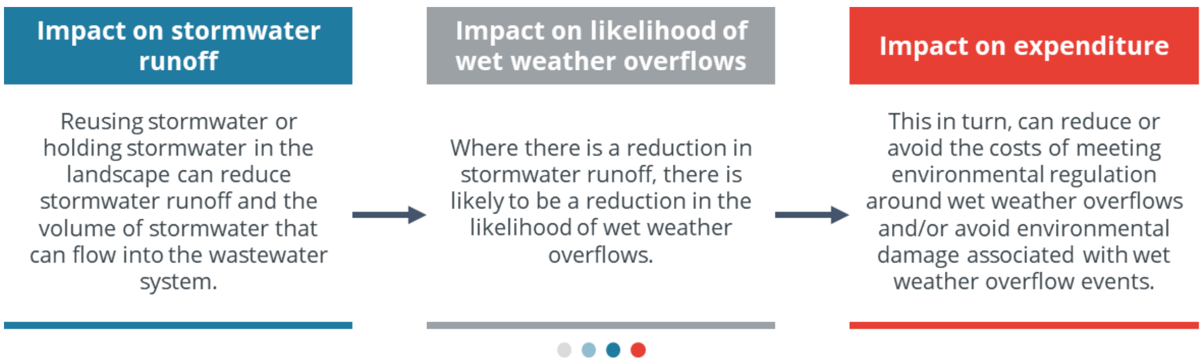


Source: Frontier Economics

Approach to valuing wet weather overflow impacts

Different approaches to the management of stormwater and flood can lead to differences in the likelihood and cost of, managing wet weather overflows. For example, as shown in **Figure 30**, the use of stormwater harvesting or measures that hold stormwater in the landscape can reduce stormwater runoff, including the volume of stormwater that can flow into the wastewater network. This can reduce the likelihood of wet weather overflows and in turn, reduce or avoid the costs to SA Water of meeting environmental regulation around wet weather overflows and/or avoid environmental damage associated with wet weather overflow events.

Figure 30: **The link between stormwater and flooding management and wet weather overflows**



Source: Frontier Economics

In practice, the environmental cost of wet weather overflow events may be relatively minor as wastewater systems are designed to meet environmental standards around the likelihood of wet weather overflows. As such, the methodology below focuses on valuing changes in the cost of meeting regulation around wet weather overflows (i.e. a comparison of the economic costs), rather than the environmental cost.

As shown in **Figure 31**, changes in the cost of meeting regulation around wet weather overflows can be calculated by comparing:

- the present value of the cost of meeting regulation around wet weather overflows under the Base Case
- the present value of the meeting regulation around wet weather overflows under the alternative options

Figure 31: **Valuing the costs of meeting regulation around wet weather overflows**

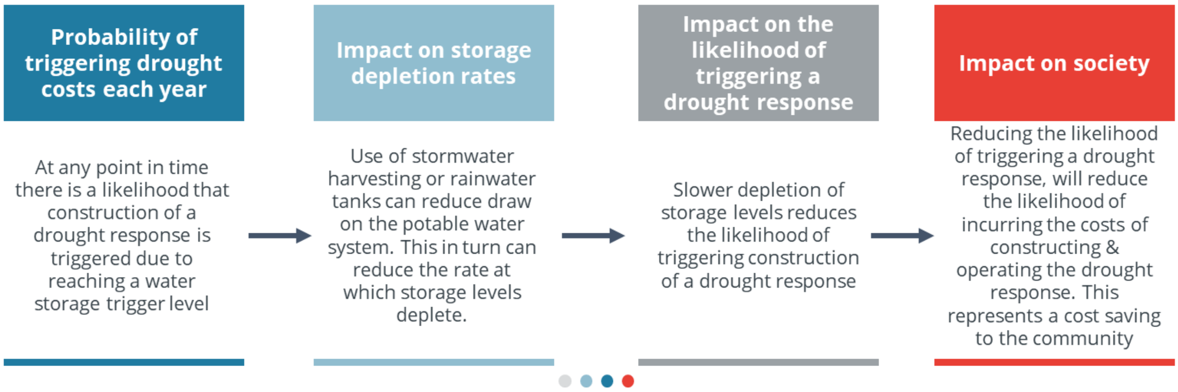
Source: Frontier Economics

Approach to valuing avoided costs of a drought response

In the event of drought, it may be necessary to bring additional measures online as part of a drought management plan to ensure that the local water utility can continue to meet its level of service. The cost of this measure will depend on the relevant drought response plan and could include the cost of construction a drought response desalination, a new pipeline and/or the cost of carting water. CBA should account for the additional operating and capital expenditure associated with these measures.

There is some likelihood of drought conditions occurring—and thus drought response measures being required—in any particular year. Water security planning ensures that all options meet the LOS system reliability criteria (i.e. frequency and duration of water restrictions, likelihood of a shortfall etc) however stormwater management options that involve the reuse of stormwater or rainwater can result in lower likelihoods of triggering a drought response, driven by differences in the depletion rate of the storages. In other words, as shown in **Figure 32**, some stormwater management options can avoid the costs of a drought response by reducing the rate at which storages deplete.

Figure 32: The link between stormwater reuse and avoided costs of a drought response

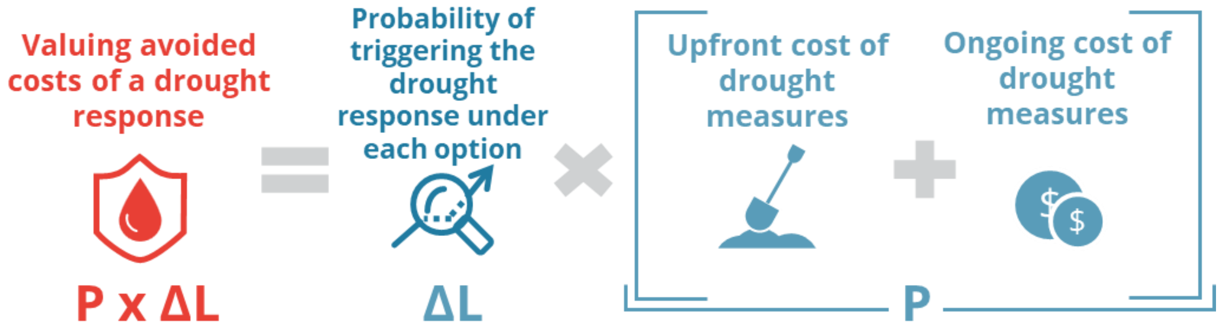


Source: Frontier Economics

As shown in **Figure 33**, the value of avoided costs of a drought response can be estimated by multiplying together:

- the change in probability of triggering the drought response under each option (**ΔL**)
- the cost of the drought response measure, including the construction costs and operating costs (**P**)

Figure 33: **Valuing avoided costs of a drought response**

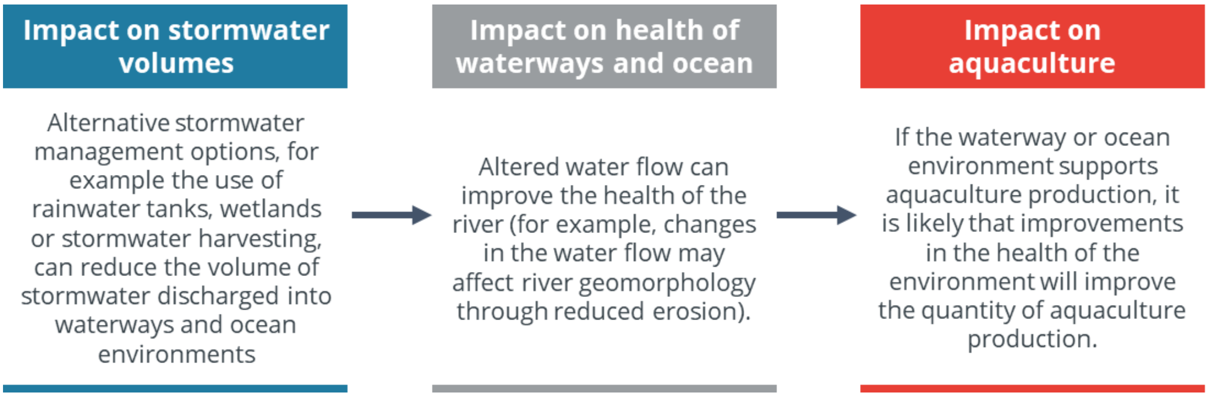


Source: Frontier Economics

Approach to valuing the impact on industries that rely on healthy watercourses and coast

Alternative approaches to stormwater and flood management can have a significant impact on the health of the receiving waters, including waterways and coastal environments. For example, as shown in **Figure 34**, stormwater harvesting can reduce the volume of stormwater discharged into coastal environments. This change can lead to improvements in ocean health, and increased production of industries that rely on healthy waterways and coasts.

Figure 34: **The link between stormwater management and aquaculture production**



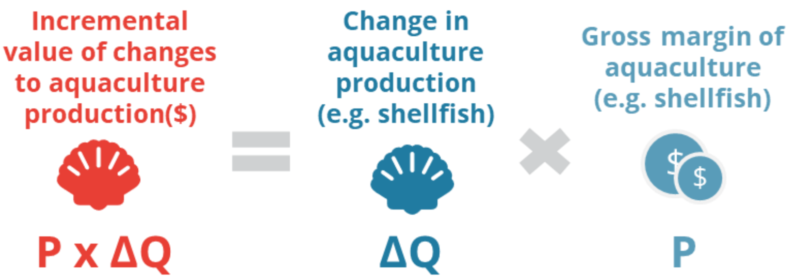
Source: Frontier Economics

As shown in **Figure 35**, the value of changes to aquaculture can be calculated multiplying together:

- the estimated change in aquaculture production, for example, production of shellfish (**ΔQ**)
- the relevant gross margin, for example the gross margin of shellfish (including considering the appropriate producer surplus) (**P**)

We then compare the present value of this impact under each of the options to identify the extent to which there are incremental costs or benefits (i.e. compared to the Base Case).

Figure 35: **Valuing the impact on industries that rely on healthy watercourses and coast**



Source: Frontier Economics

Approach to valuing governance costs, or cost savings

As shown in **Figure 36**, alternative approaches to the governance of stormwater (for example, where responsibility for the planning and provision of <u>some</u> aspects of stormwater and flood management are moved from councils to another entity) are likely to be associated with a range of additional governance-related costs and cost savings. These can include:

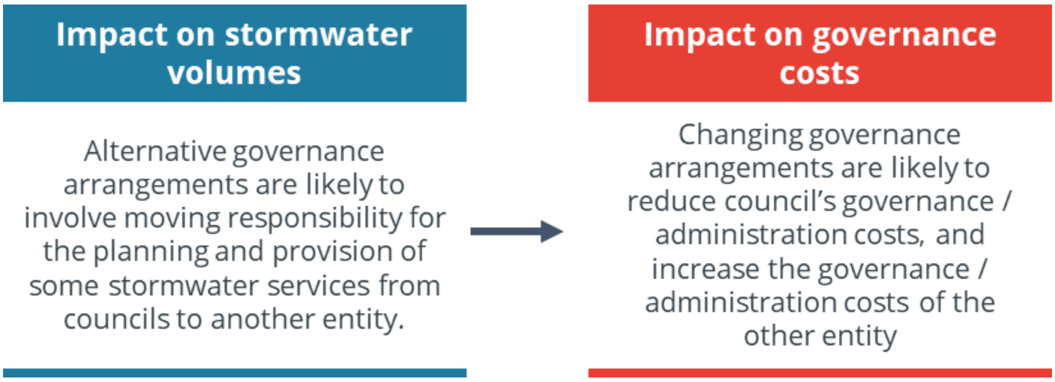
- Upfront costs of setting up a new agency, or expanding an existing agency's, role to manage stormwater on a regional scale.
- Ongoing costs of running the regional stormwater agency.
- Cost savings associated with council administration – The reallocation of responsibilities from councils to a regional entity could reduce the council-related administration costs (including

coordination between councils). This could partially offset the additional governance cost arising from the creation or expansion of a regional entity. This is likely to be minor.

- Additional regulatory burden on ESCOSA – the creation or expansion of an entity is likely to increase the regulatory burden on ESCOA (given the new or expended entity is likely to be subject to economic regulation. However, this cost is likely to be minor.

Importantly, there is still likely to be a role for councils in stormwater and flood management even under alternative stormwater governance arrangements. This could include retaining responsibility to provide and/or maintain smaller-scale infrastructure.

Figure 36: The link between alternative governance arrangements and governance costs or cost savings

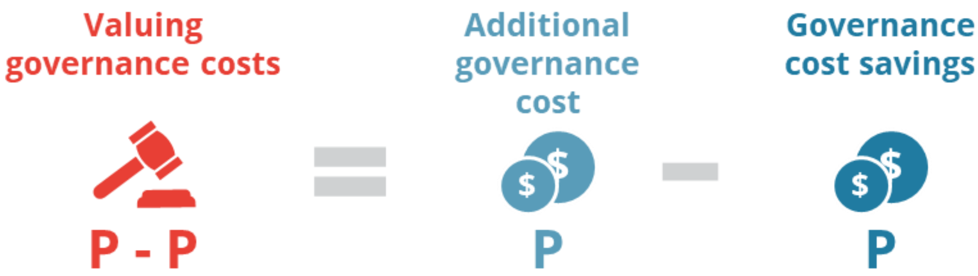


Source: Frontier Economics

As shown in **Figure 37**, the present value of these governance costs or cost savings can be calculated the difference in:

- the additional governance costs, such as the costs of establishing and running a new entity responsible for planning and delivering stormwater services on a regional scale
- any governance-related cost savings, such as cost savings associated with council administration

Figure 37: Valuing governance costs



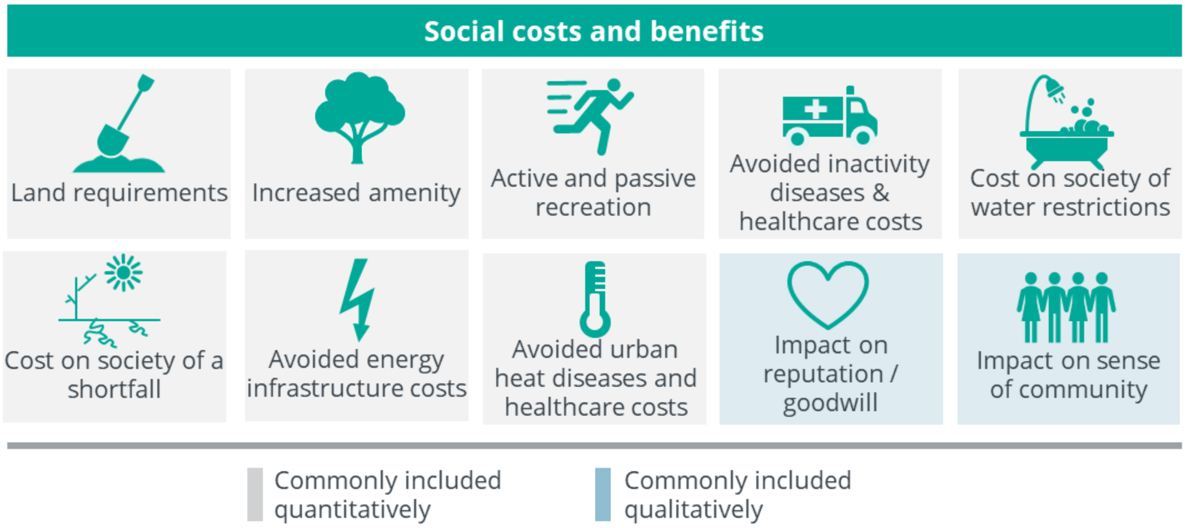
Source: Frontier Economics

C Approaches to valuing key social costs and benefits

This section provides further detail on the approach to valuing key social costs and benefits of stormwater decisions. As shown in **Figure 38**, these include:

- Land requirements (opportunity cost of land).
- Increased amenity from proximity to healthy waterways or open space.
- Active and passive recreation (including water-based recreation).
- Avoided inactivity related diseases and healthcare costs (from increased active recreation).
- Cost on society of water restrictions.
- Avoided energy distribution and generation infrastructure costs (from urban cooling).
- Avoided urban heat related diseases and healthcare costs (from urban cooling).
- Impact on reputation/goodwill.
- Impact on sense of community.

Figure 38: Overview of key social costs and benefits



Source: Frontier Economics

The methodologies to value key costs and benefits are discussed below.

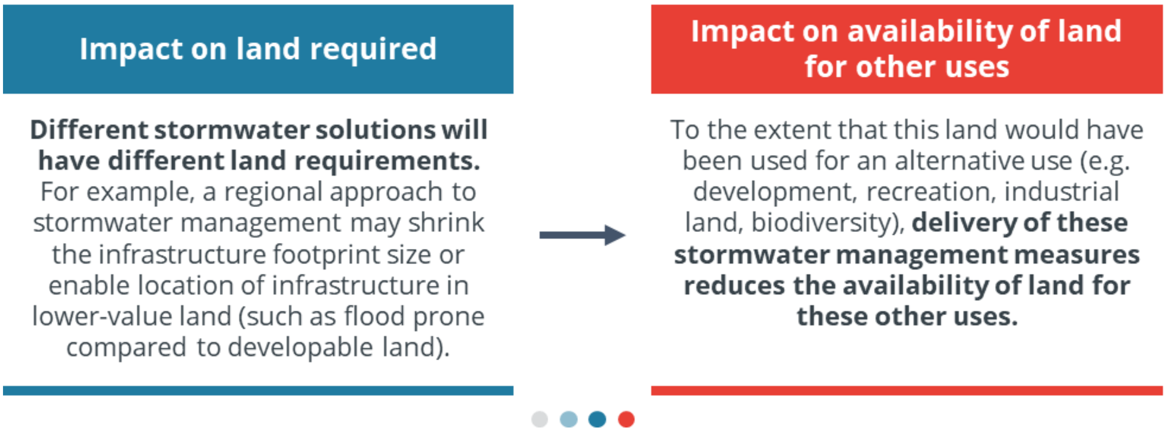
In the case of the impact of reputation and goodwill and impact of sense of community, given lack of information around the incremental change in reputation and sense of community arising from stormwater-related decisions, these impacts are typically included qualitatively.

Approach to valuing land requirements (opportunity cost of land)

As shown in **Figure 39**, differences in the approach to stormwater management can lead to differences in the amount and/or location of land required to deliver the stormwater management solution. For example, a development-by development approach to location and sizing of stormwater quality and quantity infrastructure may not allow to optimal sizing or location of systems within the broader catchment, resulting in a larger land footprint for these assets, than under a regional planning approach.

In some cases, the alternative option may not change the amount of land required but will change the location of the land (e.g. moving infrastructure from higher-value developable land to flood prone land). This movement in the location of land still represents a change in community outcomes that should be included in the CBA.

Figure 39: **The link between stormwater management and land requirements**

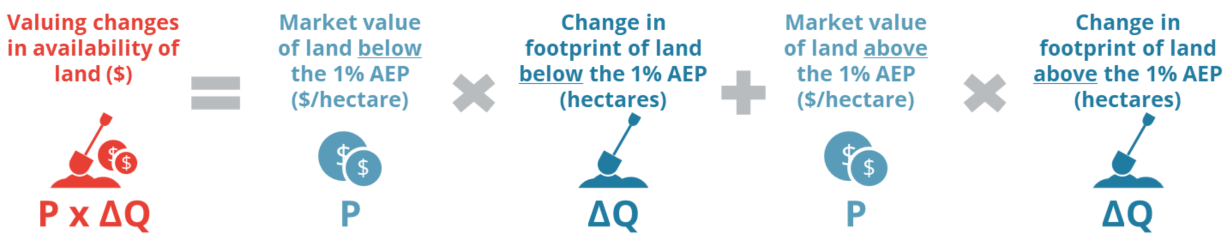


Source: Frontier Economics

As shown in **Figure 40**, the present value of the change in the availability of land (or land footprint) can be calculated by multiplying together:

- the appropriate price per hectare of land (**'P'**). As discussed in more detail in **Box 16**, in some cases such as valuing lost industrial use (where there is unlikely to be market failure) the cost of land acquisition represents an appropriate proxy for the opportunity cost of land. This value can generally be taken from the SA Valuer Generals database.
- the change in available land in hectares ('**ΔQ**') over the modelling period

Figure 40: **Valuing changes in the land footprint**



Source: Frontier Economics

The calculation above should be repeated for each location of land, as developable land will have a different price than land located in the flood plain.

Box 16: When it is appropriate to value the opportunity cost of land using the cost of land acquisition?

As discussed above, an economic appraisal is concerned with the change in real resource outcomes, rather than financial transfers between parties (i.e. the 'size of the pie', rather than how it's shared between parties). [26]

As such, including land acquisition as a cost to the utility or government agency as part of an economic appraisal is not appropriate as it is not an economic cost (i.e. a change in real resource outcomes), rather it is a transfer between two parties. For example, for land acquisition of $18m the utility acquiring the land incurs a cost of $18m and the landholder receives a benefit of $18m, leaving society as a whole unchanged.

However, if the use of that land changes under different options (regardless of whether the utility needs to acquire the land or not) there is a change in real resource outcomes to the community, and thus a relevant impact to include as part of an economic appraisal. For example, construction of wetlands may require acquiring land (a transfer) but also reduces the amount land available for other uses, such as development or industrial use (a change in real resource outcomes). This change in resource outcomes (or opportunity cost) is "*the value foregone by society from using a resource in its next best alternative use [and] reflects market prices where there is an absence of market failure*". [27]

The most appropriate proxy for the opportunity cost of land will vary depending on the specific project circumstances and alternative land-use. In some cases (i.e. in the absence of market failure), the market value (e.g. the cost of land acquisition excluding taxes) may be an appropriate proxy for the opportunity cost of land, as the cost of land acquisition may accurately represent the change in real resource outcomes. However, in other cases, such as valuing lost biodiversity, using the land acquisition is unlikely to be appropriate proxy as it does not capture the community's willingness to pay to protect biodiversity. In cases such as these, a robust Willingness to Pay (WTP) survey is likely to better represent the change in real resource outcomes. We note that land acquisition and WTP values should only be added together where there is a clear gap in the land acquisition value and a good proxy WTP to minimise the risk of double counting.

Importantly even in cases where land acquisition is an appropriate proxy, the **economic appraisal is valuing changes in land use, rather than changes to the utility's cash flow.**

Source: Frontier Economics

Approach to valuing increased amenity from proximity to healthy waterways or open space

As shown in **Figure 41**, different stormwater decisions can lead to amenity benefits for those living and working in the area. For example:

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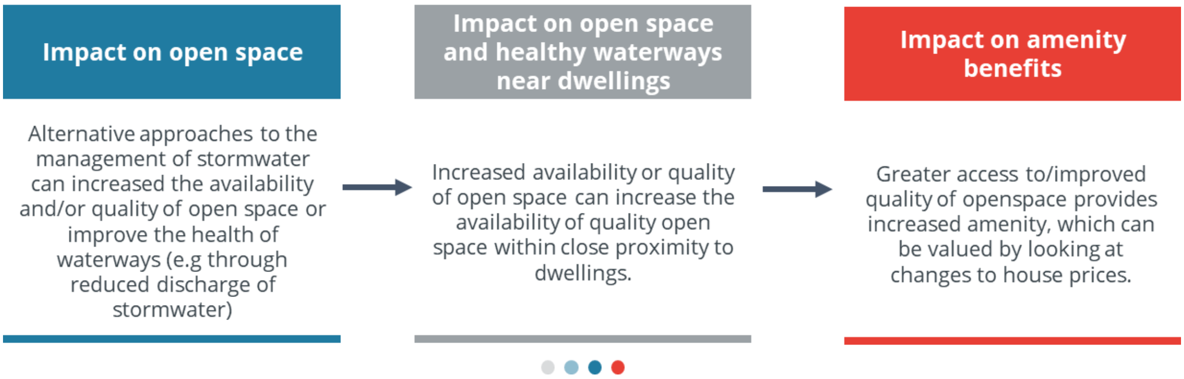
26 Transfers between parties are relevant for distributional analysis and financial appraisal.

27 NSW Government Transport for NSW, Transport for NSW Cost-Benefit Analysis Guide, p. 38.

- Naturalisation of a stormwater channel in an existing development can lead to increased pockets of open space (for example a cycle path alongside the naturalised channel). If there are dwellings located within proximity of this open space, the increased availability of open space can lead to amenity benefits for those living in the area.
- The creation of stormwater wetlands or the use of stormwater harvesting can reduce the volume of stormwater discharged to receiving waterways, leading to improvements in waterway health. If there are dwellings located within proximity of this waterway, the improvement in waterway health can lead to amenity benefits for those living in the area.

Figure 41: The link between stormwater management and amenity



Source: Frontier Economics

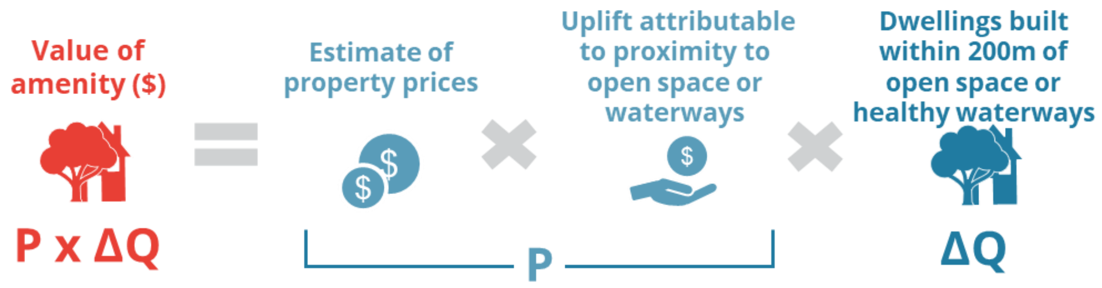
Various studies have investigated the relationship between property uplift and proximity to improvements in local environment such as accessible open space or healthy waterways that provides significant urban amenity.

This form of 'hedonic pricing' uses statistical techniques to isolate the contribution to the value of the property that is made by specific environmental characteristics, which in turn, can be used to estimate the value of the amenity impact. The uplift in the prices of properties within close proximity to accessible open space or healthy waterways, relative to those that are not, reflects an estimate of the amenity value that the community places on this space.

As shown in **Figure 42**, the total amenity value that the community attaches to this amenity can be estimated by multiplying together:

- an estimate of property prices in the area (this will vary depending on dwelling type) **('P')**. We recommend separately calculating the uplift for low, medium and high-density dwellings
- the uplift in property prices attributable to open space or healthy waterways **('P')**. This uplift will vary depending on the characteristics of the investment, for example, does it relate to irrigation of existing open space or creation of new open space.
- the number of dwellings located within 200m of open space or healthy waterways ('**ΔQ**')

Figure 42: Valuing amenity benefits from proximity to open space or waterways



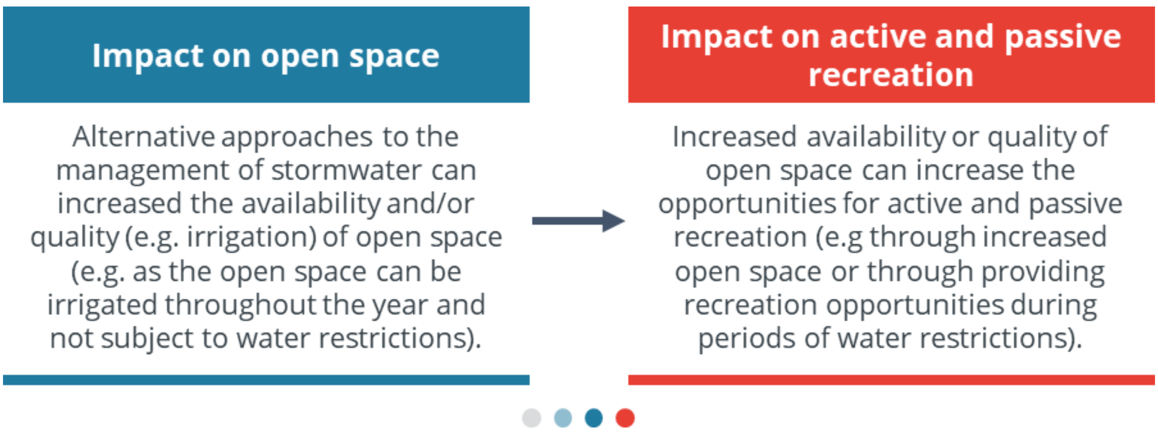
Source: Frontier Economics

Approach to valuing active and passive recreation

As shown in **Figure 43**, different stormwater decisions can lead to increased active and passive recreation opportunities. For example:

- Naturalisation of a stormwater channel can lead to increased pockets of open space or recreation infrastructure (for example a cycle path alongside the naturalised channel). Accessible open space can enhancing opportunities for active and passive recreation.
- Use of stormwater harvesting or rainwater for irrigation of open space can provide "drought-proof" irrigation of open space. This in turn provides opportunity to engage in activities that would otherwise be cancelled during periods of water-restrictions, such as some team sports.

Figure 43: The link between stormwater management and recreation opportunities



Source: Frontier Economics

As shown below, the total value of these recreational opportunities is a function of how many people use the space, and how much they may be willing to pay (WTP) for different types of recreation opportunities. Depending on the option considered, stormwater-related decisions may deliver a range of recreation opportunities including:

- **Land-based recreation** – walking, running and passive recreation (such as picnicking).
- **Water-base recreation** – swimming and other non-motorised, water-based recreation (such as canoeing).

As shown in **Figure 44**, the total value of these active and passive recreation opportunities can be estimated by multiplying together:

- an estimate of the change in the number of people engaging in the recreation activity ('**ΔQ**')
- an estimate of how much they may be are willing to pay (WTP) for different types of recreation opportunities **('P')**. There is a rich literature relating to the community's WTP for recreation opportunities (primarily reflecting use values). This includes estimates derived from surveys[28] as well as real world situations[29] including prices or charges that the community pays for these opportunities in competitive environments (e.g. fees for bike hire or car parking at recreation facilities etc)

Figure 44: **Valuing active and passive recreation opportunities**

Source: Frontier Economics

Care should be taken to avoid double counting with the estimate of:

- **Amenity related benefits** given that for those that live within close proximity (within 200 m) to accessible open space, the uplift in prices paid for property may reflect a willingness to pay for improved recreation opportunities in public open space (a direct use value) in addition to amenity value (an indirect use value).
- **Health related benefits** given that willingness to pay for recreation opportunities may reflect some individual's consideration of recreation related health benefits (e.g. the reduction in risk of morbidity or mortality as a result of recreation). However, behavioural research suggests that participants' willingness to pay for recreation may not fully account for these risks and resulting health impacts (particularly impacts that are external to the individual), so the health benefits associated with reduced inactivity may not be captured in participant's willingness to pay for recreation.

Approach to valuing health benefits from active and passive recreation

In general, improved health risk factors (in the form of reduced inactivity) have flow-on effects through reduced morbidity and mortality. While inactivity is rarely listed as the cause of death,

28 Commonly known as stated preference methods.

29 Commonly known as revealed preference methods. Revealed preference methods analyse observed behaviour to impute the dollar value that people place on non-market outcomes such as recreation or amenity.

various studies[30] have found that increased inactivity leads to increased risk of death or illness across a range of diseases, including:

- Breast cancer.
- Bowel cancer.
- Uterine cancer.
- Coronary heart disease.
- Stroke.
- Diabetes.
- Dementia.

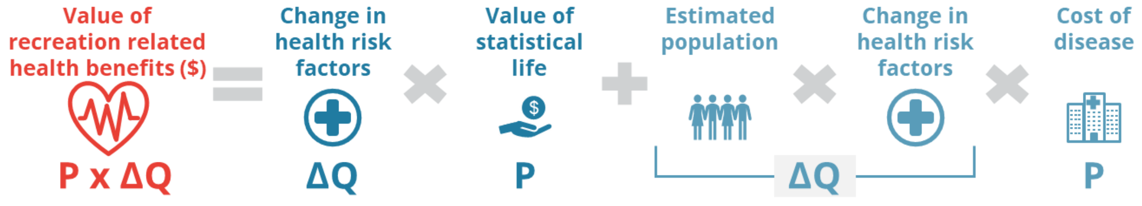
Options that increase the opportunity for active recreation (as discussed above) are likely to reduce the risk of inactivity-related diseases and the inactivity-related disease burden, as measured by Disability Adjusted Life Years (DALYs) (see **Box 17**).

As shown in **Figure 45**:

- the value of reduced disease burden arising from reduced inactivity can be calculated by multiplying together:
  - the change in health risk factors (as measured by the change in DALYs) under the options, compared to the Base Case ('**ΔQ**')
  - by the value of statistical life (**'P'**)
- the change in the cost of healthcare service utilisation arising from reduced inactivity can be calculated by multiplying together:
  - the change in health risk factors (as measured by the change in DALYs) under the options, compared to the Base Case ('**ΔQ**')
  - the population of the surrounding areas ('**ΔQ**')
  - an estimate of the cost of treatment, per instance of disease ('**P**')

We then compare the present value of this expenditure under each of the alternative options to identify the extent to which there are incremental costs or benefits (i.e. compared to the Base Case).

Figure 45: Valuing changes in inactivity related health outcomes



Source: Frontier Economic

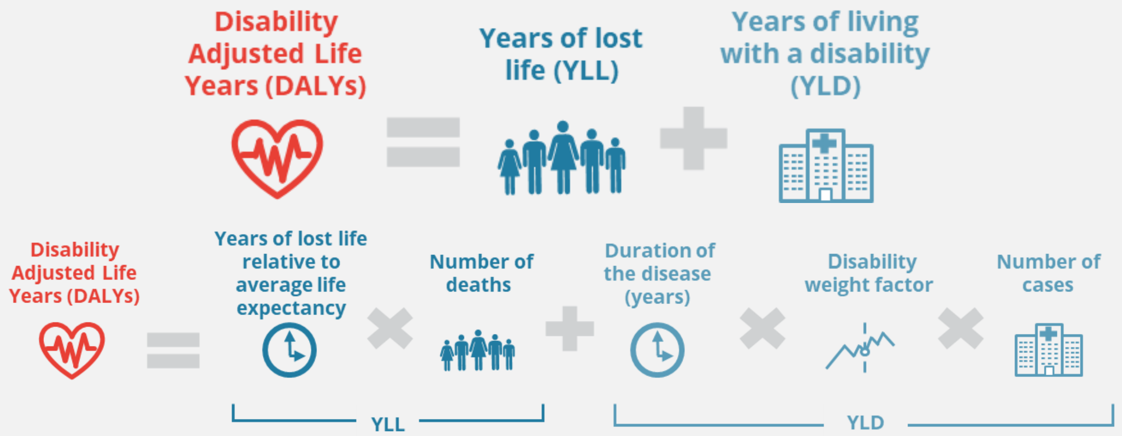
30 See for example, Australian Institute of Health and Welfare (2017), *Impact of physical inactivity as a risk factor for chronic conditions: Australian Burden of Disease Study,* Australian Burden of Disease Study series no, 15.

Box 17: Utilising disability adjusted life years to estimate the benefit of reduced activity

DALYs are a widely accepted measurement for comparing health outcomes across different diseases. One DALY can be thought of as a measurement of the gap between current health status, and an ideal situation where everyone lives into old age, free of disease and disability (i.e. one DALY is equivalent to the loss of one year of full health). When applied to a population, the number of DALYs can be regarded as a measure of the attributable burden of disease, or total disability, incurred due to a specific disease.

As shown below, a DALY is the sum of years of life lost (YLL) and years lived with disability (YLD), where:

- YLL measures the number of years of life lost due to premature mortality (also referred to as 'fatal burden')
- YLD measures the impact of living with ill-health, that is, the non-fatal component of the burden of disease. The disability weights are within a scale of 0 to 1, where 1 corresponds to death and 0 corresponds to perfect health



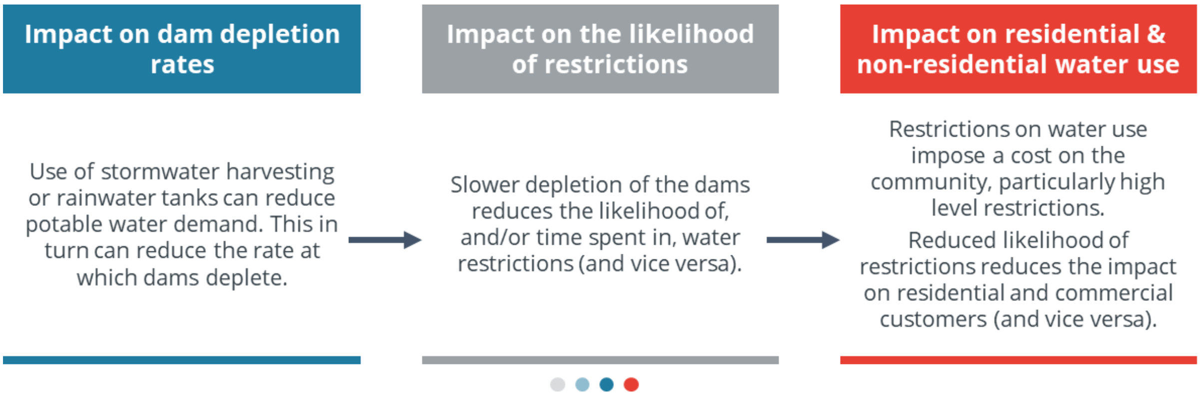
Valuing recreation-relation health outcomes requires estimating the change in disease burden (as measured by DALYs) based on a population attributable fraction (a measurement of the percentage reduction in burden that would occur if exposure to the risk factor were avoided or reduced to its theoretical minimum).

Source: Frontier Economics

Approach to valuing the cost on society of water restrictions

As shown in **Figure 46**, measures that slow the rate at which storages deplete (for example the use of stormwater harvesting or rainwater tanks), can reduce the likelihood and/or duration of water restrictions, reducing the extent to which customers experience restricted demand compared to the Base Case.

Figure 46: The link between stormwater management and water restrictions



Source: Frontier Economics

As shown in **Figure 47**, the present value of changes in the likelihood and duration of water restrictions can be estimated by multiplying together:

- the community willingness to pay to avoid water restrictions (**'P'**). The evidence suggests that the social cost of water restrictions for residential customers differs from the social cost for commercial/business customers
- the change in probability of restrictions, across the different levels of water restrictions (**'ΔL'**) (based on hydrological modelling)
- the change in restricted demand under different levels of water restrictions (**'ΔQ'**) for residential and non-residential demand. The reduction in demand is calculated based on the forecast annual demand for each scenario

Figure 47: Valuing the cost of water restrictions on the community

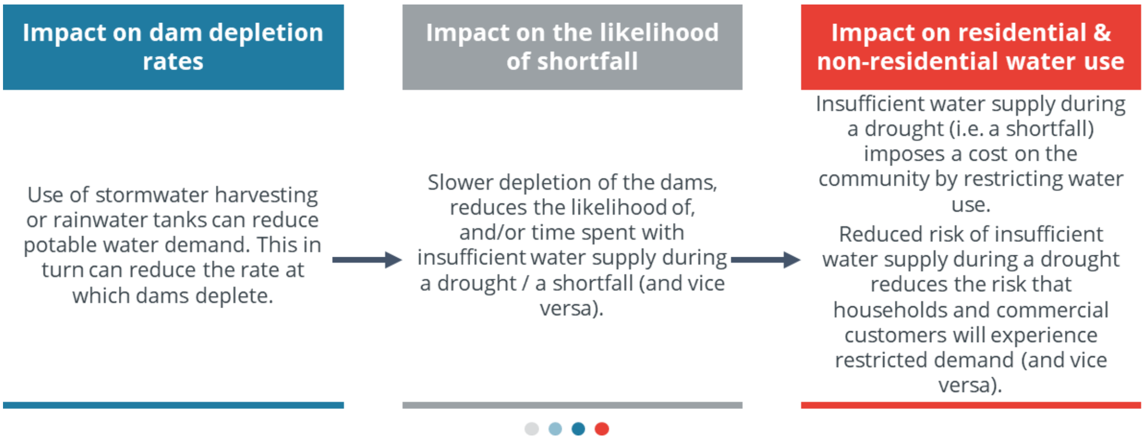
Source: Frontier Economics

Approach to valuing the cost of a shortfall

Under extreme drought conditions, there, is a risk that water supply will be insufficient to meet demand, resulting in a shortfall. Being in shortfall imposes a direct social cost on the community associated with running out of water (as measured by the community's willingness to pay to avoid shortfall).

As shown in **Figure 48**, measures that slow the rate at which storages deplete (for example the use of stormwater harvesting or rainwater tanks), can reduce the likelihood and/or duration of insufficient water supply during a drought (i.e. a shortfall), reducing the extent to which customers experience restricted demand, compared to a Base Case.

Figure 48: The link between stormwater management and the cost of insufficient water supply during a drought (i.e. a shortfall)

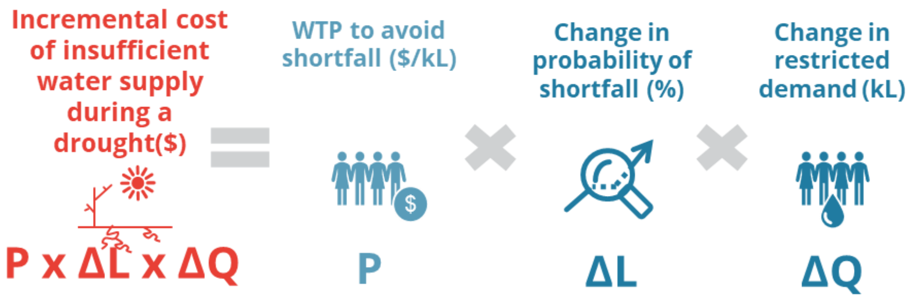


Source: Frontier Economics

Similar to the approach to valuing the cost of water restrictions on the community outlined above, as shown in **Figure 49**, the cost of shortfall can be estimated by multiplying together:

- the willingness to pay to avoid a shortfall (**'P'**). It is likely that the cost imposed on residential customers will differ from the cost imposed on commercial / business customers
- the change in probability of shortfall (**'ΔL'**) (based on hydrological modelling)
- the change in restricted water consumption under shortfall conditions (**'ΔQ'**)

Figure 49: Valuing the cost of insufficient water supply during a drought on the community



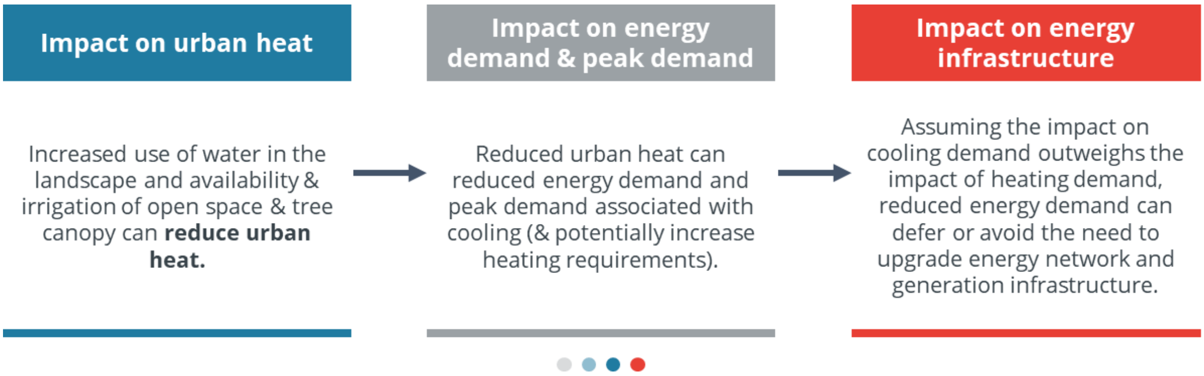
Source: Frontier Economics

Approach to valuing avoided energy distribution and generation infrastructure costs

As shown in **Figure 50**, investment in blue and green stormwater infrastructure solutions (such as water in the landscape, irrigation for tree canopy using stormwater harvesting) can lead to reductions in urban heat, which in turn can reduce the cooling related energy needs of those living and working in the area.

One of the key benefits of this urban cooling are the reductions in the future cost of providing energy generation and network infrastructure that are required to meet these energy needs. This reduction in energy consumption and peak energy demand defers the operation and augmentation of energy generation and network infrastructure.

Figure 50: The link between stormwater management and energy infrastructure requirements



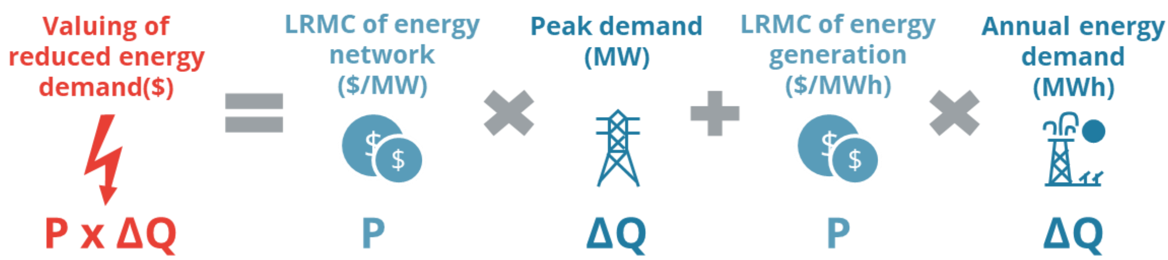
Source: Frontier Economics

As shown in **Figure 51**, the value of reduced energy demand from reduced urban heat, can be estimated by adding the value of the following products:

- the LRMC of energy network services (**'P'**) multiplied by the estimated level of peak energy demand ('**ΔQ**') in each year over the period of analysis
- the LRMC of energy generation (**'P'**) multiplied by the estimated level of energy consumption ('**ΔQ**') in each year over the period of analysis

We then compare the present value of this expenditure under each of the options to identify the extent to which there are incremental economic costs or cost savings (i.e. compared to the Base Case).

Figure 51: Approach to valuing cooling related energy demand



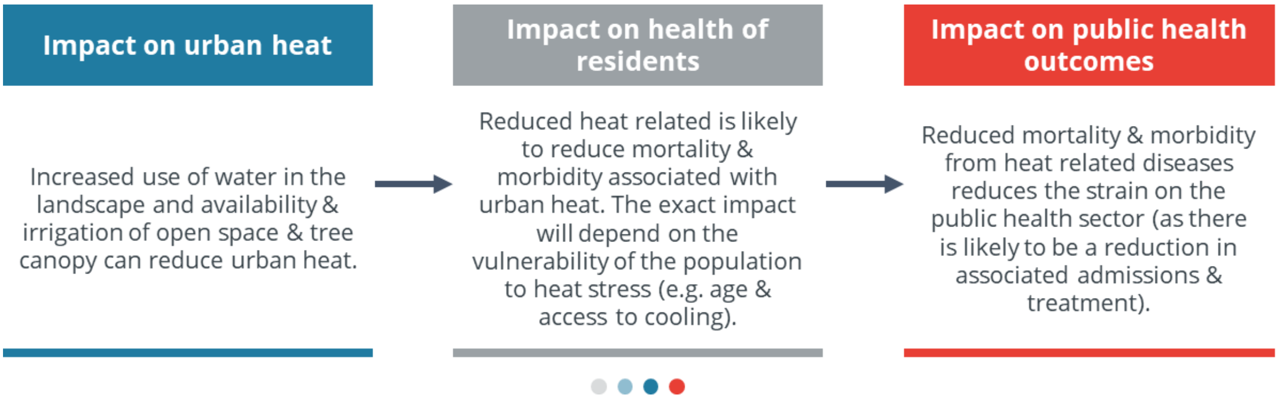
Source: Frontier Economics

Approach to valuing avoided urban heat related diseases and healthcare costs (from urban cooling)

As shown in **Figure 52**, investment in blue and green stormwater infrastructure solutions (such as water in the landscape, irrigation for tree canopy using stormwater harvesting) can lead to reductions in urban heat, which in turn can provide benefits in the form of reductions in heat-related mortality and illness.

While urban heat is rarely listed as the cause of death, various studies have found that increased heat levels lead to increased risk of death or disease, especially amongst the most vulnerable in the community: the very young and elderly. A reduction in urban heat reduces the risk of heat-related diseases, reducing the number of heat-related deaths and the use of health services utilisation, leading to a benefit for the broader community (beyond those who live and work in the area).

Figure 52: **The link between stormwater management and avoided urban heat related diseases**



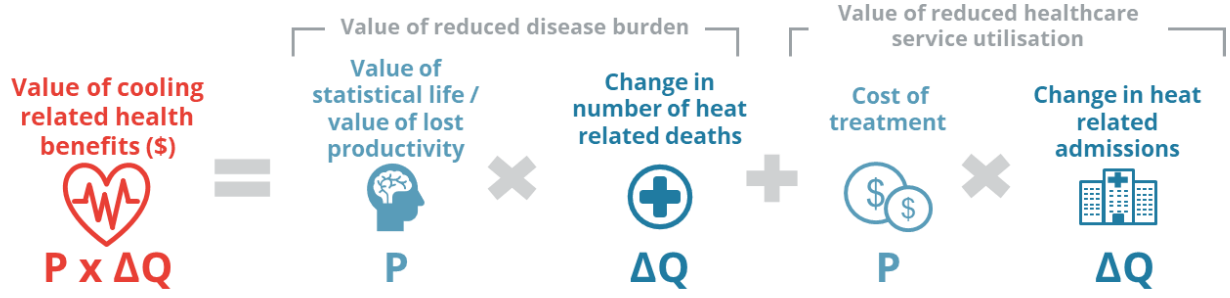
Source: Frontier Economics

As shown in **Figure 53**:

- the value of reduced disease burden arising from reduced urban heat can be estimated by multiplying together:
  - the number of heat related deaths under the Base Case and the alternative options (**'ΔQ'**)
  - the appropriate value of life (**'P'**) (adopting either the value of statistical life approach or the value of lost productivity approach)
- the change in the cost of healthcare service utilisation arising from reduced urban heat can be estimated by multiplying together:
  - multiplying the number of heat related admissions under the *Base Case* and the alternative options (**'ΔQ'**),
  - an estimate of the cost of treatment, per admission (**'P'**)

We then compare the present value of this expenditure under each of the options to identify the extent to which there are incremental costs or benefits (i.e. compared to the Base Case).

Figure 53: Approach to valuing cooling related health benefits



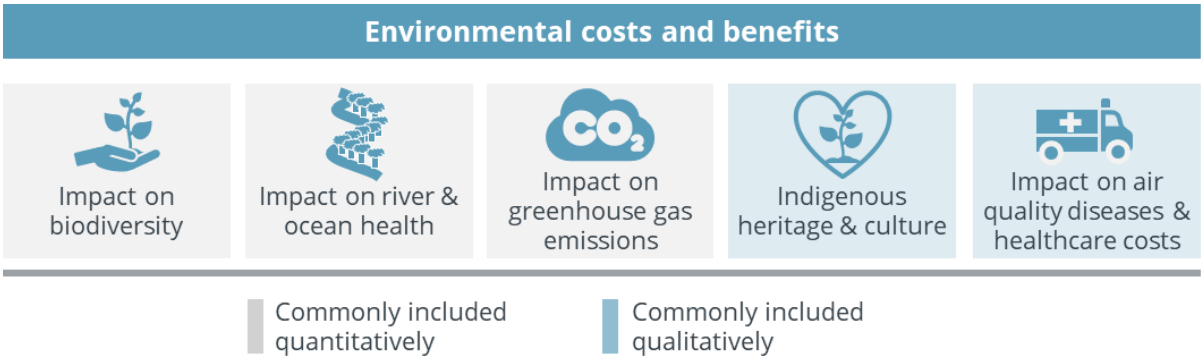
Source: Frontier Economics

D Approaches to valuing key environmental and cultural costs and benefits

This section provides further detail on the approach to valuing key environmental and cultural costs and benefits of stormwater decisions. As shown in **Figure 54**, these include:

- Impact on biodiversity.
- Impact on river and ocean environment.
- Impact on greenhouse gas emissions.
- Indigenous heritage and culture.
- Impact on air quality related diseases and healthcare costs.

Figure 54: Overview of key economic costs and benefits



Source: Frontier Economics

The methodologies to value key costs and benefits is discussed below.

In the case of the impact indigenous heritage and culture and air quality diseases and healthcare costs, these impacts are typically included qualitatively, as:

- In the case of impacts on air quality diseases and healthcare costs, as discussed in **Box 18**, there are limited, site-specific studies linking urban vegetation with changes in air quality. In addition, affecting material change in air quality generally requires large scale changes in the urban form (for example, on a city-wide scale). This means that for most stormwater decisions, changes in air quality between the Base Case and alternative options are likely to be minor.
- In the case of impacts on indigenous heritage and culture, there are no South-Australian, site specific studies of the community's willingness to pay to protect indigenous cultural sites. In addition, given stormwater management decisions will have to comply with guidance around protection of cultural sites, in general, incremental differences between the Base Case and alternative options are likely to be small.

Box 18: The link between stormwater management and air quality

Urban air pollution (a mix of gases, compounds and particles including particulates, ozone and nitrogen dioxide)[31] has been linked to a range of diseases including ischemic heart disease, chronic obstructive pulmonary disease, lung cancer and acute lower respiratory tract infections in children.[32] The smaller the particle the bigger the problem, as it can go deeper into the respiratory tract. The very young, the elderly and those with pre-existing health conditions are particularly susceptible.

Stormwater management (in particular, a WSUD approach to stormwater management using *blue* and *green* infrastructure) can affect air quality through:

- **Pollutant deposition:** airborne particles and gas molecules can be deposited on plant surfaces such as trunks, branches and leaves.
- **Pollutant dispersion:** refers to air flows that transport and dilute air pollutants at different scales (for example, trees near a road can cap pollutants under their canopies or reduce wind speeds and therefore limit dispersion).

The precise relationship between urban vegetation and air quality is highly location-dependent, influenced by the type of trees (density, canopy coverage and other features) and surrounding human activity.

Critically, understanding this relationship, and how these outcomes change with an incremental change in tree canopy (rather than adopting outcomes from an "average" investment) is necessary to robustly value the benefits of green infrastructure. This means that adopting average values (even when the value has been "calibrated" to the Australian context) is unlikely to reflect the site-specific, benefits associated with an incremental change in tree canopy, yet relatively little research has been done specifically linking urban vegetation with air quality in Australia.

Source: Frontier Economics

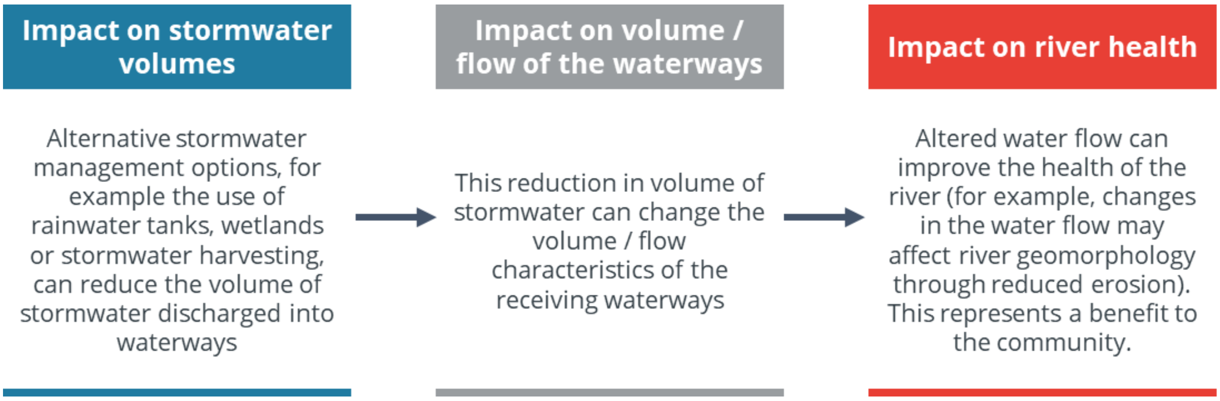
Approach to valuing environmental impacts such as impact on biodiversity and changes to river and ocean health

Alternative approaches to stormwater management (including alternative stormwater governance arrangements) can have a significant impact on the health of the environment in South Australia. For example, as shown in **Figure 55**, stormwater harvesting can reduce the volume of stormwater discharged into vulnerable waterways, leading to improvements in waterway health and the health of surrounding biodiversity.

31 Common air pollutants include carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), sulphur dioxide (SO_2), and particulate matter less than 2.5 μm (PM 2.5) and 10 μm (PM 10) in aerodynamic diameter.

32 See for example, Donovan, G., Butry, D., Michael, Y., Prestemon, J., Liebhold, A., Gatziolis, D., M, Mao. (2013) 'The relationship between trees and human health: evidence from the spread of the emerald ash borer'. *American Journal of Preventive Medicine*, 44(2). 139-145, which found that the percentage of the county covered by ash tree canopy reduced respiratory related deaths by 0.00522% and cardio related deaths by 0.0018%.

Figure 55: **The link between stormwater management and river health**



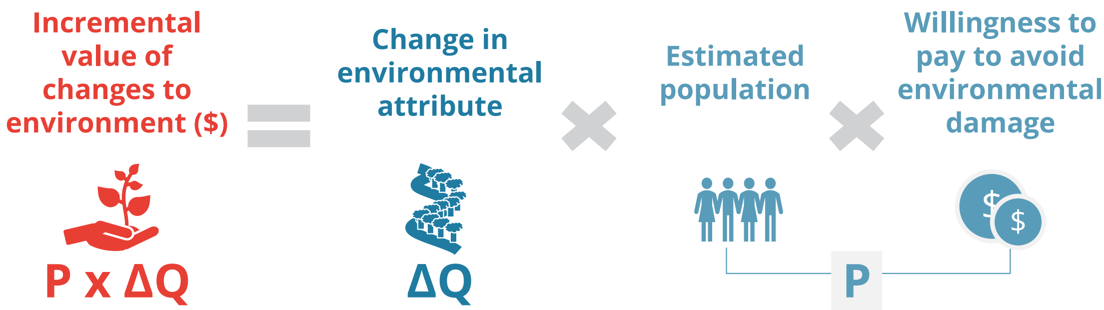
Source: Frontier Economics

As shown in **Figure 56**, the present value of changes to environmental outcomes such as biodiversity or waterway or ocean health can be calculated by multiplying together:

- the estimated change in environmental outcomes ('**ΔQ**')
- an estimate of the relevant population (which will vary depending on the characteristics of the study)
- the willingness to pay of the community for changes in these environmental outcomes ('**P**') which will vary depending on the change in outcomes. For example, if a decision affects a protected species, the community's willingness to pay to protect that species is likely to be higher than if the stormwater-decision affects a non-endangered species.

We then compare the present value of this expenditure under each of the options to identify the extent to which there are incremental costs or benefits (i.e. compared to the Base Case).

Figure 56: **Approach to valuing impact on river and ocean health**



Source: Frontier Economics

This broad valuation methodology can be applied to a range of environmental outcomes, including waterway health, ocean health and biodiversity-related metrics. However, depending on the outcome of interest (i.e. biodiversity protected or ocean health), the appropriate '**P**' and '**ΔQ**' will vary. This is because, in practice, a change in environmental outcomes that the community values can often be valued in multiple different ways.

For example, to value changes in waterway health, users may have access to information around:

- The time to catch a bass.
- The length of waterway in good health.
- The volume of nutrients discharged into the river.

While each of these metrics seek to estimate the change in the environmental outcomes related to waterway health, they use very different information on changes in biophysical outcomes. In some cases, users may be constrained by the data available to them. Users may therefore in some cases choose to use different metrics based on the data available.

In addition, as discussed in more detail in **Box 19**, in some instances, multiple waterways may be affected by a stormwater intervention. Users should take care to trace out the full causal link between an option and an outcome to ensure all relevant steps are included.

Box 19: Valuing waterway health in South Australia – receiving waterways

It is important to note that a stormwater intervention may impact more waterways than just the direct receiving waterway when quantifying changes to waterway health. Consequently, the changes in waterway health as well as the social and economic impacts associated with a given intervention should be considered for both direct receiving waterways as well as any indirect receiving waterways.

A key consideration in the South Australian context for valuing changes in waterway health pertains to when the Gulf St Vincent or Spencer Gulf are direct or indirect receiving waterways. As the image below shows, the major bodies of water that the Adelaide metropolitan region as well as other major population centres in South Australia are adjacent to are the Gulf of St Vincent and Spencer Gulf.

Given the sheltered nature of these bodies of water, they are particularly sensitive to the water quality and volume of stormwater run-off (relative to more western coastal receiving points along the Great Australian Bight for example). Direct and indirect flows into these gulfs have direct impacts on economic, social/recreation and environmental outcomes. Particularly given the sheltered nature of the respective Gulfs and the distribution of stormwater flows along the Gulfs, the impact of stormwater water quality and volume has the potential to be cumulative and significant in these areas.

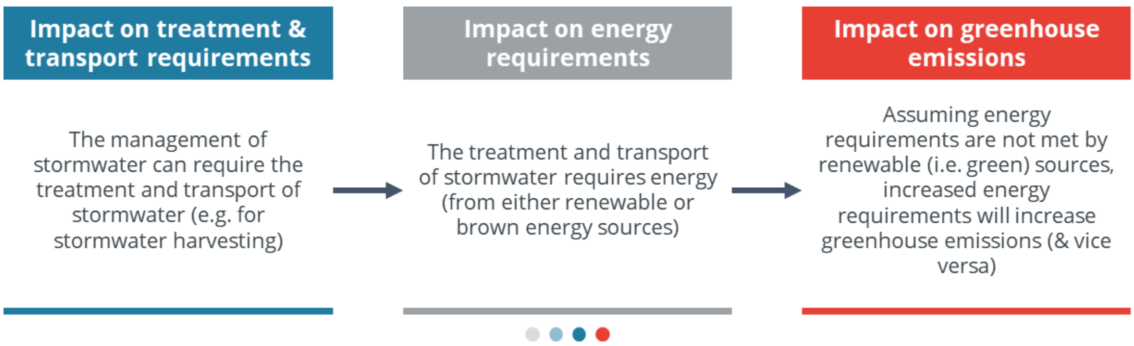
Studies such as those undertaken by Brent et al. (2017) and AITHER (2015) undertook willingness-to-pay (WTP) via choice experiment and literature review studies respectively to estimates WTP values for different stormwater management activities including improving stream health. Given similarities between Adelaide metro and Melbourne metro receiving waterways, studies such as these can be instructive and very helpful for evaluating the direct and indirect impacts on the Gulf St Vincent and Spencer Gulf.

Source: Frontier Economics, SA Government Department of Environment and Water: Water Data SA, Brent et al. 2017 'Valuing environmental services provided by local stormwater management', Water Resource Research vol. 53, no. 6 pp.4907-4921, https://doi.org/10.1002/2016WR019776; AITHER 2015, Valuing externalities for integrated water cycle management planning, Report for Victorian Department of Environment, Land, Water and Planning

Approach to valuing the cost of greenhouse emissions

As shown in **Figure 57**, alternative approaches to managing stormwater and flooding have different associated energy requirements, driven by differences in the extent to which they treat and transport stormwater. For example, options that involve the use of stormwater harvesting on a large / regional scale are likely to have higher energy requirements than portfolios that don't use stormwater harvesting. Assuming these energy requirements are not met by renewable (i.e. green) energy sources, energy demand will lead to greenhouse emissions.[33]

Figure 57: The link between stormwater management and greenhouse emissions



Source: Frontier Economics

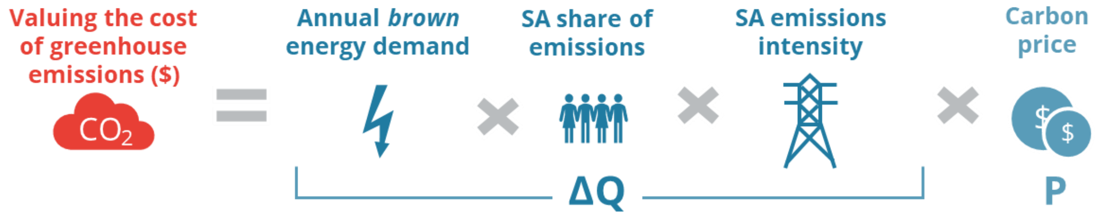
As shown in **Figure 58** the cost of greenhouse emissions can be estimated by multiplying together:

- the change in greenhouse emissions ('**ΔQ**')
  - this is equal to annual brown energy demand (i.e. not from renewable sources) multiplied by the SA emissions intensity (accounting for any energy losses)

[33] We have also included sensitivity analysis which tested the costs and benefits of reliance on renewable sources. In that case while the cost of energy would increase, the additional greenhouse emissions of the portfolios would be zero and thus the cost of greenhouse emissions would be zero.

- the proportion of greenhouse emissions attributable to the SA community. This requires determining the share of greenhouse emissions that can be attributed to the state of SA
- the carbon price **('P')** as based on the current spot price of Australian Carbon Credit Units (ACCUs) from the Clean Energy regulator[34]

Figure 58: Valuing the cost of greenhouse emissions



Source: Frontier Economics

The SA Department of Treasury and Finance (DTF) investment evaluation guidelines note that CBA should consider impacts to the state community,[35] rather than the Australian community.

This is likely to have a material impact on the impact of greenhouse emissions included in the CBA, as, given the dispersion effect, a large proportion are likely to be borne by the Australian, and potentially, global, communities (and therefore, should not be included in the core CBA results).

If greenhouse emissions are a material cost or benefit of a stormwater-decision, we recommend engaging with DTF early in the process around this issue.

34 Available here: https://www.cleanenergyregulator.gov.au/Infohub/Markets/Pages/qcmr/march-quarter-2022/Australian-carbon-credit-units-(ACCUs).aspx.

35 SA Department of Treasury and Finance, Guidelines for the evaluation of public sector initiatives, Part B: Investment Evaluation Process, July 2014, p31. See website here: https://www.treasury.sa.gov.au/__data/assets/pdf_file/0007/515293/ti17-guidelines-part-b.pdf

E Case Study A – Additional investment in stormwater treatment in a metropolitan, brownfield area

Problem definition

To deliver renewal of ageing and inadequate infrastructure across the region to ensure the infrastructure continues to meet performance standards related to flood risk and to provide additional investment in stormwater pollution reduction to deliver waterway health improvement.

Options

All options (including the Base Case) must achieve the objective of stormwater and flood management consistent with the assumed level of service:

- **Base Case: 'Business as Usual'** – council undertakes renewals of ageing grey infrastructure to achieve existing level of service. Infrastructure is renewed on a "like for like" basis.
- **Option 1: Staged WSUD** - council undertakes renewals of ageing grey infrastructure on a "like for like" basis. However, council also invests in raingardens to improve water quality, enhance amenity and improve environmental outcomes over time.
- **Option 2: Upfront WSUD** – as per Option 1, but the rate of investment in raingardens is quadrupled, bringing forward the costs and benefits of this option.

Incremental benefits and costs

The relevant costs and benefits for Case Study A include:

- **Additional stormwater management costs** – Ensuring that stormwater and flooding is managed consistent with policy, standards and regulations will require investment in stormwater and flooding management. As the options involve alternative approaches to managing stormwater and flooding, they will be associated with differing levels of capital and operating expenditure.
- **Additional cost of the infrastructure footprint –** as the options involve alternative approaches to managing stormwater quality, they will require a different footprint of land to deliver the services. To the extent that this land would have been used for an alternative use (e.g. development, recreation, industrial land, biodiversity), delivery of these stormwater management measures reduces the availability of land for these other uses.
- **Active and passive recreation benefits –** as the alternative options involve the creation of vegetated WSUD assets, they create additional usable open space. Increased availability of open space can increase the opportunities for recreation.
- **Avoided inactivity diseases and healthcare costs –** additional recreation opportunities (arising from additional usable open space), reduces inactivity related disease burden. This in turn, reduces the risk of mortality and morbidity associated with inactivity related diseases and reduces pressure on the SA healthcare system.

- **Amenity benefits** – as the alternative options involve the creation of vegetated WSUD assets, they create additional usable open space. Greater proximity to usable open space delivers amenity benefits.
- **Improvements in reputation and goodwill** - Investment in WSUD across both options could generate a positive impact on the reputation of and community goodwill toward the local council.
- **Improved river health** – as the different options manage runoff and pollutant loads to different extents, the alternative options will be associated with an improvement in river health.

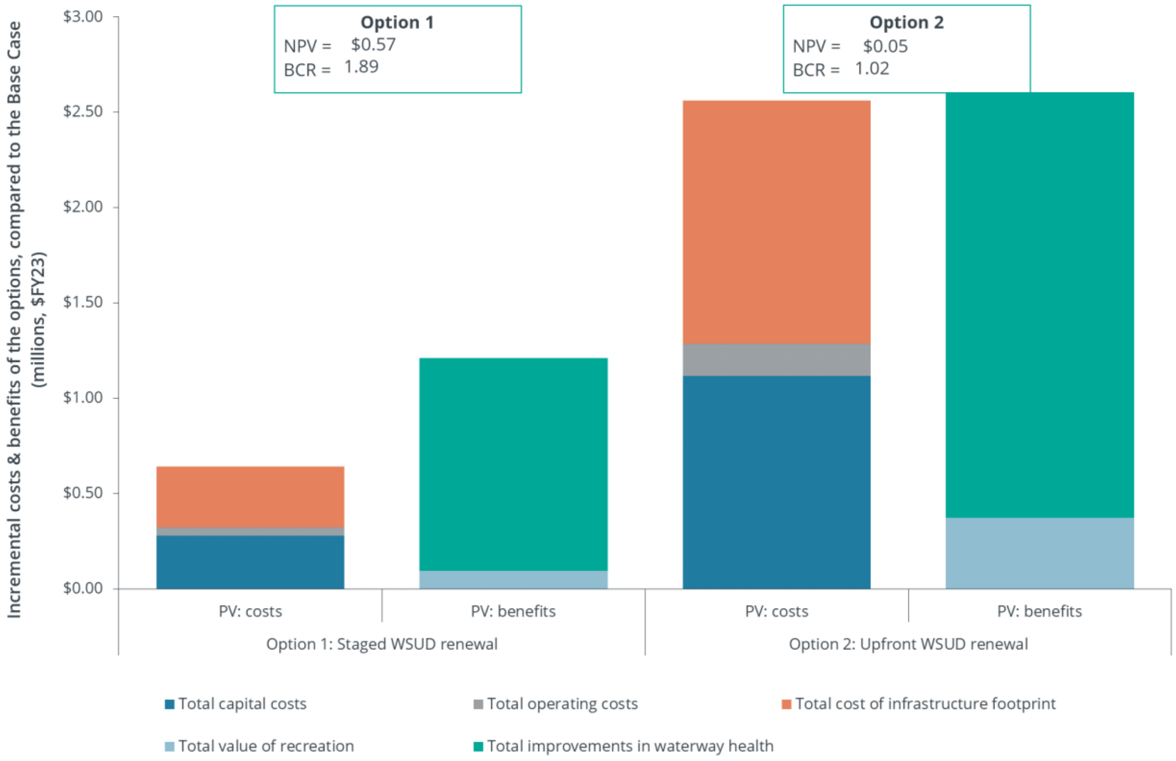
Note there are no potable water savings and avoided water-related costs in this case study.

Indicative CBA results

The results of the CBA are summarised in **Figure 59** below, outlining both the present value of incremental costs and present value of incremental benefits for each option. The results of the analysis indicate that Option 1 and Option 2 deliver a net benefit to the community of between $0.05 and $0.57m over the modelling period (NPV terms). In other words, the benefits of adopting an alternative approach to stormwater management outweighs the additional cost of doing so.

In both cases the primary benefit relates to improvements in waterway health as a result of reduced discharge of nitrogen into sensitive waterways. Importantly, we have used Melbourne Water's water quality offset charge as an example of how this framework can be applied to evaluating improvements in waterway health in this indicative case study. In practice, site-specific analysis (including analysis of the value the community places on improvements in waterway health) should be undertaken when applying this framework to specific projects or investments.

Figure 59: Case study A – indicative CBA results incremental to the Base Case (NPV terms, $FY23 millions)



Source: Frontier Economics; Alluvium

While this analysis has sought to value the most material, incremental costs and benefits of the options, this quantified incremental economic value to the community does not include impacts that have not been monetised as part of the CBA. As shown in **Table 14**, these benefits relate to avoided inactivity related disease burden, amenity benefits and reputation and goodwill benefits.

As discussed in **Table 14**, these impacts are likely to be minor benefit, and therefore, will improve the performance of the alternative options, compared to the Base Case. In other words, they will not change the finding that an alternative approach to stormwater management delivers a net benefit to the community.

Table 14: Case study A – indicative CBA results – qualitative costs and benefits

Impact	Summary	Likely materiality
Social costs and benefits		
Avoided inactivity diseases and healthcare costs	Additional active recreation opportunities (arising from additional usable open space), reduces inactivity related disease burden. This in turn, reduces the risk of mortality and morbidity associated with inactivity related diseases and reduces pressure on the SA healthcare system. Given the relatively small change in recreation opportunities, we have included this impact qualitatively.	Minor benefit
Amenity benefits	As the alternative options involve the creation of wetlands and vegetated WSUD assets, they create additional usable open space. Greater proximity to usable open space delivers amenity benefits. However, to ensure we avoid double counting with recreation benefits, we have included this impact qualitatively.	Minor benefit
Impact on reputation/goodwill	Investment in WSUD across both options could generate a positive impact on the reputation of and community goodwill toward the local council. The provision of raingardens which result in increased amenity, recreation opportunities and improved environmental outcomes could also in turn generate positive community sentiment all else equal. However, given reputation and goodwill is relatively difficult to quantify and the impact for such interventions would likely be small, this impact is included qualitatively in this case study example.	Minor benefit

Source: Frontier Economics

Risk and uncertainty analysis

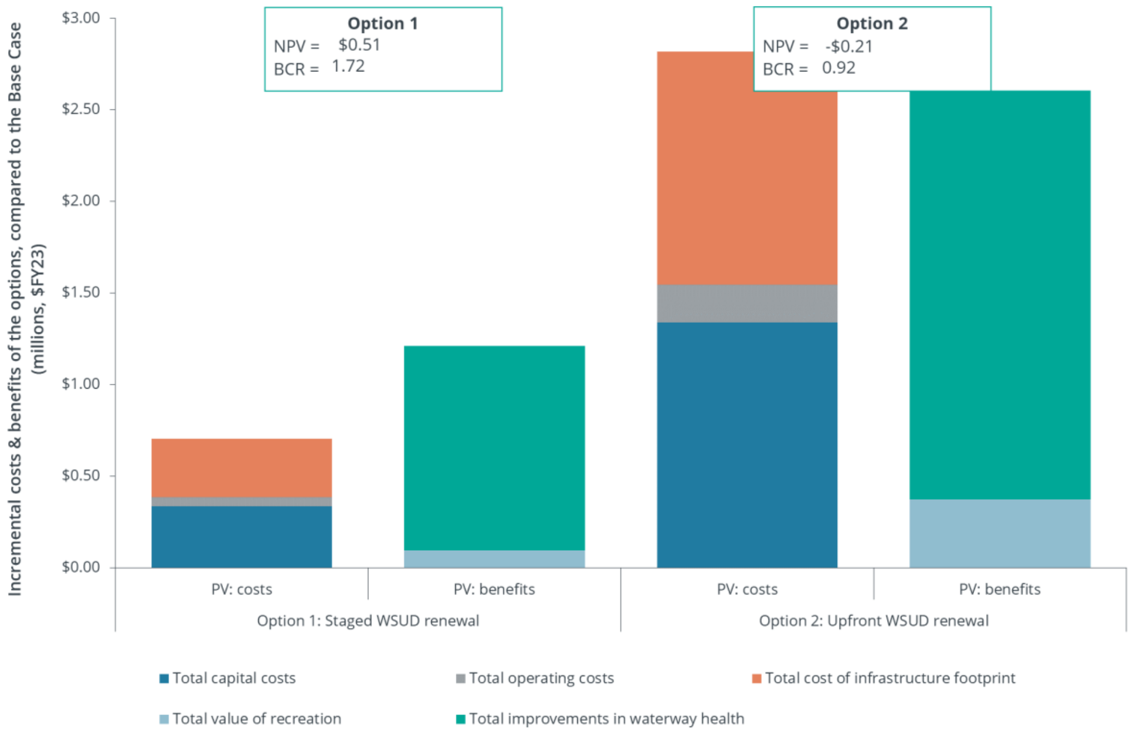
To ensure an accurate comparison of costs and benefits across response options, robust economic assessment should include tools for managing risk and uncertainty. This case study includes sensitivity analysis to identify how the value for money of the options change when key assumptions are varied. These uncertainties include:

- 20% increase in capital and operating costs (see **Figure 60**).
- 20% decrease in capital and operating costs (see **Figure 61**).

- Higher and lower discount rates (10% / 4%) (see **Figure 62** and **Figure 63**).

The results of the sensitivity tests, outlined below, indicate that while the performance of Option 1 is robust to changes in costs and discount rates (i.e. continues to deliver value to the community under alternative assumptions), in some cases, Option 2 delivers a net cost to the community. This highlights the need to better understand the cost estimates of the options.

Figure 60: Case study A – indicative CBA results incremental to the Base Case – 20% increase in costs (NPV terms, $FY23 millions)



Source: Frontier Economics; Alluvium

Figure 61: Case study A – indicative CBA results incremental to the Base Case – 20% decrease in costs (NPV terms, $FY23 millions)

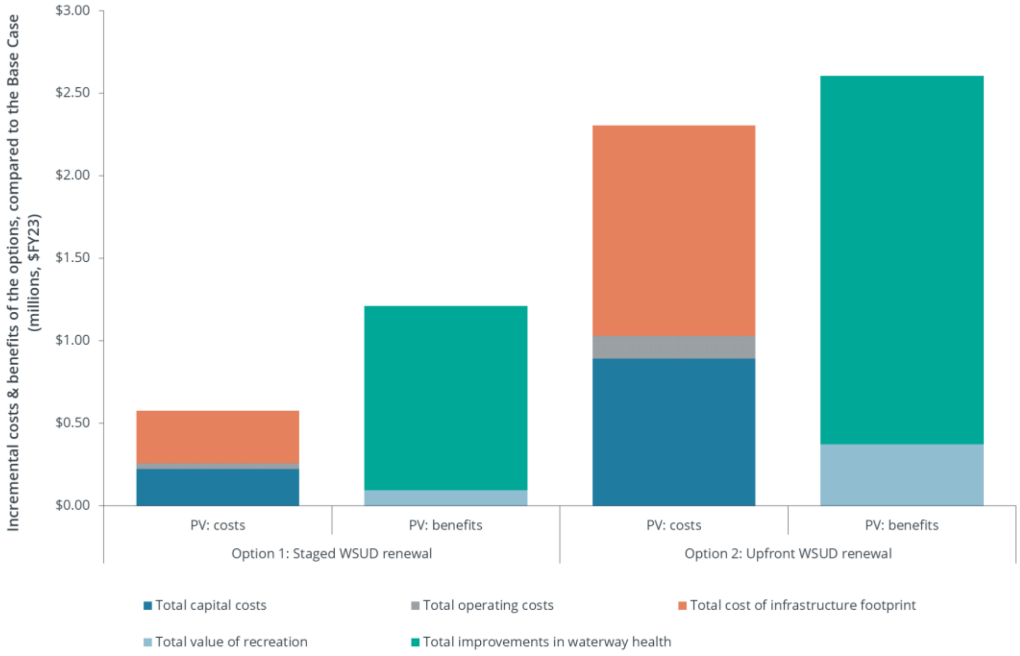
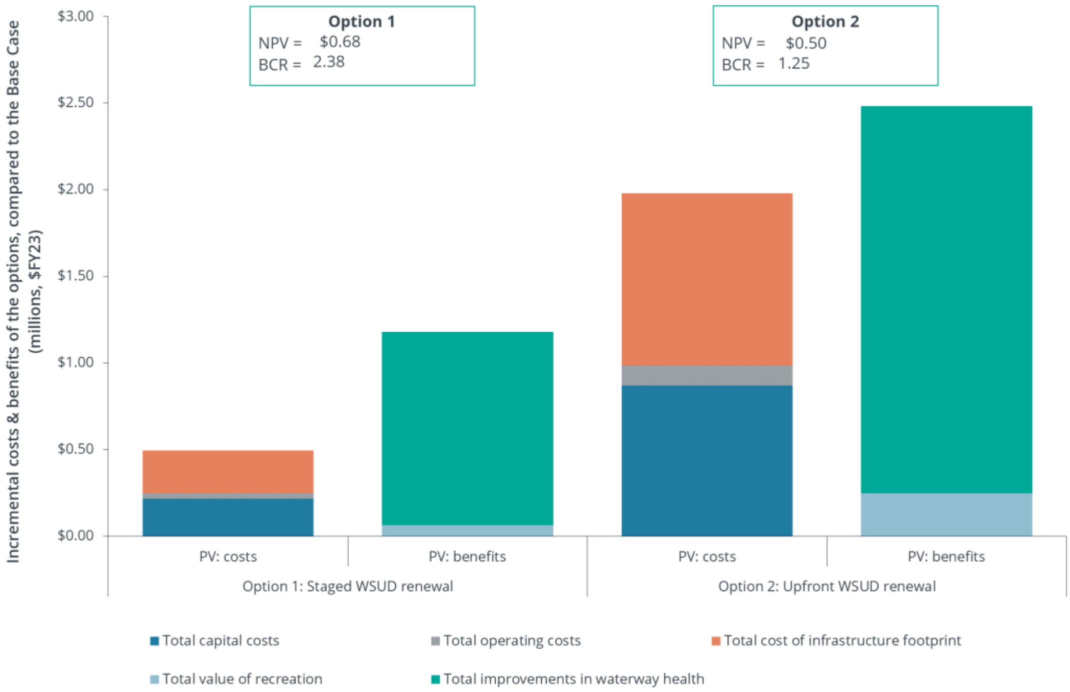
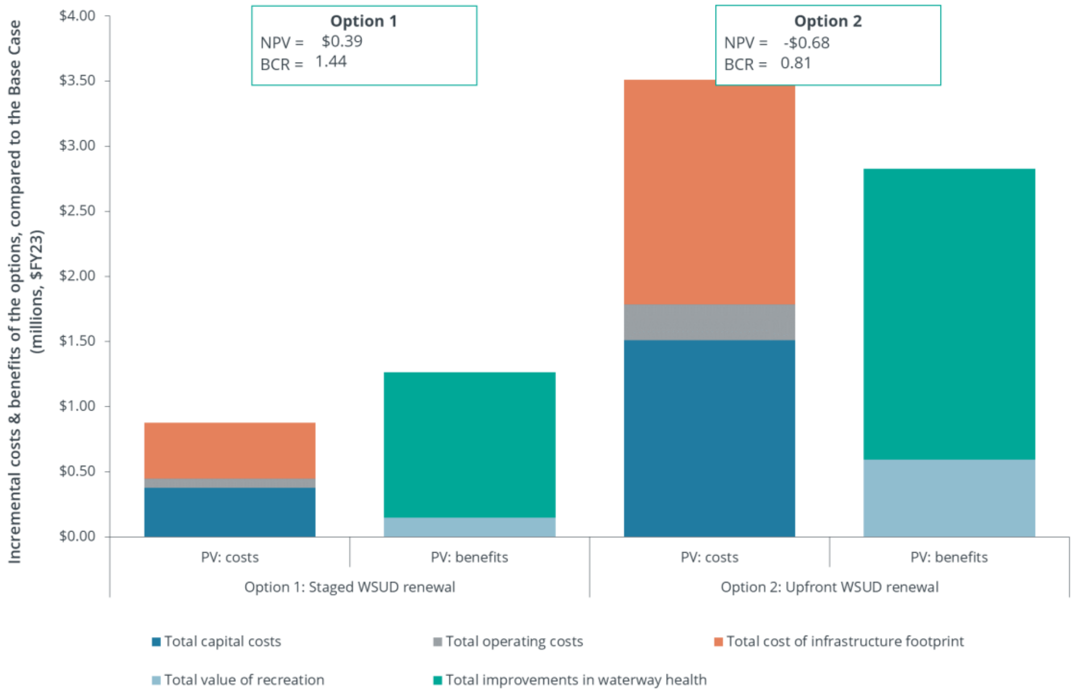


Figure 62: Case study A – indicative CBA results incremental to the Base Case – 10% discount rate (NPV terms, $FY23 millions)



Source: Frontier Economics; Alluvium

Figure 63: Case study A – indicative CBA results incremental to the Base Case – 4% discount rate (NPV terms, $FY23 millions)



Source: Frontier Economics; Alluvium

Distribution of costs and benefits

As Option 1 is the preferred option from a CBA perspective (i.e. the option that delivers the greatest next benefit to the community) this analysis has focused on the distribution of the incremental costs and benefits of Option 1, compared to the Base Case.

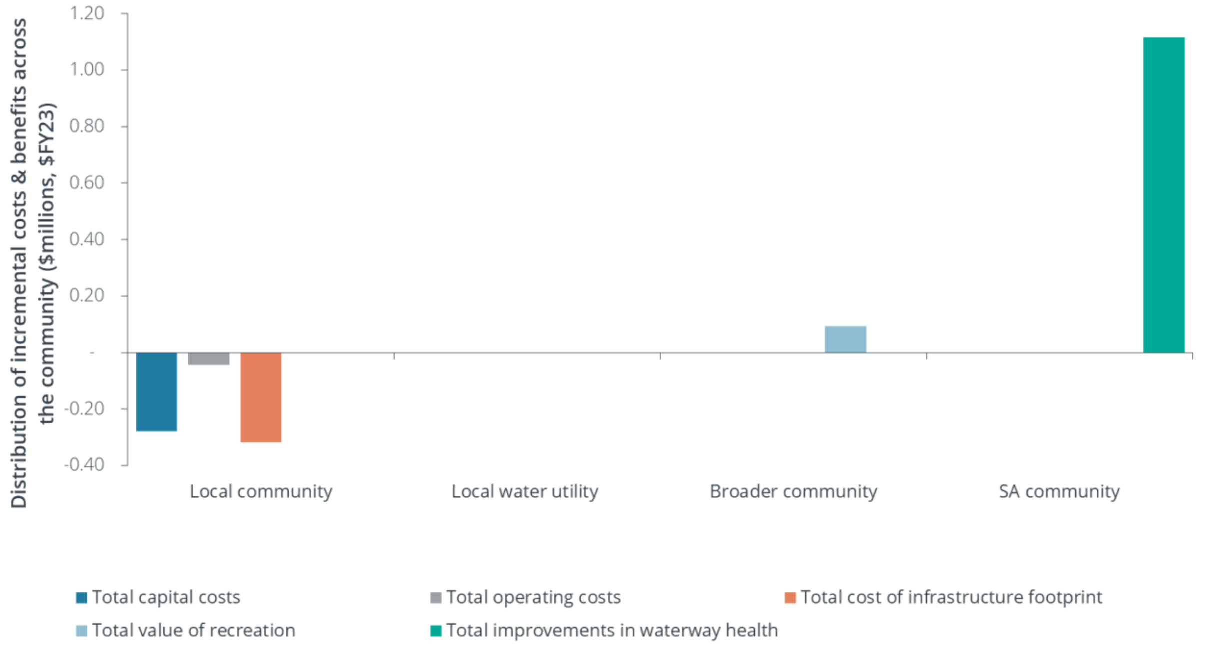
The indicative distributional analysis captured in **Figure 64** illustrates that:

- The majority of the benefits (in the form of improved waterway health) are received by the broader community.
- The majority of the costs associated with the provision of stormwater infrastructure (including capital and operating costs and the cost of the infrastructure footprint) are borne by the local community given the funding arrangements for this infrastructure.[36]

This suggests that there may be a role for co-funding from the SA community in line with the benefits they receive.

36 Noting financial transfers between entities within South Australia should be included in distributional analysis, but not in CBA results.

Figure 64: Case study A – indicative distributional analysis incremental to the Base Case – Option 1 (PV terms, $FY23 millions)



Source: Frontier Economics; Alluvium

F Case Study B – Alternative governance arrangements in a greenfield development

Problem definition

Provision of stormwater solutions for the greenfield development of 10,000 homes, that meets timing of development growth and performance standards related to waterway health and water quality and flood risk. The receiving waterways include an ecologically sensitive estuarine environment.

Given the greenfield nature of the investment, there is opportunity to consider alternative approaches to stormwater governance (i.e. who is responsible for doing what).

Options

All options (including the Base Case) must achieve the objective of stormwater and flood management consistent with the assumed level of service. For simplicity, we have tested two governance arrangements as part of this case study:[37]

- **Base Case: 'Business as Usual'** – **Council led WSUD** Council invests in a combination of grey infrastructure and WSUD to meet a 50% flow reduction target to protect high value receiving waterways. This includes investment in 'on-site' rainwater tanks to supply non-potable demands (toilet, laundry, garden and hot water) and precinct scale evapotranspiration 'sponges'.
- **Option 1: Regional WSUD –** A regional entity is responsible for aspects (i.e. the larger scale infrastructure) of stormwater management in the area. This includes investment in centralised stormwater harvesting to supply non-potable water demands and third-pipe reticulation (to supply harvested stormwater to 'on-site' residential toilet, laundry and garden demands, plus public realm open space demands). The residual continues to be provided and managed by a combination of developers and local council.

Incremental benefits and costs

The relevant costs and benefits for Case Study B include:

- **Additional stormwater management costs –** Ensuring that stormwater quality is managed consistent with policy, standards and regulations will require investment in new infrastructure. As the options involve alternative approaches to managing stormwater quality, they will be associated with differing levels of capital and operating expenditure.
- **Upstream water-related avoided costs –** the alternative governance approach also involves the use of stormwater harvesting and a third pipe system to supply non-potable demands (including residential toilet, laundry and garden demands and public open spaced demands). This will reduce the demand for potable water, compared to the Base Case, and in turn, defer or avoid the need to augment the potable water system.

[37] In practice CBA should be applied to at least three options; a Base Case and at least two alternative options.

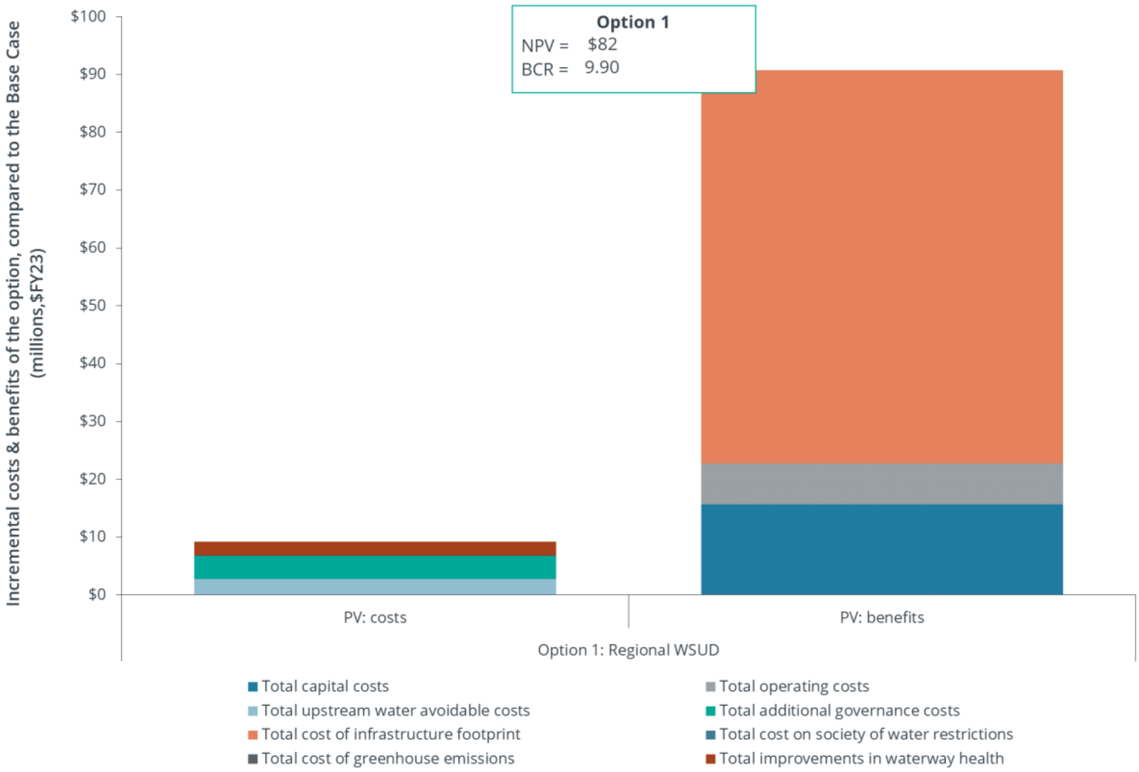
- **Governance costs or cost savings –** the alternative governance arrangements involves moving responsibility for the planning and provision of some stormwater services from councils to a regional entity. Changing governance arrangements are likely to reduce council's governance / administration costs, and increase the governance / administration costs of the other entity.
- **Avoided cost of the infrastructure footprint –** as the alternative option involves a regional approach to governance of stormwater and flooding, it reduces the footprint of land required to deliver the stormwater solution. It also enables the relocation of infrastructure to lower-value land (as the regional entity is able to plan over a much larger area). This represents a cost saving to the community as it frees the higher-value land up for alternative uses.
- **Additional cost of water restrictions –** the alternative governance arrangement slightly reduces the probability of incurring Stage 1 water restrictions due to investments in centralised stormwater harvesting to supply non-potable water demands and third-pipe reticulation.
- **Impact on waterway health –** as the alternative governance arrangement reduces the volume of runoff and pollutant loads, it will improve the health of the ecologically sensitive estuarine environment.
- **Impact on greenhouse gas emissions –** The alternative option involves the treatment and transportation of stormwater for use in stormwater harvesting but reduced potable water demand. The treatment and transportation of stormwater or potable water requires energy (from either renewable or brown energy sources). Assuming the energy demand is not met by renewable sources, these increased (decreased) energy requirements will increase (decrease) greenhouse emissions.

Indicative CBA results

The results of the CBA are summarised in **Figure 65** below, outlining both the present value of incremental costs and present value of incremental benefits for each option. The results of the analysis indicate that Option 1 delivers a net benefit to the community of $82m over the modelling period (NPV terms). In other words, the benefits of adopting a regional approach to stormwater management outweighs the additional cost of doing so.

The primary benefits of the alternative approach to stormwater management relate to the avoided cost of the infrastructure footprint and capital cost savings.

Figure 65: Case study B – indicative CBA results incremental to the Base Case (NPV terms, $FY23 millions)



Source: Frontier Economics; Alluvium

While this analysis has sought to value the most material, incremental costs and benefits of the options, this quantified incremental economic value to the community does not include impacts that have not been monetised as part of the CBA. As shown in **Table 14** these benefits relate to governance cost savings and amenity benefits.

As the qualitative impacts are expected to be of these impacts are likely to be minor benefits, and therefore, will improve the performance of the alternative option, compared to the Base Case. In other words, they will not change the finding that an alternative approach to stormwater governance delivers a net benefit to the community.

Table 15: Case study B – indicative CBA results – qualitative costs and benefits

Impact	Summary	Likely materiality
Economic costs and benefits		
Governance cost savings	The alternative governance arrangement involves moving responsibility for the planning and provision of some stormwater services from councils to a regional entity. Changing governance arrangements are likely to reduce council's governance / administration costs. However, given information availability on cost savings to local government, we have sought to include this impact qualitatively.	Minor benefit
Additional regulatory burden on ESCOSA	The creation or expansion of an entity is likely to increase the regulatory burden on ESCOSA (given the new or expanded entity is likely to be subject to economic regulation). However, this cost is likely to be minor, compared to the benefits of reform.	Minor cost
Social costs and benefits		
Increased amenity arising from improvements in waterway health:	As the alternative governance arrangement reduces the volume of runoff and pollutant loads, it will improve the health of the ecologically sensitive estuarine environment. Improved health of waterways, increases the likelihood that dwellings will be in close proximity to healthy waterways. Greater proximity to healthy waterways delivers amenity benefits. However, to ensure we avoid double counting with the benefits of improved waterway health, we have included this impact qualitatively.	Minor benefit
Environmental costs and benefits		

Greenhouse emissions	The alternative option involves the treatment and transportation of stormwater for use in stormwater harvesting but reduced potable water demand. The treatment and transportation of stormwater or potable water requires energy (from either renewable or brown energy sources). While this analysis has quantified the change in greenhouse emissions associated with increased treatment and transportation of stormwater, given lack of information regarding the change in energy demand from reduced potable water demand, we have included this impact qualitatively. Depending on whether the increase in energy demand from treatment and transportation of stormwater outweighs the energy demand from treatment and transportation of potable water, greenhouse emissions may increase or decrease.	Unclear impact

Source: Frontier Economics

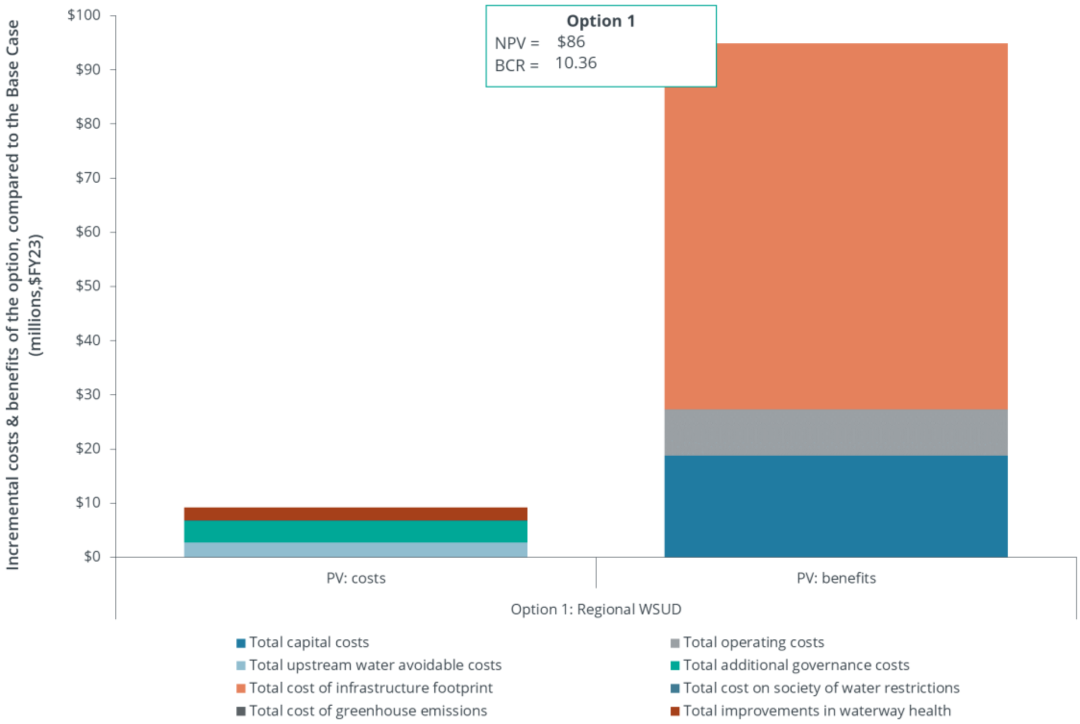
Risk and uncertainty analysis

To ensure an accurate comparison of costs and benefits across response options, robust economic assessment should include tools for managing risk and uncertainty. This case study includes sensitivity analysis to identify how the value for money of the options change when key assumptions are varied. These uncertainties include:

- 20% increase in capital and operating costs (see **Figure 66**).
- 20% decrease in capital and operating costs (see **Figure 67**).
- Higher and lower discount rates (10% / 4%) (see **Figure 68** and **Figure 69**).

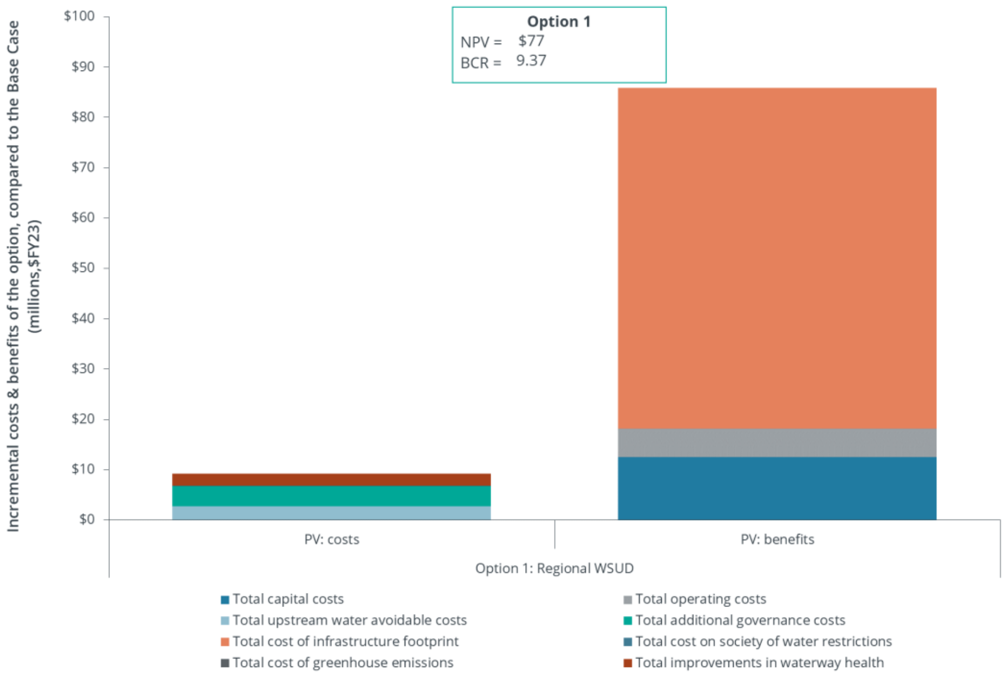
The results of the sensitivity tests, outlined below, indicate that the results of the CBA are robust to changes in costs and discount rates. In other words, Option 1 continues to deliver value to the community under alternative assumptions.

Figure 66: Case study B – indicative CBA results incremental to the Base Case – 20% increase in costs (NPV terms, $FY23 millions)



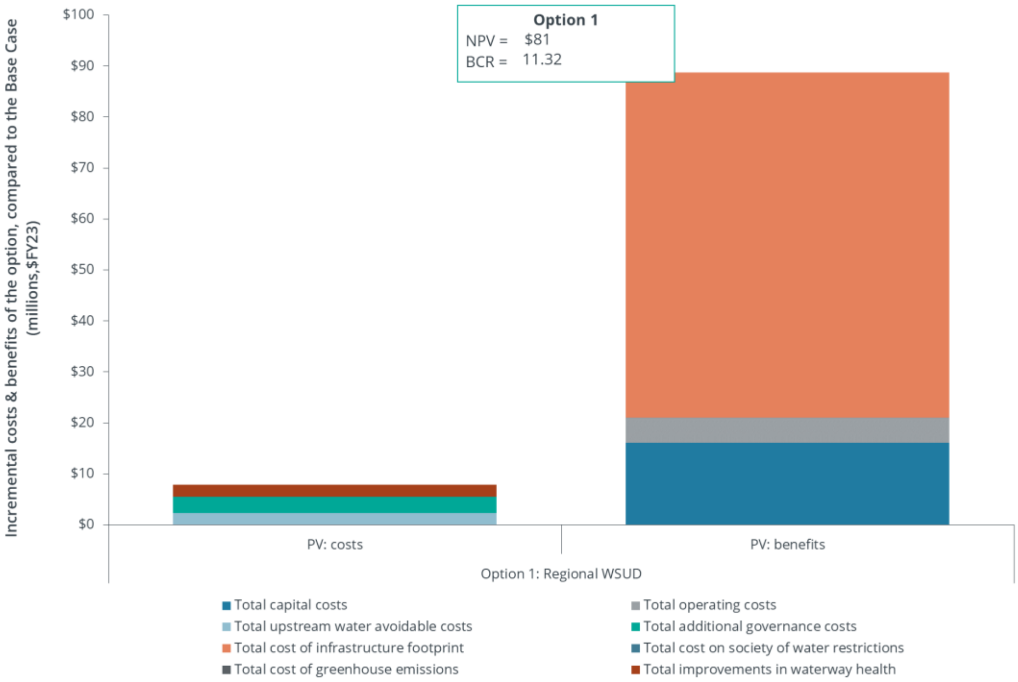
Source: Frontier Economics; Alluvium

Figure 67: Case study B – indicative CBA results incremental to the Base Case – 20% decrease in costs (NPV terms, $FY23 millions)



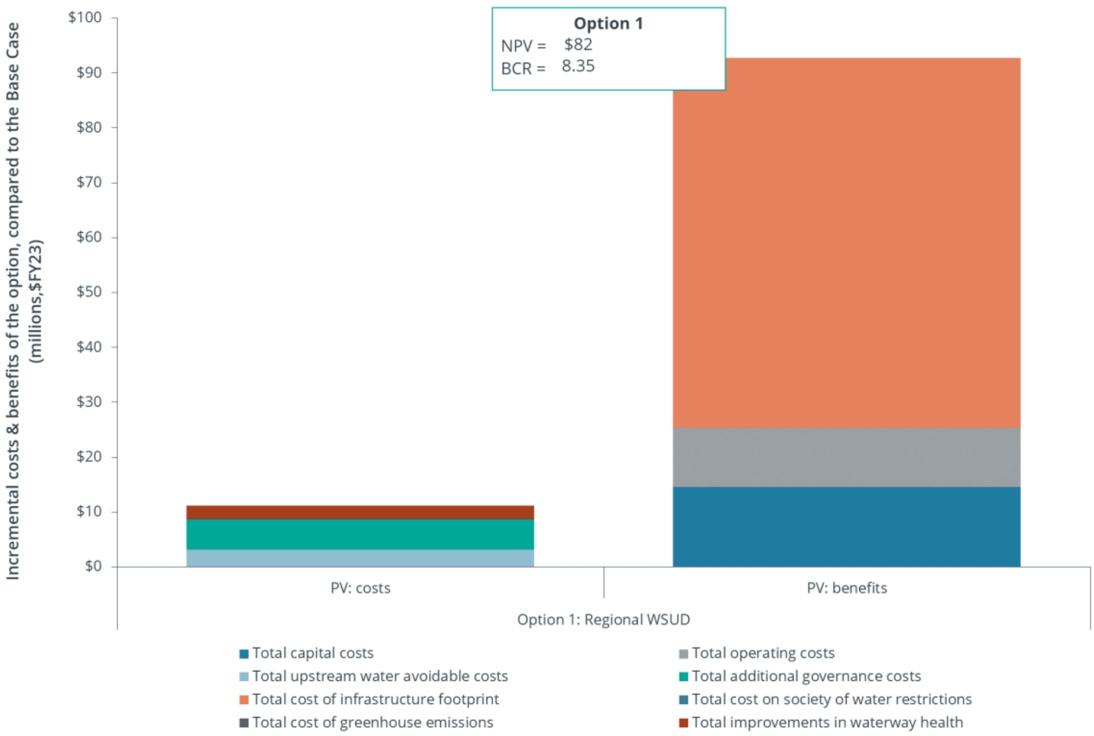
Source: Frontier Economics; Alluvium

Figure 68: Case study B – indicative CBA results incremental to the Base Case – 10% discount rate (NPV terms, $FY23 millions)



Source: Frontier Economics; Alluvium

Figure 69: Case study B – indicative CBA results incremental to the Base Case – 4% discount rate (NPV terms, $FY23 millions)



Source: Frontier Economics; Alluvium

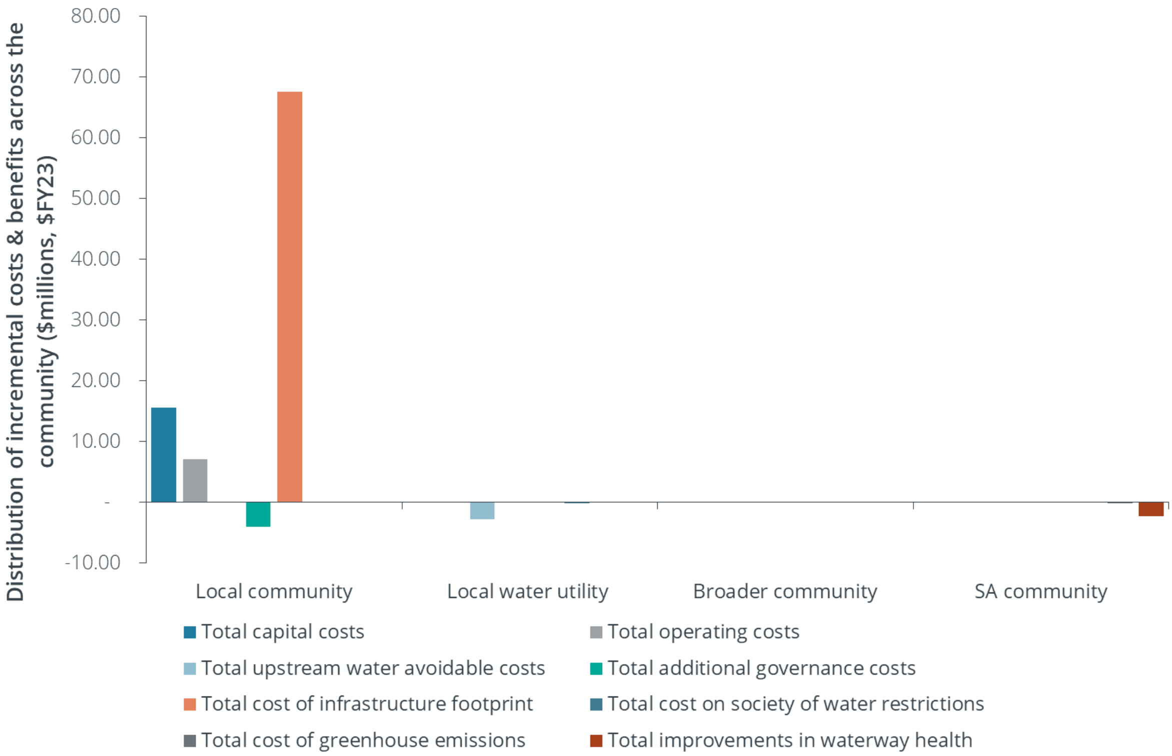
Distribution of costs and benefits

The indicative distributional analysis captured in **Figure 70** illustrates that:

- The majority of the benefits (in the form of reduced cost of stormwater solution and reduced cost of the infrastructure footprint) are received by the local community.
- The majority of the costs are borne by the local community given the funding arrangements for this infrastructure.[38]

In other words, in this case study, the local community receives the majority of the benefits and incurs the majority of the costs.

Figure 70: Case study B – indicative distributional analysis incremental to the Base Case – Option 1 (NPV terms, $FY23 millions)



Source: Frontier Economics; Alluvium

38 Noting financial transfers between entities within South Australia should be included in distributional analysis, but not in CBA results.

G Case Study C – Infrastructure renewal in regional, coastal centre

Problem definition

To deliver renewal of specific aging stormwater channels to meet performance standards related to waterway health & water quality and flood risk.

Options

All options (including the Base Case) must achieve the objective of stormwater and flood management consistent with the assumed level of service:

- **Base Case: 'Business as Usual' –** for flooding and drainage purposes, council renews existing grey infrastructure on a like-for-like basis as required to maintain the minimum level of service. For stormwater quality, targets are achieved on lot by private developers when/as redevelopment occurs using WSUD assets.
- **Option 1: Naturalised channel -** council to undertake renewals of ageing grey infrastructure on a "like for like" basis. Council also makes additional investments in the naturalisation of a stormwater channel and construction of a stormwater treatment wetland. This includes widening and meandering of the channel, revegetation of the riparian zone and tree planting.
- **Option 2: Naturalised channel and stormwater harvesting –** as per Option 1, but with additional investment in stormwater harvesting (from the constructed wetland) to supply fit-for-purpose irrigation water for tree canopy (located in the creek reserve) and the local sports area.

Incremental benefits and costs

The relevant costs and benefits for Case Study C include:

- **Additional stormwater management costs:** Ensuring that stormwater quality and flooding risk is managed consistent with policy, standards and regulations will require investment in stormwater infrastructure. As the options involve alternative approaches to managing stormwater, they will be associated with differing levels of capital and operating expenditure.
- **Additional upstream water-related costs:** Option 1 involves increased water demand associated with the irrigation of the new tree canopy (under Option 2 this irrigation demand is met by stormwater harvesting). This will increase the demand for potable water, compared to the Base Case, and in turn, bring forward the need to augment the potable water system.
- **Additional cost of the infrastructure footprint:** as the options involve alternative approaches to treating and harvesting stormwater they will require a different footprint of land to deliver the services. To the extent that this land would have been used for an alternative use (e.g. development, recreation, industrial land, biodiversity), delivery of these stormwater management measures reduces the availability of land for these other uses.
- **Increased amenity:** as the alternative options involve the provision of irrigated tree canopy and a naturalised stormwater channel, they create additional usable open space and healthier waterways. Greater proximity to usable open space delivers amenity benefits.

- **Active and passive recreation benefits:** as the alternative options involve the creation of wetlands and vegetated WSUD assets, they create additional usable open space. Increased availability of open space can increase the opportunities for active and passive recreation.
- **Avoided inactivity diseases and healthcare costs:** additional active recreation opportunities (arising from additional usable open space), reduces inactivity related disease burden. This in turn, reduces the risk of mortality and morbidity associated with inactivity related diseases and reduces pressure on the SA healthcare system.
- **Additional cost of water restrictions:** Option 1 involves increased water demand associated with the irrigation of the new tree canopy (under Option 2 this irrigation demand is met by stormwater harvesting). This will increase the demand for potable water, and in turn, increase the rates at which storages deplete. Faster depletion of the dams increases the likelihood of, and/or time spent in, water restrictions. Restrictions on water use impose a cost on the community, particularly high-level restrictions. Increased likelihood of restrictions reduces the impact on residential and commercial customers.
- **Avoided urban heat diseases and healthcare costs:** As discussed above, the increased amount of irrigated tree canopy under the alternative options can reduce urban heat. This in turn can reduce the risk of mortality and morbidity associated with urban heat related diseases. Reduced mortality and morbidity reduces the strain on the public health sector (as there is likely to be a reduction in associated admissions and treatment).
- **Avoided energy infrastructure costs:** The alternative options involve the provision of additional irrigated tree canopy. This increased tree canopy can reduce urban heat, which in turn, can reduce energy demand and peak demand associated with cooling (and potentially increase heating requirements). Assuming the impact on cooling demand outweighs the impact of heating demand, reduced energy demand can defer or avoid the need to upgrade energy network and generation infrastructure.
- **Impact on waterway health:** as the different options manage runoff and pollutant loads to different extents, the alternative options will be associated with an improvement in river health.
- **Impact on air quality diseases and healthcare costs:** As discussed above, the alternative options involve the provision of increased tree canopy. Canopy planting can remove pollutants in the air (including carbon dioxide), leading to improvements in air quality. This in turn could reduce mortality and morbidity associated with diseases related to air quality.

It should be noted for the purposes of this Case study, we have assumed that the stormwater infrastructure solution can materiality reduce urban heat (and therefore reduce the risk of urban heat related diseases and cooling-related energy infrastructure costs). In practice, the extent to which the stormwater solution can influence urban heat will depend on the specific characteristics of the stormwater solution.

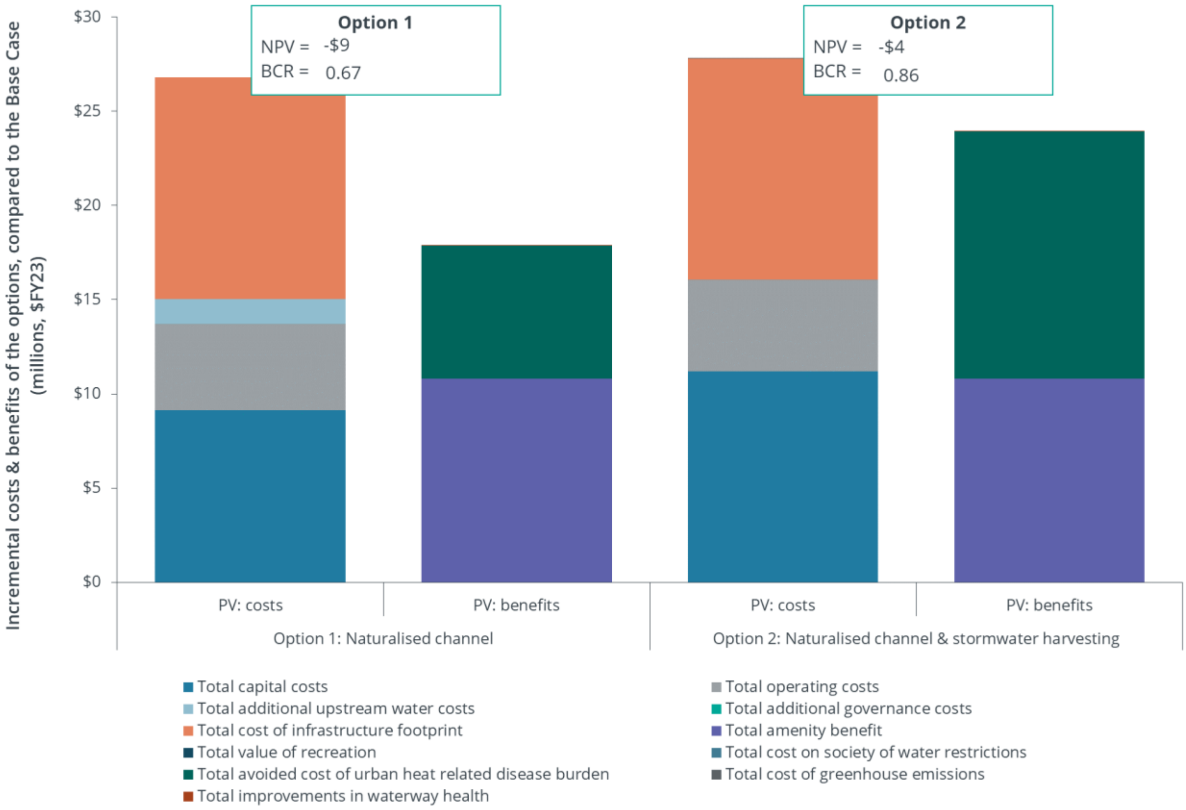
Indicative CBA results

The results of the CBA are summarised in **Figure 59** below, outlining both the present value of incremental costs and present value of incremental benefits for each option. The results of the analysis indicate that Option 1 and Option 2 deliver a net cost to the community of between $4m and $10m over the modelling period (NPV terms).

In other words, in this case study, the costs of adopting an alternative approach to stormwater management outweighs the additional benefits of doing so, and the Base Case is the stormwater management solution that delivers the greatest benefit to the community.

In both cases the primary costs relate to the additional stormwater infrastructure costs and cost of the infrastructure footprint. The primary benefits relate to reduced mortality associated with urban heat related diseases.

Figure 71: Case study C – indicative CBA results incremental to the Base Case (NPV terms, $FY23 millions)



Source: Frontier Economics; Alluvium

While this analysis has sought to value the most material, incremental costs and benefits of the options, this quantified incremental economic value to the community does not include impacts that have not been monetised as part of the CBA. As shown in **Table 14** these benefits relate to:

- Active and passive recreation benefits, and related health benefits.
- Avoided energy infrastructure costs.
- Impact on air quality related healthcare costs.

The qualitative costs and benefits of each option are analysed in **Table 14**. Depending on the size of these qualitative benefits, they may be material enough to improve the performance of the options, relative to the Base Case. There is likely to be benefit in undertaking further analysis of these qualitative impacts to determine their likely materiality.

Table 16: Case study C – indicative CBA results – qualitative costs and benefits

Impact	Summary	Likely materiality
Social costs and benefits		
Active and passive recreation benefits	As the alternative options involve the creation of wetlands and vegetated WSUD assets, they create additional usable open space. Increased availability of open space can increase the opportunities for active and passive recreation.	Minor benefit
Avoided inactivity diseases and healthcare costs	Additional active recreation opportunities (arising from additional usable open space), reduces inactivity related disease burden. This in turn, reduces the risk of mortality and morbidity associated with inactivity related diseases and reduces pressure on the SA healthcare system.	Minor benefit
Avoided energy infrastructure costs:	The alternative options involve the provision of additional irrigated tree canopy. This increased tree canopy can reduce urban heat, which in turn, can reduce energy demand and peak demand associated with cooling (and potentially increase heating requirements). Assuming the impact on cooling demand outweighs the impact of heating demand, reduced energy demand can defer or avoid the need to upgrade energy network and generation infrastructure. Given the change in urban heat related disease burden is significant, this benefit could similarly be significant. However, given information availability related to the change in energy demand, we have included this benefit qualitatively.	Material benefit
Environmental costs and benefits		
Impact on air quality diseases and healthcare costs	As discussed above, the alternative options involve the provision of increased tree canopy. Canopy planting can remove pollutants in the air (including carbon dioxide), leading to improvements in air quality. This in turn could reduce mortality and morbidity associated with diseases related to air quality. However, the impact on air quality (and related impacts on air quality related diseases and healthcare costs), are very site specific. As such, we have included this impact qualitatively.	Minor benefit

Source: Frontier Economics

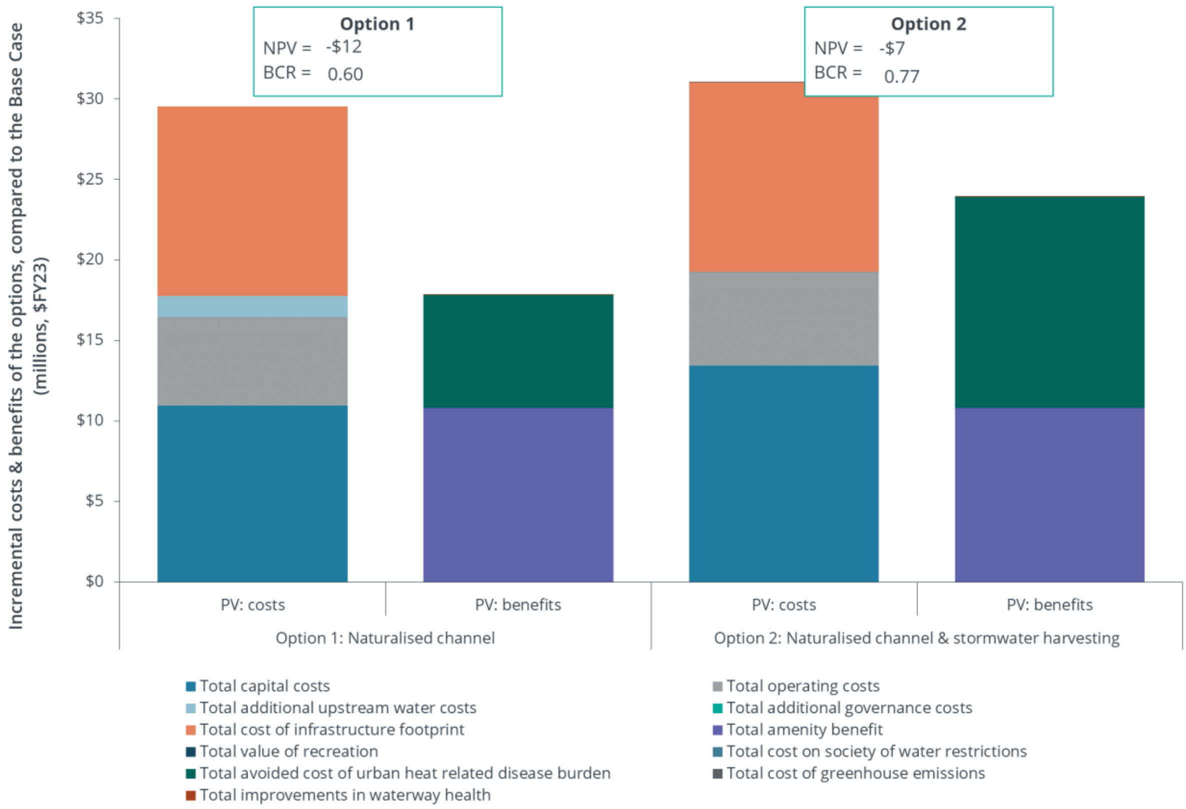
Risk and uncertainty analysis

To ensure an accurate comparison of costs and benefits across response options, robust economic assessment should include tools for managing risk and uncertainty. This case study includes sensitivity analysis to identify how the value for money of the options change when key assumptions are varied. These uncertainties include:

- 20% increase in capital and operating costs (see **Figure 72**).
- 20% decrease in capital and operating costs (see **Figure 73**).
- Higher and lower discount rates (10% / 4%) (see **Figure 74** and **Figure 75**).

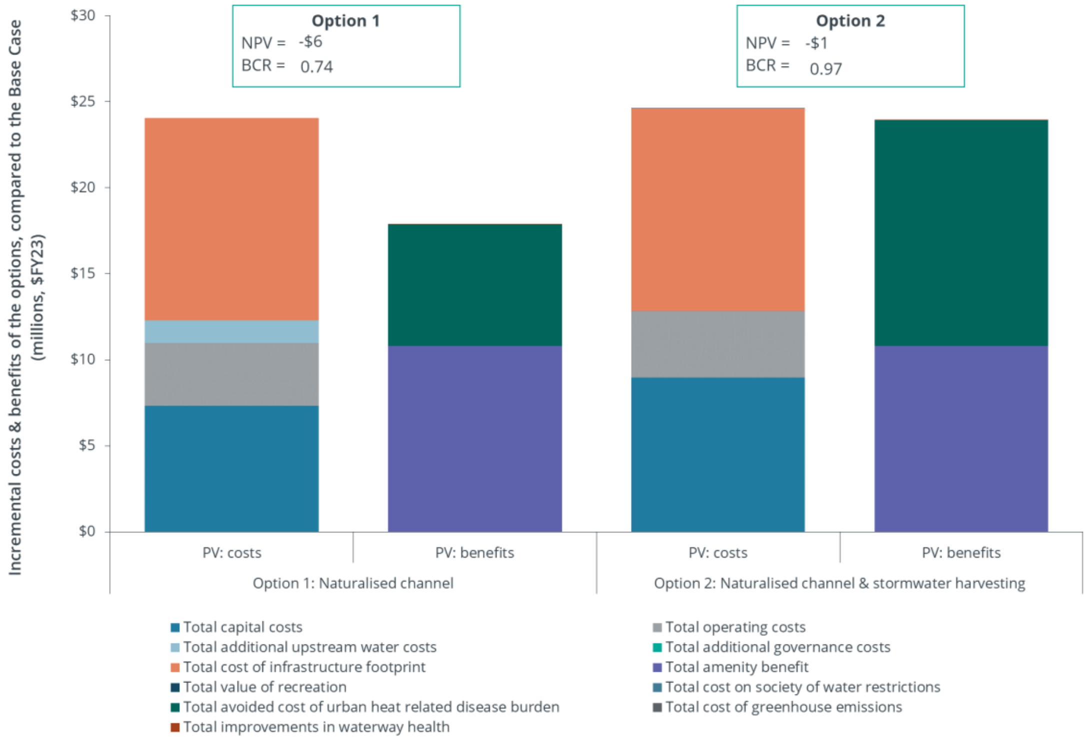
The results of the sensitivity tests, outlined below, indicate that the results of the CBA is robust to changes in capital costs and discount rates. In other words, the incremental costs of the options continue to outweigh the incremental benefits.

Figure 72: Case study C – indicative CBA results incremental to the Base Case – 20% increase in costs (NPV terms, $FY23 millions)



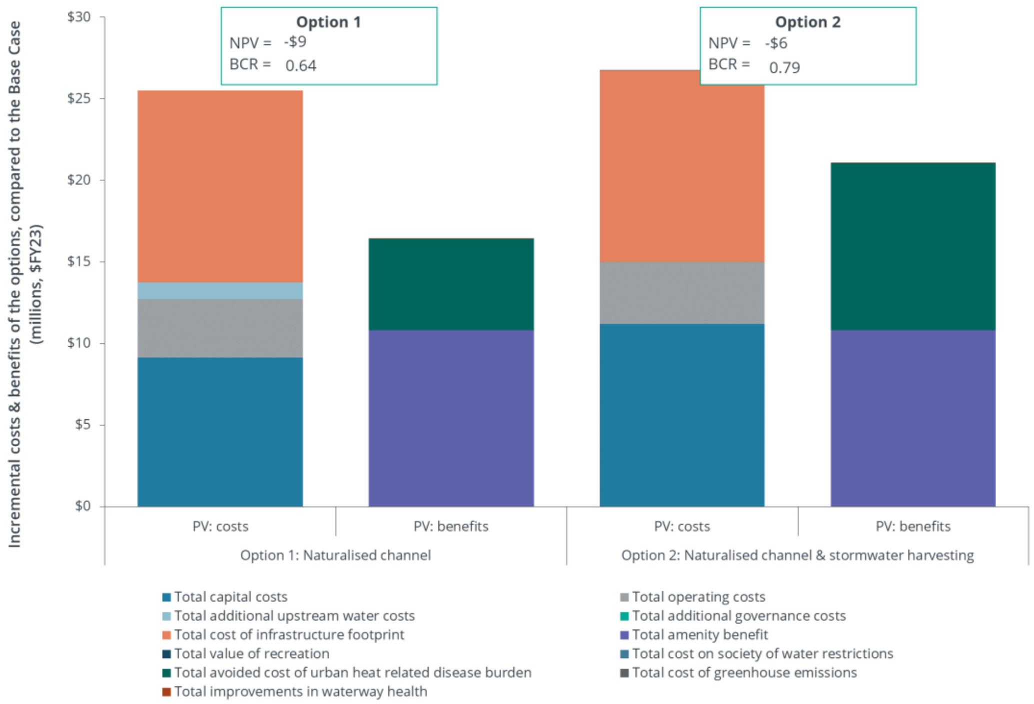
Source: Frontier Economics; Alluvium

Figure 73: Case study C – indicative CBA results incremental to the Base Case – 20% decrease in costs (NPV terms, $FY23 millions)



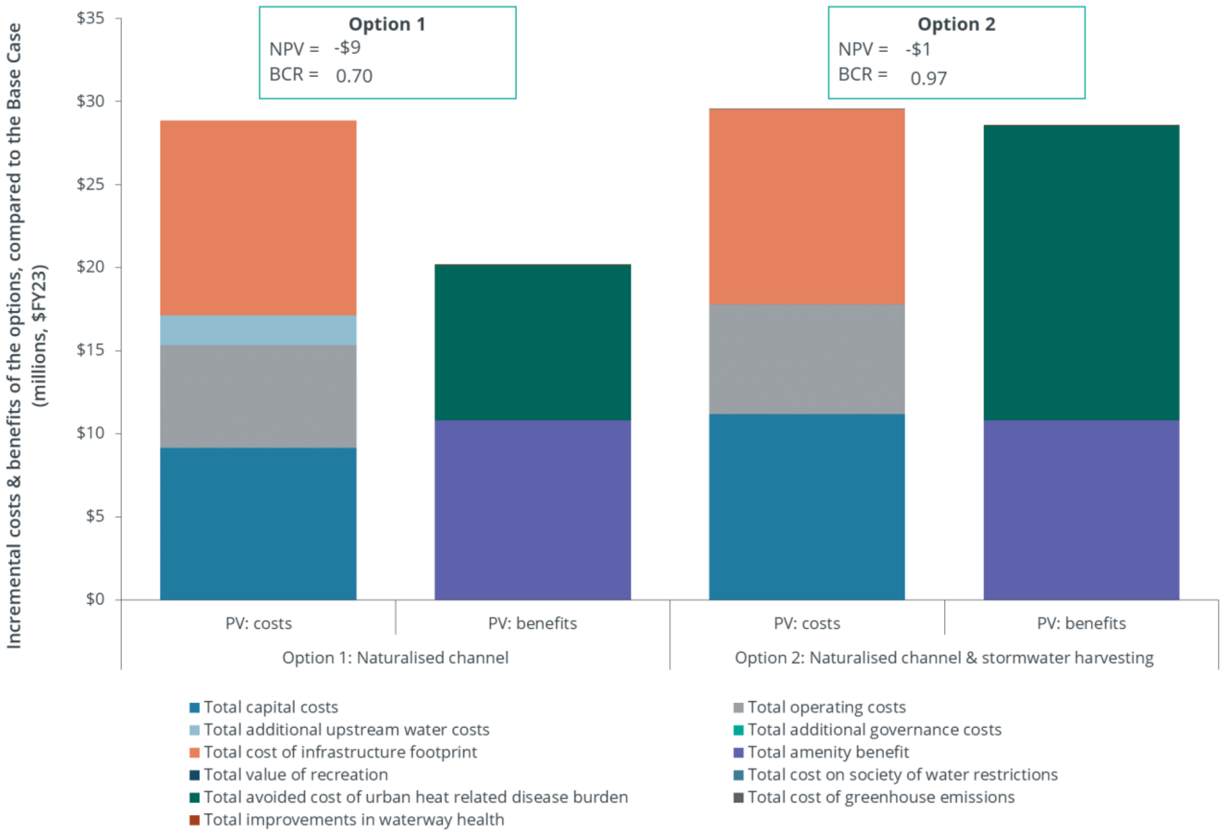
Source: Frontier Economics; Alluvium

Figure 74: Case study C – indicative CBA results incremental to the Base Case – 10% discount rate (NPV terms, $FY23 millions)



Source: Frontier Economics; Alluvium

Figure 75: Case study C – indicative CBA results incremental to the Base Case – 4% discount rate (NPV terms, $FY23 millions)



Source: Frontier Economics; Alluvium

Distribution of costs and benefits

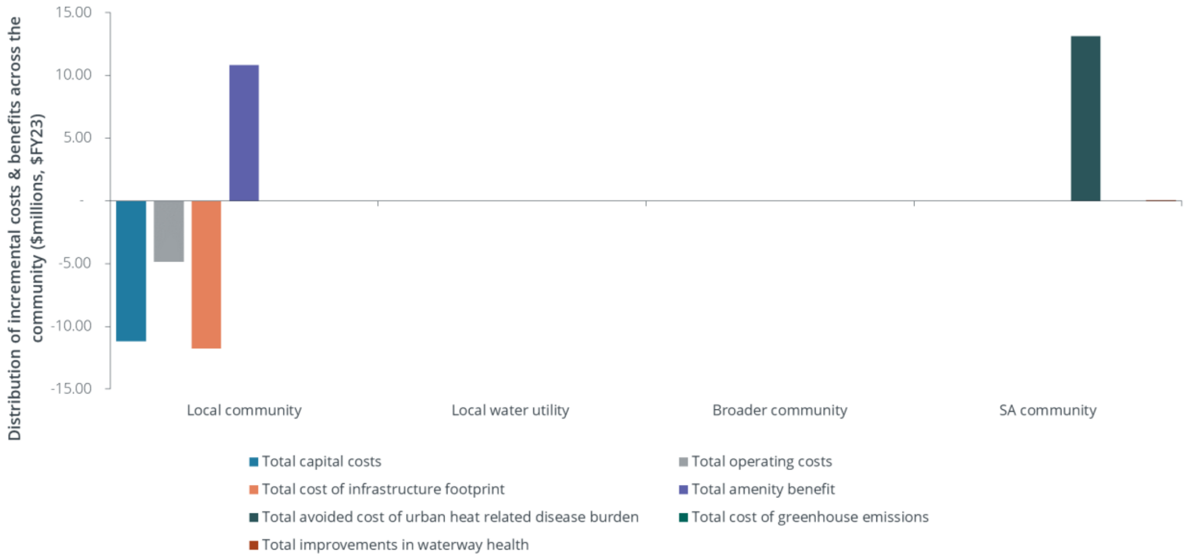
As Option 2 is the preferred option from a CBA perspective (i.e. the option that delivers the greatest next benefit to the community) this analysis has focused on the distribution of the incremental costs and benefits of Option 2, compared to the Base Case.

The indicative distributional analysis captured in **Figure 76** illustrates that:

- The majority of the benefits (in the form of reduced urban heat related disease burden and improvements in waterway health) are received by the SA community.
- The majority of the costs are borne by the local community, in the form of additional costs of delivering the stormwater solution and the additional cost of the infrastructure footprint, given the funding arrangements for this infrastructure.[39]

[39] Noting financial transfers between entities within South Australia should be included in distributional analysis, but not in CBA results.

Figure 76: Case study C – indicative distributional analysis incremental to the Base Case – Option 2 (PV terms, $FY23 millions)



Source: Frontier Economics; Alluvium

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