Department of Planning and Environment

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Framework for Valuing Green Infrastructure and Public Spaces

October 2023

Acknowledgement of Country

The Department of Planning and Environment acknowledges that it stands on Aboriginal land. We acknowledge the Traditional Custodians of the land, and we show our respect for Elders past, present and emerging through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places in which Aboriginal people are included socially, culturally and economically.

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More information

For more information about the framework, contact the department via email at: vgipsframework@dpie.nsw.gov.au

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1 Introduction

1.1 Purpose of the framework

The framework provides detailed guidance to support practitioners undertaking cost–benefit analysis (CBA) of projects, programs and policies relating to green infrastructure and public space.

CBA is the NSW Government's preferred evaluation method. It is required as part of a business case to support funding proposals, in line with NSW Government policy.

The framework aims to provide a standardised, robust and comprehensive approach to identify, quantify and monetise common costs and benefits associated with green infrastructure and public spaces. It can be used by staff, consultants and analysts to undertake CBA as part of developing a business case to support a funding request or policy change.

We expect that the framework would be applied to all green infrastructure and public space business cases prepared by the department. The types of activities covered by the framework are identified in section 1.2.

Parts of the framework may also be relevant for business cases prepared by other departments. For example, a transport project may include green infrastructure or public space and may draw upon this framework to inform the analysis of costs and benefits related to those elements of the project.

The framework may also be used by local governments or other jurisdictions to inform their decision-making processes. It is specifically developed to assess green infrastructure and public space in NSW. Third parties in other jurisdictions should carefully consider whether the cost and benefit parameters presented in the framework are directly applicable to their area.

This framework is designed as a companion to NSW Treasury's NSW Government Guide to Cost-Benefit Analysis (TPG23-08).

1.2 Definitions of green infrastructure and public space

Green infrastructure and public space are defined in Table 1.1. The definitions refer to green infrastructure and public spaces as concepts, not as land-use terms or development types. Some assets, such as parks and bushland, fall under both definitions. Depending on the context, they may be identified as a component of green infrastructure or public space.

Table 1.1 Definitions of green infrastructure and public space

Concept	Definition
Green infrastructure	Green infrastructure is the network of green spaces, natural systems and semi-natural systems that support sustainable communities. It includes waterways, bushland, tree canopy and green ground cover, parks and open spaces that are strategically planned, designed and managed to support a good quality of life in an urban environment.[1]
Public space[2]	Public spaces are all places publicly owned or for public use, accessible and enjoyable by all free and without a profit motive. These include: • public open spaces – active and passive (such as parks, gardens, playgrounds, public beaches, riverbanks and waterfronts, outdoor playing fields and courts and publicly accessible bushland) • public facilities – public libraries, museums, galleries, civic/community centres, showgrounds and indoor public sports facilities • streets, avenues and boulevards, squares and plazas, pavements, passages and lanes and bicycle paths.

A practitioner applying this framework should adopt those concepts and asset classes that are most relevant to their analysis. Practitioners should refer to the sub-asset categories and applicable benefits provided under section 3, Table 3.2 and Table 3.3 to identify which green infrastructure and public spaces benefits apply to their project. In applying this framework, note that green infrastructure is not defined by the level of public accessibility or profit motive, while public space is accessible to all, without a profit motive.

1.3 The business case

A business case is a documented proposal to meet the NSW Government's objectives that is used to inform an investment and/or policy decision. It contains an analysis of the costs, benefits, risks and assumptions associated with various investment and policy options linked to policy or program outcomes and informs future implementation, monitoring and evaluation.[3]

In practice, a business case is a management tool that is developed over time and reflects the priorities of investment stages. It is a multipurpose document that summarises in one place the research and analysis of how proposals will contribute to key investment objectives and reflect the strategic context. The business case provides the basis for comparing and evaluating continued funding, and for measuring the success of the investment and/or policy intervention.

A critical component of a business case is the CBA, which provides evidence that the option(s) selected achieves the required objectives and benefits, maximises social welfare and delivers value

[1] NSW Government Architect, *Draft Greener Places Design Guide*, governmentarchitect.nsw.gov.au/guidance/greener-places-guide, 2020

[2] *UN Habitat Global Public Space Toolkit*, p24

[3] NSW Treasury, *NSW Government Business Case Guidelines*, TPP18-06, treasury.nsw.gov.au/information-public-entities/nsw-business-case-policy-and-guidelines, 2018

for money. This framework is focused on undertaking CBA for green infrastructure and public space-related projects, programs and policies.

For more guidance on business cases, refer to the NSW Government Business Case Guidelines (TPP18-06).[4]

1.4 Cost–benefit analysis

CBA is an appraisal and evaluation technique that estimates the economic, social, environmental and cultural costs and benefits of a project or program in monetary terms. A CBA aims to measure the full impacts of any government decision or action on the households and firms in a specified community. These include any impacts on human welfare.[5]

CBA is the preferred approach for assessing government initiatives because it is the most comprehensive and evidence-based evaluation method. It is an important part of a business case.

For more guidance on CBA, refer to section 2 of this framework, and the NSW Government Guide to Cost-Benefit Analysis (TPG23-08).[5]

1.5 Alignment with other guidance documents

This framework is aligned with other NSW Government project appraisal guidelines, which you should consult alongside the framework. The relevant guidelines referenced by the framework are:

- NSW Government Guide to Cost-Benefit Analysis (TPG23-08)
- NSW Government Business Case Guidelines (TPP18-06)
- Transport for NSW Cost-Benefit Analysis Guide.[6]

1.6 How to use this framework

This framework provides guidance on how to conduct CBA for projects, programs and policies related to green infrastructure and public space. The structure is as follows:

- section 2 introduces CBA
- section 3 identifies typical benefits of green infrastructure and public space
- section 4 identifies the typical costs of green infrastructure and public space
- section 5 details approaches to valuing benefits, including recommended parameter values
- section 6 provides guidance on sensitivity testing

[4] NSW Treasury, *NSW Government Business Case Guidelines*, TPP18-06, treasury.nsw.gov.au/information-public-entities/nsw-business-case-policy-and-guidelines, 2018.

[5] NSW Treasury, *NSW Government Guide to Cost-Benefit Analysis*, TPG23-08, treasury.nsw.gov.au/finance-resource/guidelines-cost-benefit-analysis, 2023.

[6] Transport for NSW website, *Transport for NSW Cost-Benefit Analysis Guide*, transport.nsw.gov.au/projects/project-delivery-requirements/evaluation-and-assurance/transport-for-nsw-cost-benefit.

- section 7 provides guidance on reporting results of CBA
- section 8 discusses the challenges and limitations of economic analysis and common mistakes
- section 9 provides a case study using the framework to value a new district/regional park
- section 10 summarises commonly used non-market valuation techniques.

The framework can be applied to projects of varying sizes, complexities, risks and uniqueness; however, it is important to consider how the guidance should be adjusted. For example, parameter values reported in the framework may not be directly applicable to unique projects, but the framework guides how project-specific parameters can be estimated consistently with the overall framework.

In addition to using the framework, practitioners should engage with stakeholders, including the department's subject matter experts, NSW Treasury and Infrastructure NSW.

2 Cost–benefit analysis

2.1 The purpose of CBA

CBA is an appraisal and evaluation technique that estimates the economic, social, environmental and cultural costs and benefits of a project, policy or program in monetary terms.

A CBA aims to measure the full impacts of any government decision or action on the households and firms in a specified community (reference community). For this framework, the referent group is the State of NSW.[7] There may be circumstances where the relevant community is smaller or larger in scope, which may be reported separately. The full impacts include any impacts on human welfare, including economic, social or environmental impacts, that might arise from a project.

Impacts across the various types of costs and benefits are converted into a common unit. The preferred unit is the Australian dollar in current-day prices.[8] All costs and benefits should be quantified and monetised where feasible and material. These values are then aggregated into the **net present value** (NPV) and **benefit-cost ratio** (BCR) for a proposed project. Report unquantified impacts where they are considered material to the decision-making.

Overall, a CBA reports whether the benefits of a proposal are likely to exceed the costs, and which of the options will result in the highest net social benefit. CBA can also indicate through a distributional analysis which groups bear costs or receive benefits.

CBA results are used to inform the government when it is determining the projects, programs or policies that offer the best outcome for the community. The policy option that delivers the highest **net social benefit** is considered an important indicator of the best outcome for society. This is subject to consideration of any major unquantified effects and major adverse impacts on groups in the community.

2.1.1 Key concepts in CBA

2.1.1.1 Incremental approach

Incremental change is measured relative to what would have happened without the government action – that is, the base case. A CBA should only consider the incremental or marginal impact of a program or project. To ensure this is done well, the base case should be specified in as much detail as possible and quantified to set a baseline for the incremental changes in outcomes that are being measured.

[7] NSW Treasury, *NSW Government Guide to Cost-Benefit Analysis*, TPG23-08, treasury.nsw.gov.au/finance-resource/guidelines-cost-benefit-analysis, 2023.

[8] This excludes future inflation in general prices. Changes in prices relative to inflation are included, such as real changes in coal prices.

2.1.1.2 Long-term perspective

A CBA framework considers the timing of each of the impacts, where future impacts are 'converted' into today's terms so that all impacts can be meaningfully compared, regardless of timing. A CBA, for example, will enable an evaluation of policies that deliver different streams of benefits and costs over time.

2.1.1.3 Microeconomic approach

Microeconomics provides the basic technical and conceptual foundations for CBA. CBA is based on measuring the change in social welfare due to a specific investment, policy or program. Net social benefit is the sum of the change in consumer surplus, producer surplus, labour surplus and government surplus and impacts on the broader community (that is, externalities) associated with the investment, policy or program under consideration.

2.1.1.4 Valuation of benefits

NSW Treasury outlines the 2 key concepts for the valuation of goods and services as:

- the opportunity cost principle
- willingness-to-pay principle.

2.1.1.4.1 Opportunity cost

When resources are used in a particular project or program, they are unavailable to be used elsewhere. Opportunity cost is the value of these resources used in their most attractive alternative use. In general, market prices for capital, labour or other inputs reflect the opportunity cost of the resources.

2.1.1.4.2 Willingness to pay

'Willingness to pay' (WTP) is the maximum amount an individual or firm is willing to pay for a good or service.

2.1.1.5 Evaluation period

The evaluation period must capture all costs and benefits over the life of the project, program or policy.[9] That is, the evaluation period will capture impacts, regardless of whether they occur in 10 years, 20 years or longer.

Often the evaluation period for CBA reflects the expected economic life of the principal asset. However, where a project has environmental impacts (positive or negative), the impacts may continue well after the productive life of the project under consideration. The residual value should be estimated for all remaining impacts that occur beyond the evaluation period.

[9] NSW Treasury, *NSW Government Guide to Cost-Benefit Analysis*, TPG23-08, pp 31-32 treasury.nsw.gov.au/finance-resource/guidelines-cost-benefit-analysis, 2023

NSW Government Guide to Cost-Benefit Analysis (TPG23-08) recommends an evaluation period of 30 to 60 years after construction for major new capital expenditure, and, where applicable, a residual value for impacts beyond that period.[10]

2.1.1.6 Discount rate

CBA measures the flow of costs and benefits over time. To make these flows over time comparable, the value of future costs and benefits is discounted to determine their present value, which is the value today of a future stream of costs and benefits. Present values allow decisions to be made today about initiatives that have costs and benefits in the future.

The NSW Government Guide to Cost-Benefit Analysis (TPG23-08) recommends a social discount rate of 5% (in real terms). Sensitivity testing should be undertaken at 3% and 7% (in real terms). A consistent social discount rate also enables comparisons between all NSW Government initiatives across time on a 'like-with-like' basis.

2.2 Steps in CBA

Table 2.1 briefly outlines the key steps in a CBA. Detailed information is available in the NSW Government Guide to Cost-Benefit Analysis (TPG23-08).

Table 2.1. Steps in CBA. Source – NSW Government Guide to Cost-Benefit Analysis (TPG23-08)

Step	Key tasks
1. **State the objectives**	Define the problem (program logic mapping is a useful technique to identify the issues and link them to options and outcomes). Specify the intended objectives and outcomes of the proposal. The objectives should be specified in terms of welfare outcomes (for example, health improvement).
2. Define the base case	The base case is the state of the world without the proposed project, program or policy. It is a continuation of the current quality and quantity of services (including planned maintenance and usage rates). Clearly define the base case as the projection of costs and benefits without the project or program. Provide evidence for benchmarks, assumptions and forecasts used to define the base case.
3. Develop options	NSW Treasury guidelines specify that it is not sufficient to assess only a single option. A set of feasible options which meet the policy objectives should be developed.

[10] NSW Treasury, *NSW Government Guide to Cost-Benefit Analysis*, TPG23-08, p 58-59, treasury.nsw.gov.au/finance-resource/guidelines-cost-benefit-analysis, 2023

Step	Key tasks
4. Identify and forecast costs and benefits	Identify and forecast the incremental costs and benefits of each option over the life of the project, relative to the base case. Specific costs and benefits can be disaggregated into direct and indirect impacts, and first- and second-round impacts. Direct and indirect first-round impacts should be identified and, where possible, forecast in a CBA. Second-round impacts are generally not included in CBA. See NSW Government Guide to Cost-Benefit Analysis (TPG23-08) for a description of direct and indirect impacts, and first- and second-round impacts. Refer to section 8.3 'Confusing costs and benefits' and section 8.6 'Confusing economic impacts and benefits'.
5. Value costs and benefits	Costs and benefits must be valued using a standard unit of measure. The most used measure is a unit of local currency in present-day prices (real prices). Increases in prices due to inflation or other forms of cost escalation should not be included in the values of future benefits and costs. The present values of the cost and benefit streams should be calculated using a real discount rate of 5%. Take care to avoid double-counting costs and benefits (see section 8.5 'Double-counting and treatment of transfers'.
6. Identify non-market impacts (benefits and costs)	Impacts that cannot be quantified should be accounted for qualitatively. A list of qualitative factors may be included in the CBA to inform decision-makers. These factors should be presented without subjective formal weightings. Market prices are always preferred when available.
7. Distributional analysis	The distributional analysis outlines the gains and losses to different stakeholder groups. All stakeholders must be within the referent group (that is, NSW residents). Distributional analysis can be included as supplementary information in a CBA and will not affect the final BCR.
8. Assess risks and sensitivities	Risks should be identified and managed (for example, contingency allowances, commercial or technical risks) The degree of detail in identifying and assessing risks will depend on the nature of the government action. CBA should include sensitivity analysis of results to key identified risks or changes in key assumptions or parameters. General sensitivity testing should be conducted at a 3% and 7% discount rate. For example, a risk example could prove beneficial (that is, a water (dam) project could test high-, medium- and low-rainfall scenarios). Analysts should assess possible outcomes of a CBA under alternative scenarios and present these based on the expected mean (average) costs and benefits.

Step	Key tasks
9. Assess the net benefit	All costs and benefits to individuals and businesses within the specified community are aggregated into an overall measure of net social benefit. At a minimum, the NPV and BCR should be calculated for each option in the CBA. In the BCR calculation, the NPV of total benefits is the numerator and the NPV of total costs is the denominator. The NPV and BCR measures show, for a given discount rate, when the benefits exceed the costs of a project, program or policy. A project, program or policy is potentially worthwhile if the NPV is positive or the BCR is greater than 1.00. Whether a project, program or policy is worthwhile will depend on the net social benefit of other options.
10. Report the results	A CBA should report the following: • The central value of the 2 referred measures of net social benefit, NPV and BCR, as well as the range of these measures based on key sensitivities. • A summary of the base case, options assessed and the main results of the sensitivity tests. • A summary table showing key categories of benefits and costs in the base case, options assessed, and the dollar values and percentage contribute of each benefit (cost) to total benefits (costs) in each option, relative to the base case. • All assumptions adopted in the CBA. • Where possible, the distribution of costs and benefits among different stakeholders (used in the distributional analysis) should be presented systematically.
11. Undertake post-project evaluation	Major programs undertaken by government agencies are expected to be evaluated at an appropriate point in their life cycle, including evaluation of the process, outcome and economic evaluation. CBA is the preferred approach for economic evaluation. A monitoring plan and post-evaluation plan should be referenced in the ex-ante CBA. Ex-post economic evaluation of projects and programs should be conducted when an outcome evaluation has been completed. Ex-post evaluation should be undertaken once the project or program is fully operational and sufficient information is available to assess whether intended program outcomes have been achieved.

3 Benefits of green infrastructure and public space

Green infrastructure and public spaces deliver a range of environmental and social benefits to urban communities. For example, expanding or improving parkland may result in recreational benefits, health benefits, urban cooling benefits and a range of environmental benefits.

Typical green infrastructure and public space benefits are shown in Table 3.1. These include both:

- direct impacts, which are primarily impacts on producers and consumers of goods or services associated with a proposed project or policy
- indirect impacts, which are impacts on third parties (for example, households or firms) not involved directly in the consumption or production of the primary good or service. For example, tree plantings may result in air quality improvements and reductions in greenhouse gas emissions that benefit third parties.

Table 3.1. Typical green infrastructure and public space benefits

Benefit category	Description
Use value (recreational benefits)	User benefits reflect the value derived from individuals directly interacting with public space. It is the amount that consumers are willing to pay for their use of the good or service or amenity. Examples of recreational use values for green infrastructure and public space include the value to an individual of visiting a public park, an art gallery or a plaza, and the amenity provided by public space (including visual amenity and urban amenity such as functional considerations of safety, comfort and convenience).
Use value (health benefits)	The use of public open space may be associated with improvements in health, due to regular active and passive recreation. Recreation can result in reductions in: • the risk of mortality and morbidity arising from related diseases (such as certain cancers, coronary heart disease, diabetes and mental health conditions) • the costs of providing health services to the community • productivity losses arising from absenteeism and presenteeism.
Aboriginal cultural and heritage value	Aboriginal cultural heritage consists of places, traditions, beliefs, customs, values and objects that represent the living history of Aboriginal generations and are of important cultural and heritage significance to Aboriginal people. This benefit category measures the value to society of protecting and preserving: • sites and on-site artefacts • artefacts maintained off-site (for example, through galleries and museums). NSW Treasury is developing a framework for considering costs and benefits related to Aboriginal cultural heritage impacts. This team should be consulted if this is a major component of the project's objectives.

<table>
<tr><th>Benefit category</th><th>Description</th></tr>
<tr><td>Active transport benefits</td><td>Active transport such as cycling and walking can result in reduced congestion and better health outcomes. Road congestion benefits may arise from mode-switching to active transport from other modes.</td></tr>
<tr><td>Air quality</td><td>Air pollution, such as particulate matter and volatile organic compounds, is damaging to human health. Improved air quality can reduce the risk of respiratory-related diseases, such as ischaemic heart disease, chronic obstructive pulmonary disease, lung cancer and acute lower infections in children. This reduces the costs of mortality, morbidity and associated costs to the public health system.</td></tr>
<tr><td>Biodiversity</td><td>Biodiversity encompasses the variety of plant and animal life in a particular area. The term includes the diversity of genes, species and ecosystems. Biodiversity can be enhanced by providing habitat, supporting ecosystems and planting diverse plant species.
The value of biodiversity may include:
direct use value through benefits created by recreation and tourism activities that are dependent on biological resources and/or benefits arising from goods such as pharmaceuticals and agricultural projects that are impacted by biological resources
passive use value including life-support services such as nutrient removal, flood control and climate stabilisation
non-use value including existence, bequest and option values.
The direct use and passive use values are measured under other benefit categories in the framework. The non-use values are measured in the biodiversity benefit category.</td></tr>
<tr><td>Greenhouse gas (GHG) impacts</td><td>Urban trees and other plants act as a sink for carbon dioxide (CO_2) by fixing CO_2 during photosynthesis and storing carbon as biomass. Urban plantings can therefore have a benefit related to mitigating the impacts of climate change and contributing to the achievement of government targets for greenhouse gas emissions.</td></tr>
<tr><td>Urban cooling benefits</td><td>Lower ambient temperatures can result in health benefits, energy savings (from reduced cooling energy demand) and avoided GHG emissions (from reduced cooling energy demand).</td></tr>
<tr><td>Stormwater management</td><td>Urban green spaces capture water run-off, which reduces the volume of stormwater that needs to be processed. This can result in:
cost savings associated with lower water stormwater servicing and water filtration
improved water quality due to lower stormwater volumes entering waterways.
These benefits, in particular cost savings, are likely to vary from project to project.</td></tr>
<tr><td>Option, existence and bequest value</td><td>Individuals may experience benefits associated with public spaces, without visiting or interacting with these spaces. These benefits may include:
option values – the value to community members of having the option to visit green infrastructure and public space in the future
existence value – the benefits gained from knowing green infrastructure and public space or biodiversity is conserved
bequest value – the value associated with the knowledge that green infrastructure and public space will be preserved for future generations.</td></tr>
</table>

Table 3.2 and Table 3.3 summarise which of the benefits listed in Table 3.1 may arise from particular types of projects. The tables are broken into asset classes to reflect the different range of benefits, for example, new assets and improvements to existing assets.

The blue-shaded cells marked B represent relevant benefits for the particular asset category (those for which there may be a benefit).

This provides **a starting point for the list of relevant benefits** that should be considered and verified for a project related to a particular asset class. Specific projects may generate benefits not discussed here, which should also be considered in any CBA. Where these other benefits are included, justification should be provided establishing the causal link between the proposed investment or intervention and the benefit being attributed.

In Table 3.2, new public open space for beaches and waterways is marked as 'n/a' because projects will not create new spaces for these 2 asset classes. Rather, projects will improve existing open space through changes to amenity, accessibility and water quality. Recreational use values for swimming, fishing and boating may occur in new or improved parklands, gardens and play spaces and bushland/protected open space if water assets are already present in existing spaces or are created in new spaces.

Table 3.2. Benefit types applicable to each asset for public open space and green infrastructure

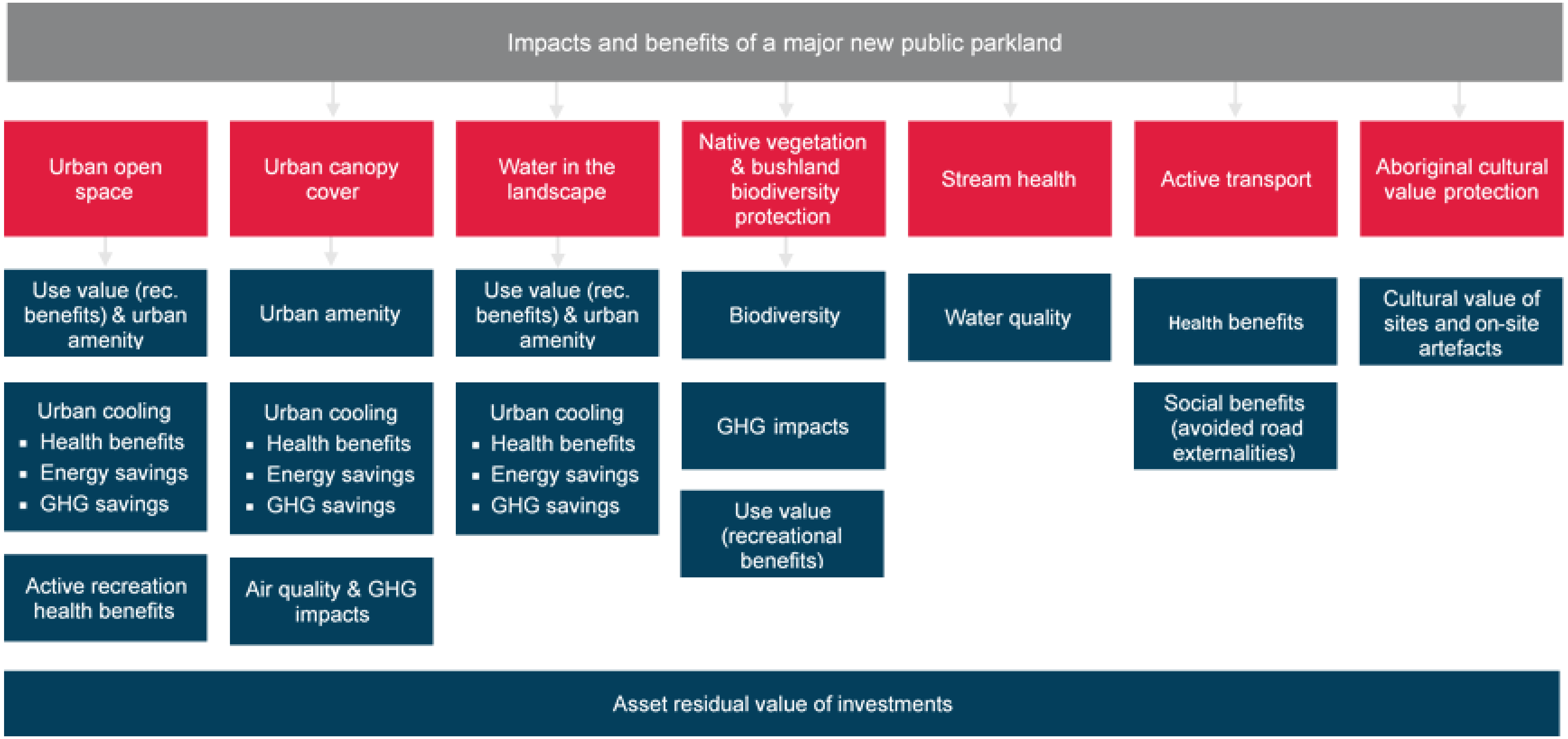
Type of benefit	Section	Asset class	New public open space					Improvements to existing spaces				
-	-	Sub-asset class	Parklands, gardens and playspaces	Bushland/protected open space	Beaches	Sport fields	Waterway	Parklands, gardens and playspaces	Bushland/protected open space	Beaches	Sport fields	Waterway
Use value (recreational benefits)	5.1.1	Recreational use value – non-water related	B	B	n/a	B	n/a	B	B	B	B	-
		Recreational use value – swimming	B	B	n/a	-	n/a	B	B	B	-	B
		Recreational use value – fishing	B	B	n/a	-	n/a	B	B	B	-	B
		Recreational use value – boating	B	B	n/a	-	n/a	B	B	B	-	B
		Urban amenity	B	B	n/a	B	n/a	B	B	B	B	B
Use value (health benefits)	5.1.2	Health benefits from increased physical activity (excluding active transport)	B	B	n/a	B	n/a	B	B	B	B	B
Aboriginal cultural and heritage value	5.1.8	Cultural value of sites and on-site artefacts	B	B	n/a	-	n/a	B	B	B	-	B
		Cultural value of artefacts maintained off-site	-	-	n/a	-	n/a	-	-	-	-	-
		Connection to Country benefits	B	B	n/a	-	n/a	B	B	B	-	B
Active transport	5.1.3	Health, social and environment benefits of (cycling/walking)	B	-	n/a	-	n/a	B	-	-	-	-
Air quality	5.1.4	Improved air quality from tree cover	B	B	n/a	B	n/a	B	B		B	-
		Improved air quality from public open space (non-tree cover)	-	-	n/a	-	n/a	-	-	-	-	-
Biodiversity	5.1.5	New and improved habitat	B	B	n/a	-	n/a	B	B	-		B
GHG impacts	5.1.6	Carbon sequestration from tree cover	B	B	n/a	B	n/a	B	B	-	B	-
Stormwater management	5.1.8	Avoided cost to manage stormwater flow during storm events	B	B	n/a	B	n/a	B	B	-	B	B
Urban cooling benefits	5.1.7	Health benefits from urban cooling	B	B	n/a	B	n/a	B	B	-	B	-
		Energy savings from urban cooling	B	B	n/a	B	n/a	B	B	-	B	-
		Avoided energy GHG emissions from urban cooling	B	B	n/a	B	n/a	B	B	-	B	-
Option, existence, and bequest value	5.1.8	Value of option for future uses, research purposes, historical value	B	B	n/a	B	n/a	B	B	B	B	B

Table 3.3. Benefit types applicable to each asset for streets and public facilities

Type of benefit	Section	Asset class	Improved streets		New public facility						Improvements to an existing facility					
-	-	Sub-asset class	Walkable shady	Walkable shady plazas	Library	Museum	Community centre	Gallery	Showgrounds	Indoor public sports facilities	Library	Museum	Community centre	Gallery	Showgrounds	Indoor public sports facilities
Use value (recreational benefits)	5.2.1 and 5.3.1	Recreational use value – non-water related	B	B	B	B	B	B	B	B	B	B	B	B	B	B
		Urban amenity	B	B	-	-	-	-	-	-	-	-	-	-	-	-
Aboriginal cultural and heritage value	5.2.2	Cultural value of sites and on-site artefacts	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Cultural value of artefacts maintained off-site	-	-	B	B	-	B	-	-	B	B	-	B	-	-
		Connection to Country benefits	-	-	B	B	-	B	-	-	B	B	-	B	-	-
Active transport	5.3.2	Health, social and environment benefits of (cycling/walking)	B	-	-	-	-	-	-	-	-	-	-	-	-	-
Air quality	5.3.2	Improved air quality from tree cover	B	B	-	-	-	-	-	-	-	-	-	-	-	-
		Improved air quality from public open space (non-tree cover)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biodiversity	5.3.2	New and improved habitat	B	B	-	-	-	-	-	-	-	-	-	-	-	-
GHG impacts	5.2.2 and 5.3.2	Carbon sequestration from tree cover	B	B	-	-	-	-	B	-	-	-	-	-	B	-
Stormwater management	5.2.2	Avoided cost to manage stormwater flow during storm events	-	-	-	-	-	-	B	-	-	-	-	-	B	-
Urban cooling benefits	5.2.2 and 5.3.2	Health benefits from urban cooling	B	B	-	-	-	-	B	-	-	-	-	-	B	-
		Energy savings from urban cooling	B	B	-	-	-	-	B	-	-	-	-	-	B	-
		Avoided energy GHG emissions from urban cooling	B	B	-	-	-	-	B	-	-	-	-	-	B	-
Option, existence, and bequest value	5.2.2	Value of option for future uses, research purposes, historical value	-	-	B	B	B	B	B	B	B	B	B	B	B	B

As an example, Figure 3.1 shows the typical benefits that should be considered for a major new public parkland comprising a mix of passive and active recreation, bushland and stormwater retention and management. There are a wide range of possible impacts of such a project and an even wider range of benefits. For example, the project could provide additional urban canopy cover, which reduces heat island effects, filters air pollution and provides urban amenity, as well as providing bushland that provides biodiversity benefits and sequesters carbon. It may also provide lakes or ponds that assist in stormwater management, while also providing amenity value.

Figure 3.1 Example project impacts and benefits – new public parkland. The red boxes denote impacts and the blue boxes denote benefits.



4 Costs of green infrastructure and public space

The costs of green infrastructure and public space projects will include:

- costs related to the construction of the project, such as the opportunity cost of land, land acquisition, design and constructing infrastructure
- costs related to the replacement of capital during the project evaluation period, such as components of the project's assets with a short life that need replacing
- costs related to the ongoing maintenance and operation of the project.

As a rule, cost estimates will be specific to the individual project and reflect the design and conditions associated with the construction and operation of the project. In some cases, where project-specific costs are not available, you can use cost benchmarks. This will be more appropriate during strategic analysis and for projects with low risk.

Examples of cost benchmarks for CBA practitioners are shown in Table 4.1. Other benchmarks may be available from the department based on recent projects. However, in most instances, specific cost advice would be needed. For example, benchmark land costs are not provided as these are likely to vary considerably, depending on the location and zoning of land.

The costs presented in Table 4.1 are representative of 2022 prices. These should be indexed using the consumer price index of, if available, a relevant output producer price index to bring these to the dollars for the reference year used in the CBA.[11]

[11] Producer price indices can be found at: www.abs.gov.au/statistics/economy/price-indexes-and-inflation/producer-price-indexes-australia/latest-release. The construction indices are the most likely to be relevant for projects covered by the framework.

Table 4.1. Benchmark costs (2022 dollars)

Infrastructure	Capital expenditure (Capex)	Operational expenditure	Assumption	Source
Active transport (shared path)	**Sydney:** • $6.0 million/km for 0 km to 5 km • $1.6 million/km for >5 km **Parramatta:** • $3.2 million/km for 0 km to 5 km • $1.3 million/km for >5 km **Western Sydney Airport:** • $2.0 million/km for 0 km to 5 km • $0.9 million/km for >5 km	1.5% of capex per year	n/a	Transport for NSW (2019) Cycling Investment Program Strategic Business Case Economic Analysis
Active transport (national park)	$650/m for a walking trail $220/m low-grade walking track (mountain bike trail)	1.5% of capex per year	n/a	Draft Cumberland Plain Conservation Plan (2020)
Tree planting	**For tube stock:** $16/tree **For street trees:** (includes purchasing and installation) $317/tree (small) $391/tree (medium) $489/tree (tall) **For open space trees:** (includes purchasing and installation) $261/tree (small) $336/tree (medium) $434/tree (tall)	**For tube stock:** $185/tree/year first year $33/tree/year thereafter **For street trees:** $160/tree/year (small) $194/tree/year (medium) $240/tree/year (tall) **For open space trees:** $23/tree/year (small) $57/tree/year (medium) $103/tree/year (tall)	**Tree size (height) at maturity:** Small – 6 to 9 metres Medium – 10 to 15 metres Tall – 16 metres and over	Dept of Planning and Environment (2023)
Protection and improvement of existing vegetation	$41,000/ha for protection $82,000/ha for improvement	$2,240/ha/year ($0.245/m^2/year)	n/a	Western Sydney Place Based Infrastructure Compacts (PICs)
Waterway management activities	$41,000/ha for protection $82,000/ha for improvement	$2,450/ha/year ($0.245/m^2/year)	n/a	Western Sydney PICs
Land maintenance	n/a	$0.19/m^2	Cost of maintaining acquired land before project delivery – calculated based on the cost of maintenance for the Western Sydney Parkland	Western Sydney Parkland
Passive open space	$163 to $218/m^2 for regional open space for embellishment cost (not including land acquisition or management costs)	$1.05/m^2/year	n/a	Dept of Planning and Environment (2020)
Active open space	$272 to $327/m^2 embellishment cost (not including land acquisition or management costs)	$1.05/m^2/year	Costs are based on the average costs for a natural turf field	Dept of Planning and Environment (2020)

4.1 Changes in costs over time

Costs may change over time. The CBA is undertaken in real dollars. That is, costs would exclude the impact of general changes in inflation. The estimates of costs should include changes to costs that are higher or lower than general inflation. For example, if construction costs are expected to increase by 4.5% per year relative to today's costs and general price inflation is expected to increase by 2% per year, then the CBA would include a real increase in construction costs of 2.5% per year.

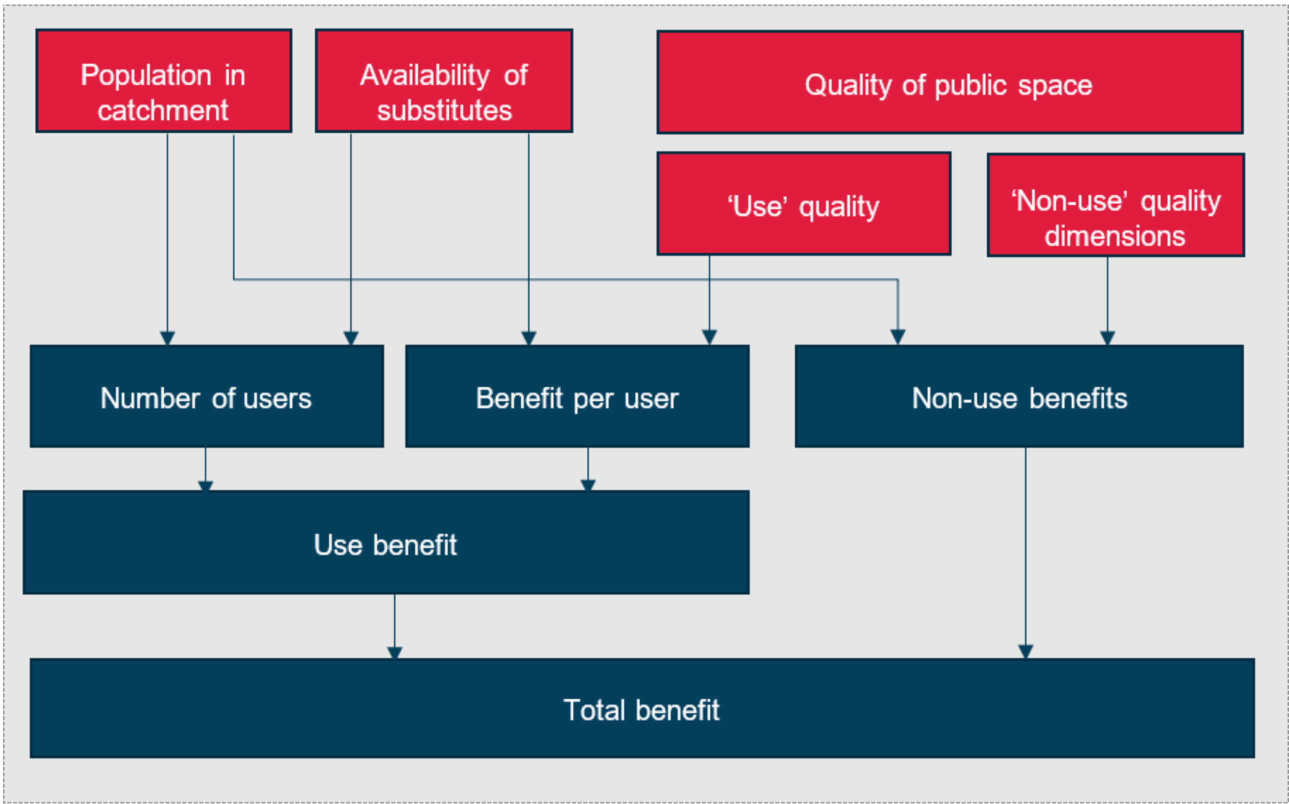
Land price escalation can be of particular importance for public space projects because land can be a high proportion of costs. Land prices, which reflect the opportunity cost of land, have historically increased faster than general inflation. The residual value of land, or opportunity cost of land, at the end of the evaluation period, may be relatively large for some projects that have a high share of land costs. Land price escalation can be included based on historical averages or based on forecasts provided by the NSW Government, which you can get through the NSW Office of Strategic Lands.

5 Approaches to valuing the benefits of green infrastructure and public space

The benefits of public space are driven by a range of features, as shown in Figure 5.1.

- Use value will be highest where the public space has a large **population in the catchment** (which defines the area where infrastructure users typically come from), few available **substitutes** and is of **high quality**.
- Some non-use values (such as amenity, cooling and air pollution) will also typically be highest where the population in the catchment is larger and quality is higher, although what represents 'quality' from a user's perspective will be different to what represents 'quality' from a non-user's perspective.
- Other non-use values (such as non-use values of biodiversity) will not directly depend on the population in the catchment.

Figure 5.1 The major drivers of the value of a public space



The valuation literature does not cover all green infrastructure and public space in sufficient depth to specify the full set of issues that will drive value. However, the conceptualisation in Figure 5.1 provides a guiding principle on the main issues relevant to an evaluation and what needs to be measured.

In the following sections, the framework sets out the recommended approaches and, where possible, parameters that can be applied to value the benefits of green infrastructure and public space. Further detail on the basis of the recommended parameters is provided in the Technical Appendices to the framework. The Technical Appendices are also a good reference for available literature on project impacts. These will be updated over time with new research and information.

In the case where a proponent considers there are alternative values to those recommended in this framework, the proponent should present the CBA using the framework's recommended parameter values, as well as separately using the alternative values. Justification and evidence for the use of the alternative parameter values should also be provided.

Most projects can apply the parameter values for green infrastructure and public open spaces, public facilities and streets. For projects that have higher costs, or where there is a specific focus on one objective (such as maximising urban cooling impacts), then additional analysis, environmental modelling and adjustments to parameters and approaches may be required.

Sections 5.1 to 5.6 set out the recommended approaches and parameters summarised in Table 5.1.

Table 5.1 Summary of parameter values provided

Project type	Benefit category	Framework section	Application of parameters
Green infrastructure and public open space	Use value (recreational benefits and urban amenity)	Section 5.1.1	Urban parks & sports fields Blue Space National Parks Beaches
Green infrastructure and public open space	Use value (health benefits)	Section 5.1.2	Active transport projects Urban parks & sports fields
Green infrastructure and public open space	Active transport	Section 5.1.3	Active transport projects
Green infrastructure and public open space	Air quality	Section 5.1.4	Any projects with tree planting
Green infrastructure and public open space	Biodiversity	Section 5.1.5	Protection or enhancement of areas of native vegetation
Green infrastructure and public open space	GHG impacts	Section 5.1.6	Any projects with tree planting
Green infrastructure and public open space	Urban cooling benefits	Section 5.1.7	Any projects with tree planting
Green infrastructure and public open space	Other benefits – option, existence and bequest value	Section 5.1.8	No parameters provided
Public facilities	Use value	Section 5.2.1	New or improved public facilities
Public facilities	Other benefits	Section 5.2.2	No parameters provided
Streets	Use and amenity value	Section 5.3.1	Projects that improve street or public place amenity Projects with street tree planting
Streets	Other benefits	Section 5.3.2	No parameters provided

5.1 Parameter values – green infrastructure and public open space

5.1.1 Use value (recreational benefits)

Use benefits reflect the value derived from individuals directly interacting with public open spaces. It is the amount that consumers are willing to pay for their use of the good, service or amenity.[12] Examples of recreational use values of public open space include the value to an individual of visiting a public park or national park.

The key determinants of the use value of new or improved public open space include the:

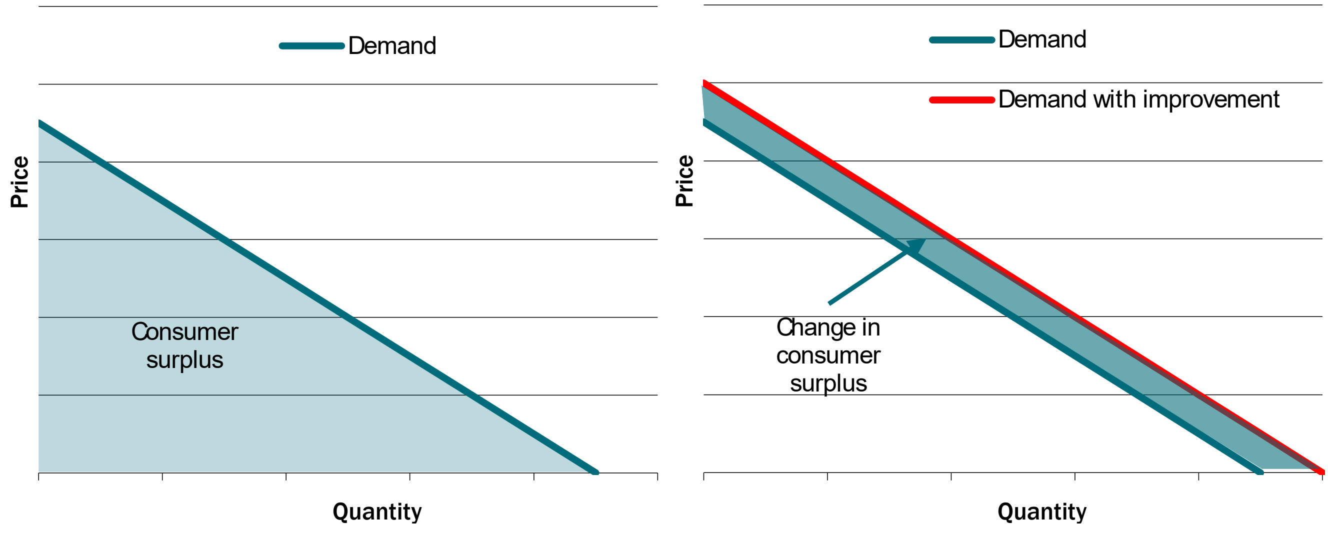
- types of uses and diverse functions that the place allows
- number of people within a catchment, which will impact the number of users
- quality of a place, which could include improved facilities, functional size, accessibility and connectivity
- availability (quantity), quality and capacity of other substitute facilities – diminishing returns would be expected for higher levels of green and blue space.

At its broadest conceptual level, use value captures the area under the demand curve for a particular public open space. For CBA, the focus is on the overall demand curve for new public open space or how the demand curve changes from an improvement to an existing public open space.

This is shown in Figure 5.2 for free public open space — that is, where the price is zero:

- The left-hand panel shows the value of use for an existing or new public open space. This is the total area under the demand curve.
- The right-hand panel shows the value of use for an improvement to a public open space, which is the area between the demand curve and demand with the improvement.

Figure 5.2 Measuring consumer surplus from public open space



[12] NSW Treasury, *NSW Government Guide to Cost-Benefit Analysis*, TPG23-08, p 26, treasury.nsw.gov.au/finance-resource/guidelines-cost-benefit-analysis, 2023

5.1.1.1 Recommended parameters

Different parameters are recommended for different types of public open space. The default parameters shown in the section below are specified for use primarily at strategic level analysis. Further supporting information and judgements about the application of these parameters would be expected at more detailed levels of project analysis and for larger projects. For example, for a large project, project-specific parameters could be developed using a project-specific choice modelling study or hedonic pricing model. Approaches to developing project-specific parameters are discussed in section 5.6.

5.1.1.1.1 New urban parks and sports fields

For new urban parks and sports fields, the recommended valuation approach has 2 components:

- base value — the approach to estimating the base value for urban parks and sports fields relates changes in public open space to changes in property values. The framework recommends measuring this benefit by applying a 0.3% increase in property prices per percentage point increase in the share of open space in the surrounding catchment area that is open space (see Box 5.1).[13] This value would be applied to blue infrastructure within parks, as well as green areas, such as wetlands
- value of additional facilities — apply WTP estimates for additional facilities such as playspace, BBQ facilities, cricket nets and walking tracks.

Estimating the base value of new urban parks and sport fields

Box 5.1 outlines the recommended catchments for estimating the base value for new urban parks and sports fields.

Box 5.1. Guide to calculating catchments for new urban parks and sports fields

> If a new park led to the share of the park catchment that was parkland increasing from 10% to 15%, the value would be measured as a 1.5% increase in property values across the park catchment (5 percentage points increase multiplied by 0.3%).
>
> The area to which the value is applied (the catchment) will depend on the park. As a guide, the following catchments are recommended:
>
> - 200 m for a small local park (0.15 ha to 0.5 ha)
> - 400 m for a local park (0.5 ha to 5 ha)
> - 1,600 m for a district park (5 ha to 25 ha)
> - 5 km for a regional park (25 ha to 50 ha)
> - 10 km for a metropolitan park (above 50 ha).

While the benefit for the base value is measured through a **once-off change in property values**, this is simply a proxy for the value of the annual services provided to users of a park, which is then incorporated into the value of the property.

[13] Greater London Authority Economics, 'Valuing Greenness: Green spaces, house prices and Londoner's priorities', and technical paper at www.london.gov.uk/sites/default/files/valuing_greenness_paper.pdf, 2003

Note that the assumed benefit related to the amount of open space is a highly generic value. It does not reflect differences in the quality of the green place and the existing amount of green space. The value of providing certain additional facilities at new parks can be estimated using available WTP estimates or through a broad approach to open space augmentation based on capital expenditure levels.

A caveat to the recommended approach to estimating the base value is it does not allow for a lower value to be applied if there is a large amount of existing parkland and a higher amount if there is a scarcity of parkland.

Estimating the value of additional facilities at new urban parks and sports fields

A choice modelling study by Community and Patient Preference Research (CaPPRe), 2022 estimated the value NSW households place on additional facilities provided at an urban park or sports field.[14] The recommended parameters for additional facilities at an urban park and sports field are shown in Table 5.2.

Table 5.2 Household WTP by characteristic at an urban park or sports field[14]

Characteristic	Urban park $/household	Sports field $/household
Picnic shelter and BBQ facilities	29.0	34.1
Playspace (standard)[15]	29.3	30.0
Cycling or walking track	23.0	n/a
Lighting	12.5	n/a
Outdoor fitness area	16.5	25.0
Skatepark	9.4	16.6
Event space	12.5	n/a
Dog off-leash area	29.3	n/a
Basketball and netball court	n/a	20.2
Bike tracks	n/a	23.3
Basketball court	n/a	8.7
Cricket nets	n/a	6.0

The estimated WTP values per household should be applied to each additional characteristic for the households located within the 'nearest catchment'. The nearest catchment contains all households

[14] Community and Patient Preference Research (CaPPRe), 2022, Willingness to pay for green infrastructure and public spaces in NSW, Final Report prepared for the Department of Planning and Environment.

[15] It is recommended this value be applied to playspaces that are of a standard quality. The description for Playspace provided in the Discrete Choice Experience was 'Playspaces for difference age groups and abilities, including shade, access and seating'. See page 78 of Community and Patient Preference Research (CaPPRe), 2022, *Willingness to pay for green infrastructure and public spaces in NSW,* Final Report prepared for the Department of Planning and Environment.

for which the proposed characteristic is the nearest. Table 5.3 provides an example of the nearest catchment for a proposed new skatepark.

In this example, the nearest existing skatepark is 1 kilometre from Household 1 and 5 kilometres from Household 2. The proposed new skatepark will be 2 kilometres from Household 1 and 2. The proposed new skatepark will be the nearest for Household 2, but not for Household 1. Only Household 2 should be included in the 'nearest catchment' when applying the WTP of $9.40 per household for a new skatepark in an urban park.

Table 5.3. Defining the 'nearest' catchment for characteristics at urban parks or sports fields. Source – the Centre for International Economics

Additional attribute provided	Household 1 km	Household 2 km
Distance to nearest existing skatepark	1	5
Distance to proposed new skatepark	2	2
Include household in 'nearest catchment'	No	Yes

Estimating the value of varying qualities of parks

The WTP estimates for specific attributes capture some aspects of quality but not others. An alternative approach where a new park is augmented to a lower or higher quality than the standard or where an existing park is embellished, is to scale the base park amenity factor by the level of expenditure. The expenditure used should only include expenditures related to park amenity and would not include land acquisition and excavation-type activities that are not related to the benchmark.

For example, if a new park has a capital expenditure of $100 per m^2, compared to a standard capital expenditure of $200 per m^2, then the base park amenity factor would be halved from 0.3% per additional 1% share of open space to 0.15%.

This approach has the advantage that it can control for varying levels of quality of the embellishments for a park. The disadvantage is that higher or lower expenditure than standard could simply reflect the level of efficiency with which a park is developed and may not reflect higher or lower value. For example, one project may spend $200 per m^2 and have high benefits because the augmentations are well aligned with what the community would like. Another park with similar expenditure may have very low benefits if the augmentations don't align with the community's preferences.

In general, where a park is spending much less than the benchmark capital expenditure amount, it is reasonable to consider a downward adjustment to the base amenity factor. Where a much higher level of expenditure is being contemplated for the embellishment of an existing park, the reasonableness of applying an upward adjustment to the amenity factor could be tested against the expected change in visitation.

5.1.1.1.2 Improvements in blue space (swimmable waterways)

For improvements to water quality that enables swimming, the recommended parameters are based on Bennett et al 2015:[16]

- $3.45 per household per km of additional swimmable waterway, where there are less than 70 km of swimmable waterway already available
- $2.65 per household per km of additional swimmable waterway, where there is 70 km to 100 km of swimmable waterway already available
- $0 for increases above 100 km.

These values are:

- per household
- per km of additional swimmable waterway
- per year for 10 years in 2022 dollars.

The catchment to be applied should be the population for which this is the closest natural swimming area of comparable quality.[17]

5.1.1.1.3 National parks

For national parks and other protected areas[18], the use benefit should be estimated through the application of the network-wide transport cost model developed by Heagney et.al. 2019.[19] This can be used to measure the change in consumer surplus from new or upgraded protected areas. The value per visit reported in the study should not be applied — rather the model itself should be used. To use this model for CBA, practitioners should contact the department[20] and/or the authors.

5.1.1.1.4 Upgrades to existing urban parks and sports fields

The recommended parameters for additional facilities at an urban park and sports field are shown in Table 5.2 and should be applied to upgrades to existing urban parks and sports fields (where applicable).

5.1.1.1.5 Beaches

The recommended value for a visit to an existing beach is $18.04 (2022 dollars). This is based on the average consumer surplus estimated by Anning (2012) across 2 Sydney beaches, Collaroy–Narrabeen and Manly Ocean Beach.[21]

Practitioners will need to estimate the change in visitation due to the policy/project in question to apply this value per beach visit. The types of projects this would be relevant to would relate to

[16] J Bennett, J Cheesman, R Blamey, and M Kragt, 'Estimating the non-market benefits of environmental flows in the Hawkesbury-Nepean River', *Journal of Environmental Economics and Policy*, Vol. 5(2), pp 236–248, doi.org/10.1080/21606544.2015.1083484, 2015

[17] The original study used an approximate 1-hour catchment. However, such a wide catchment is likely to be too large, particularly in urban areas and areas where there are many existing available swimming areas.

[18] Protected areas are set aside for conservation and managed by the NSW National Parks and Wildlife Service (NPWS). NPWS also jointly manages several reserves in partnership with Aboriginal people. National parks are one category of protected areas.

[19] EC Heagney, JM Rose, A Ardeshiri, & M Kovac, *The economic value of tourism and recreation across a large, protected area network, Land Use Policy*, volume 88, 2019

[20] Practitioners can contact the department via email at: vgipsframework@dpie.nsw.gov.au

[21] Anning, D. (2012), *Estimation of the economic importance of beaches in Sydney, Australia, and implications for management*, PhD Thesis UNSW, March, unsworks.unsw.edu.au/fapi/datastream/unsworks:10467/SOURCE02?view=true.

changes to water quality to make a beach available for more of the time and investments that reduced coastal erosion impacts on beaches.

5.1.2 Use value (health benefits)

The availability of public open space is an important enabler of physical activities, including organised and casual sports. Physical activity has a positive impact on health and wellbeing. It improves mental health and cognitive function and reduces the risks of non-communicable diseases such as coronary heart disease, stroke, type 2 diabetes, breast cancer and colon cancer.[22] In NSW, approximately 66% of the population is estimated to be overweight (35%) and obese (31%), based on the body mass index.[23]

Health benefit categories could include:

- improved quality of life or reduced mortality, including improvements in mental health.
- reduced public health system costs.

The recommended approaches discussed below focus on reduced health system costs. Improved quality of life and reduced mortality are expected to be factored into the use value of public open space, at least in part. For example, the positive impact of physical activity on one's health will be included in decision functions for levels of physical activity and measured as part of the use value of open space set out in the previous section. This approach reduces the risk of double-counting user benefits.

Green infrastructure and public space may also have impacts on mental health that arise without any change in the level of physical activity.[24] This is an area for further research. Mental health impacts related to physical activity are measured in some studies and not others.

Key determinants of the health benefit from public open space are the:

- number of people impacted by the public open space
- amount of additional physical activity caused by the change in public open space
- extent to which increases in physical activity occur for less active people, where the health benefits will be higher
- access, location and quality of public open space, which is important in driving the above determinants.

Three recommended methods could be used to quantify this benefit, based on information available for the project. These are the:

- per km method, which will most commonly be used to measure the health benefits of active transport infrastructure
- visitation-based model, which applies a benefit parameter per visitor. This requires information about the number of visitors

[22] Ding, Lawson, Kolbe-Alexander, Finkelstein, Katzmarzyk, van Mechelen, Pratt, The economic burden of physical inactivity: a global analysis of major non-communicable diseases, *The Lancet*, 2016

[23] Australian Bureau of Statistics (ABS), National Health Survey: First Results, 2017–18, 2018.

[24] T Astell-Burt, X Feng, Association of Urban Green Space With Mental Health and General Health Among Adults in Australia, *JAMA Network Open*, 2(7):e198209. doi:10.1001/jamanetworkopen.2019.8209, 2019

- catchment-based method, which applies a benefit parameter per person in the catchment of public open space. This is generally applied when an investment significantly improves the attractiveness of parks or establishes an attractive, large, new park.

The choice of method will primarily depend on the information available for the project.

5.1.2.1 Method 1: Per km method – active transport infrastructure

This approach is most applicable to active transport infrastructure within public open spaces or elsewhere. The method is implemented as follows:

- Measure the **additional** kilometres of walking and cycling expected as a result of the project. This could use an active transport model (that is, a transport model that explicitly models active transport trips) or the New Zealand Transport Agency method, also applied by Transport for NSW and set out in Box 5.2.
- Apply values for the public health system costs avoided as a result of additional activity based on the Australian Transport Assessment and Planning parameters ($2021):[25]
  - $1.13 per additional km of walking
  - $0.56 per additional km of cycling

  Note these parameter values differ from those recommended by Transport for NSW's method for estimating active transport use.

Health system avoided costs are based on the relationship that sees a healthier population consume fewer health services than would otherwise be required. However, this impact is marginally offset by the population on average living longer and consuming more health services within that time.

These health values do not include mortality and morbidity associated with inactivity. This is to minimise the likelihood of double-counting with use value recreational benefits measured in section 5.1.1.

[25] ATAP 2016, M4: Active Travel, www.atap.gov.au/sites/default/files/m4_active_travel.pdf.

Box 5.2. Transport for NSW method for estimating active transport use

Transport for NSW has used a method to calculate additional future demand based on the New Zealand Transport Agency (NZTA).[26]

The main steps to calculate future demand and benefits relative to the base case of no active transport infrastructure include:

1. calculating catchment areas (400 m, 800 m and 1,600 m) around the proposed active transport link
2. calculating the population in these catchments by combining the catchments with travel zone data – the benefits will depend on the staging of the infrastructure development and the forecasted population in any given year and buffer zone
3. applying the parameter estimates of NZTA for each buffer zone. These parameter estimates are multipliers of the likelihood of new daily cyclists for each catchment area. For example, the likelihood for the population living 400 m to 800 m away from the active transport infrastructure is 0.54 because 54% of the cycling population within this catchment is likely to use cycling paths daily
4. applying the mode share for cycling and walking from the household travel survey.

This methodology does not estimate substitution from other activities. If users substitute active transport for other forms of exercise, the health benefit will be overstated.

5.1.2.2 Method 2: Visitation-based method

This approach is applicable if estimates of use are available, such as for new or improved protected areas or improvements to parks where visitation information is available. The method is implemented as follows:

- Measure the amount of expected use (or change in use) of the public open space in terms of number of visits.
- Apply an estimate of the average time spent doing moderate-intensity exercise per visit. This assumption should, where possible, be supported by evidence.
- Apply a factor for how much of the activity is additional. This will be high where there are few alternatives and low where there are many alternatives. At this stage, there is insufficient guidance on additionality.
- Convert additional minutes of activity into walking-equivalent kilometres, based on 5 kilometres per hour of activity.
- Apply the values for Method 1 of $1.13 (2021 dollars) per additional km of walking to the walking-equivalent kilometres.

[26] NZTA, Monetised benefits and costs manual, www.nzta.govt.nz/assets/resources/monetised-benefits-and-costs-manual/Monetised-benefits-and-costs-manual.pdf, section 4.2., 2020. Note that Transport for NSW will replace this approach by an activity-based model when this has been developed.

5.1.2.3 Method 3: Catchment-based method

This approach is applicable for projects that substantially increase the attractiveness of parks or establish an attractive, large, new park. The method is implemented as follows:

- Measure the population within the catchment of the asset: [27]
  - 1.6 km for large regional parks (such as Parramatta Park, Centennial Park, Sydney Park and Bicentennial Park) or smaller high-quality regional parks >5 hectares
  - 400 metres for smaller parks.
- For each person for which the project provides the following, use the following expected impacts:[27]
  - For a large, new, regional-level park, assume the proportion of people living in the 1.6 km catchment achieving sufficient activity levels (defined as ≥150 minutes per week)[28] increases by 6 percentage points. A somewhat lower impact would be expected for substantial changes to upgrade existing large areas of open space. However, there is limited information available to scale this impact.
  - For major augmentations to smaller parks to make them more attractive, assume the share of people achieving sufficient activity levels (defined as ≥150 minutes per week) in the 400 m catchment increases by 6 percentage points. This assumes that these people would otherwise have been inactive.
- Apply the following values:
  - $929 per person per year (2021 dollars) for moving a person from inactive to sufficiently active
  - $789 per person per year (2021 dollars) for moving a person from insufficiently active to sufficiently active
  - apply the above 2 values as a weighted average for the change in people becoming sufficiently active from a new large, regional-level park. Based on the 2017-18 Health Survey data (see Table 3.2 in the Technical Appendices) the weighted average value is $828 per person achieving sufficient activity levels
  - $139 per person per year (2021 dollars) for moving from inactive to insufficiently active. This would be applied to the 6% of people undertaking some walking due to major augmentations to smaller parks.

These health values are updated from ATAP guidance[29] and assume use values related to recreational benefits are being measured separately. ATAP guidance on values is currently being reconsidered. If the values change, updated ATAP values should be used.

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[27] These are based on: T Sugiyama, J Francis, NJ Middleton, N Owen, B Giles-Corti, Associations Between Recreational Walking and Attractiveness, Size, and Proximity of Neighborhood Open Spaces. Am J Public Heal. 2010 Sep;100(9): pp 1752–7.

[28] This was used in Sugiyama et al 2010, and is consistent with the lower range of health guidelines, which recommend 2.5 to 5 hours of moderate intensity physical activity (such as a brisk walk, golf, mowing the lawn or swimming) per week (health.gov.au/health-topics/physical-activity-and-exercise/physical-activity-and-exercise-guidelines-for-all-australians/for-adults-18-to-64-years)

[29] ATAP 2016, M4: Active Travel, atap.gov.au/sites/default/files/m4_active_travel.pdf, p. 37-38.

5.1.3 Active transport

Active transport such as cycling, and walking can result in reduced congestion and improved health outcomes (discussed in section 5.1.2.1). Congestion reduction benefits may arise from mode-switching from car to active transport, while reduced public transport crowding benefits may come from mode-switching from public transport to active transport.

The key benefits associated with active transport include:

- health benefits from increased physical activity (see section 5.1.2.1)
- congestion cost savings
- avoided vehicle operating costs from reduced congestion
- environmental benefits (including reductions in air pollution, noise, water pollution, nature and landscape impacts, urban separation and GHG emissions) due to fewer car trips
- avoided cost of accidents from reduced congestion[30]
- avoided road provisioning costs due to fewer car trips.

The methodology and parameters to quantify the benefits of active transport are provided in Transport for NSW's CBA and Economic Parameter Values guidelines, which should be consulted for recommended parameters and information on how to estimate these benefits.[31] The approach to measuring active transport health benefits is outlined in section 5.1.2.1. Take care to ensure there is no double-counting of active transport benefits between projects and that the benefits are correctly attributed.

5.1.4 Air quality

Green infrastructure and public open space can lead to improvements in air quality. This has value because poor air quality leads to health impacts for people. To measure the magnitude of the benefits of improved air quality, it is necessary to understand how much green infrastructure and public open space improve air quality and how much people value changes in air quality.

Trees and vegetation may affect air quality by:

- capturing pollutants on the plant surface
- absorbing gaseous pollutants (for example, ozone and nitrogen dioxide) into leaves
- resuspending particles into the atmosphere that were captured on the plant surface
- emitting particles (for example, pollen)
- disrupting the dispersion of pollution as a result of wind systems.

Changing the amount, type or configuration of canopy cover and other vegetation can reduce air pollution that may be damaging to human health. Air pollution can cause respiratory-related diseases, such as ischaemic heart disease, chronic obstructive pulmonary disease, lung cancer and

[30] This should be offset against the increased accident costs for cycling.

[31] Transport for NSW, *Transport for NSW Economic Parameter Values*, pp 41–42, 2020 and Transport for NSW, *Transport for NSW Cost-Benefit Analysis Guide*, 2020.

acute lower infections in children. Improved air quality can reduce mortality and morbidity associated with these diseases.

The key determinants of the air quality benefits are:

- population density within the catchment impacted by air pollution reduction
- amount of reduction in air pollution, which depends on the change in tree canopy proposed by the option
- existing and expected air pollution levels.

5.1.4.1 Recommended approach and values

The approach recommended to measure the benefit is as follows:

$$Health\ benefits\ (urban) = \ area\ of\ tree\ canopy\ in\ m^2 \times \ benefit\ per\ m^2\ of\ tree\ canopy$$

All tree cover within a significant urban area should be included and no impacts included for other forms of greenery, such as grassed areas.

Recommended parameters are shown in Table 5.5.

Table 5.4. Recommended parameter values to apply to the canopy cover

Significant urban area	Value per m^2 of tree canopy 2022 $/$m^2$/year
Greater Sydney	0.109
Central Coast	0.056
Wollongong	0.050
Port Macquarie	0.048
Forster–Tuncurry	0.041
Newcastle–Maitland	0.038
Goulburn	0.036
Ballina	0.034
Lismore	0.031
Griffith	0.035
Ulladulla	0.034
Wagga Wagga	0.028
Orange	0.027
Nelson Bay	0.024
Dubbo	0.020
Grafton	0.017
Batemans Bay	0.017
Nowra–Bomaderry	0.018
St Georges Basin–Sanctuary Point	0.017
Tamworth	0.017
Bathurst	0.017
Mudgee	0.017
Taree	0.014
Albury–Wodonga	0.015
Coffs Harbour	0.014
Singleton	0.012
Broken Hill	0.009
Lithgow	0.011
Bowral–Mittagong	0.009
Armidale	0.009
Kempsey	0.007
Morisset–Cooranbong	0.007
Parkes	0.005
Muswellbrook	0.005
Camden Haven	0.003
Not in any significant urban area (NSW)	0.0003

The figures in Table 5.5 are the estimates from Table 4.1 in the Technical Appendices multiplied by the amount of pollution reduction per m^2 of tree canopy of 0.3 grams.

This benefit depends on the actual area of canopy cover, which may change over time as trees mature. In estimating this benefit, practitioners should consider the:

- expected starting area of the canopy cover (which will depend on the species and maturity of trees being planted)
- growth rate of the tree (which depends on species. See Table 5.10 for indicative growth rates)
- expected ultimate canopy area (depends on species).

For most projects, the parameters set out in Table 5.5 can be used. Where a project has the main objective of reducing air pollution and is concerned with how different designs or tree species may impact air pollution, then specific modelling of how different project options impact air pollution may be required, such as through tools like i-Tree.[32]

5.1.5 Biodiversity

Biodiversity encompasses the variety of plant and animal life in a particular area. The term includes the diversity of genes, species and ecosystems.[33]

The physical impacts of green space on biodiversity are not well understood in the literature. However, studies have focused on aspects of biodiversity.[34] The provision of urban green infrastructure can enhance biodiversity through the planting of diverse plant species that provide habitat and support ecosystems. However, new green infrastructure may reduce biodiversity, such as when native vegetation is replaced with green infrastructure which has less biodiversity (for example, open grass areas). Careful consideration should be given to each project to determine whether this benefit is applicable.

Biophysical modelling is used to estimate the environmental outputs that result from changes in either the quantity and/or quality of environmental assets. For example, biophysical modelling can estimate the environmental outputs that are likely to result from improved wetland management. Biophysical modelling is also important to estimate impacts that may cause permanent and/or irreversible change.

Environmental outputs are specified in a range of metrics – there is no single metric that measures changes in biodiversity in its entirety. For the economic evaluation, the metrics used to estimate the community's value for biodiversity must align with the metrics used to estimate changes in environmental outputs.

Biodiversity can generate value under 3 broad categories, summarised in Table 5.6.

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[32] For more information on i-Tree, see www.itreetools.org

[33] D Pearce and D Moran, The economic value of biodiversity, IUCN – The World Conservation Union, 1994

[34] J Bennett, The economic value of biodiversity: a scoping paper, presented to the National Workshop 'The Economic Value of Biodiversity' on 22 and 23 October 2003.

Table 5.5. Biodiversity benefit categories[34]

Benefit category	Benefit description	Treatment in this CBA framework
Direct use value	Benefits generated by recreation and tourism activities that are dependent on biological resources	Measured separately in Use Value (Recreational Benefits)
Direct use value	Benefits arising from goods such as pharmaceuticals and agricultural products that are impacted by the diversity and extent of biological resources	Not applicable for urban green infrastructure except in cases where there are agricultural outputs such as community gardens, but it is applicable for national parks/reserves etc. This is typically measured as the market value of goods produced.
Passive use value	This includes life-support services such as nutrient removal, flood control and climate stabilisation	Passive use values for air quality, carbon sequestration and flood mitigation are measured separately. Passive use values from improved water quality are included in this analysis for biodiversity.
Non-use value	The existence value of diverse species and ecosystems	Measured as part of the non-use value for biodiversity
Non-use value	Bequest motives, where current generations derive benefit from continuing the availability of a biological resource for future generations	Measured as part of the non-use value for biodiversity
Non-use value	Option value (or insurance benefit) that is derived from the protection of a resilient ecological system	Measured as part of the non-use value for biodiversity Note: NSW Government Guide to Cost-Benefit Analysis (TPG23-08) Appendix 2.2 does not recommend estimating option value as it is often not possible to confidently sign or quantify it.

The key determinants of the biodiversity benefits are the:

- change in the quantity of biodiversity that is created or to be preserved (that is, the number of fauna and flora species affected)
- change in the quality of biodiversity and habitats that is created or to be preserved in both terrestrial and water environments.

5.1.5.1 Valuing biodiversity benefits

There are 2 approaches to valuing biodiversity benefits:

- benefit-transfer approach – transfers estimated values of biodiversity from previous non-market valuation studies
- replacement-cost approach – estimates the value of biodiversity based on the cost of replacing it with a substitute.

Parameter values for both approaches are outlined in this framework.

Practitioners should present central CBA results by applying parameter values using the benefit-transfer approach. The benefit-transfer approach is the preferred approach in this framework because it is conceptually persuasive compared to the replacement-cost approach, despite its limitations, because it attempts to measure the intrinsic value of a change in biodiversity.

Estimates of biodiversity value using the replacement-cost approach should be included in a sensitivity analysis.

Parameter values have been selected to be applied as a generic value across a broad range of projects. Table 5.7 specifies the project types to which the approaches can be applied:

- local, district and regional parks – replacement-cost approach can be applied to district and regional parks where the biodiversity conservation area exceeds 5 hectares to align with area requirements for an offset conservation agreement.[35] The 5-hectare threshold is the minimum requirement to ensure that offset conservation agreements will deliver viable biodiversity conservation outcomes.[36] The benefit-transfer approach should not be applied to local, district or regional parks[37]
- reserves – both approaches can be applied
- national parks – both approaches can be applied.

Table 5.6. Application of approaches for different project types.

Project type	Benefit-transfer approach	Replacement-cost approach
Local park	No	Yes, central analysis if biodiversity conservation area exceeds 5 hectares
District park	No	Yes, central analysis if biodiversity conservation area exceeds 5 hectares
Regional park	No	Yes, central analysis if biodiversity conservation area exceeds 5 hectares
Reserves	Yes, central analysis	Yes, sensitivity analysis
National parks	Yes, central analysis	Yes, sensitivity analysis

5.1.5.1.1 Benefit-transfer approach

Recommended parameter values using benefit transfer are as follows:

- terrestrial biodiversity – an annual value (2022 dollars) of:
  - $0.0005 per household per hectare of scrublands
  - $0.0007 per household per hectare of grassy woodlands

[35] Biodiversity Conservation Trust, *Guidelines for proponents and consent authorities – using offset conservation agreements: when development consent conditions require the use of conservation agreements to establish biodiversity offsets*. Version 2: July 2020.

[36] Biodiversity Conservation Trust, *Guidelines for proponents and consent authorities – using offset conservation agreements: when development consent conditions require the use of conservation agreements to establish biodiversity offsets*. Version 2: July 2020.

[37] There is no information available on the value of biodiversity in small pockets of green space. We recommend the terrestrial biodiversity parameter value only be applied to large-scale green space such as national parks and reserves.

– $0.0009 per household per hectare of wetland

values should be applied for 30 years after the green asset has been established

- aquatic biodiversity – an annual value of $0.83 per household per kilometre of waterway per year for 30 years (2022 dollars).

In applying these parameters, the following adjustments should be made:

- the proportion of households in NSW – parameter values per household should be applied to 50% of NSW households[38]
- discount rate for aggregation – apply the same discount rate used in the overall analysis when converting per annum payments into a present value sum.[39]

These parameter values do not reflect iconic species or unique site characteristics. Furthermore, parameter values should not be applied where biodiversity values are a major driver of the project. In these instances, the practitioner should review the non-market valuation literature for studies that closely reflect the attributes, context and other site-specific characteristics of the project. Various studies related to biodiversity are summarised in annexures A, B and C of the Technical Appendices to the framework. In the absence of a comparable study, a primary non-market valuation study may be required to align with the specific context and the particular changes of the proposed project.

5.1.5.1.2 Replacement-cost approach (for sensitivity analysis)

The parameter values for the replacement-cost approach are based on the credit prices from historical trades under the NSW Biodiversity Offset Scheme. Table 5.8 outlines the recommended undiscounted dollar-per-hectare-per-year parameter values by Interim Biogeographic Regionalisation for Australia (IBRA) subregion[40] and the statewide weighted average. The undiscounted annual values should be applied over 30 years. Some credits have not been traded before or have minimal trades. For these, the price information will be less reliable.

An average of values for all IBRA subregions (where values are available) within an IBRA region should be applied to any IBRA subregions that are not listed in Table 5.8. Alternatively, the statewide weighted average value (excluding the Sydney Basin IBRA Region) can be applied.

Table 5.7. Parameter values by IBRA subregion (replacement-cost approach for sensitivity analysis)

IBRA subregion	Parameter value PV $/hectare	Undiscounted annualised parameter value $/hectare/year
Bateman	8,690	565
Burragorang	84,212	5,478
Clarence Lowlands	5,331	347
Clarence Sandstones	6,702	436

[38] Aligns with the general approach of using the study's response rate and assuming 30% of non-respondents have values similar to respondents and all other non-respondents have zero values. The aggregation factor of 50% is a conservative estimate based on the average response rate across a selection of non-market valuation studies of 42.6% and an average extrapolated response rate (accounting for non-respondents likely to have values) of 59.8% (see Table 15.1 in the Technical Appendices for further detail).

[39] Authors have used alternative discount rates including 15% and 28%. We recommend 5% as it aligns with NSW Treasury guidelines.

[40] See environment.nsw.gov.au/threatenedspeciesapp/areahabitatsearch.aspx for a map of NSW IBRA Regions.

IBRA subregion	Parameter value PV $/hectare	Undiscounted annualised parameter value $/hectare/year
Coffs Coast and Escarpment	12,253	797
Cumberland	148,435	9,656
Hill End	30,723	1,999
Hunter	22,419	1,458
Illawarra	60,080	3,908
Inland Slopes	21,593	1,405
Jervis	29,013	1,887
Karuah Manning	19,993	1,301
Lower Slopes	11,992	780
Macleay Hastings	27,794	1,808
Monaro	46,268	3,010
Murrumbateman	20,401	1,327
Northern Outwash	7,538	490
Oberon	40,361	2,626
Peel	12,113	788
Pilliga	21,250	1,382
Pittwater	37,674	2,451
Richmond	36,906	2,401
Sydney Cataract	171,635	11,165
Upper Hunter	14,338	933
Wollemi	76,310	4,964
Wyong	47,076	3,062
Yengo	91,191	5,932
State-wide weighted average (excl. Sydney Basin IBRA Region)	13,065	850

5.1.6 GHG impacts

Urban trees and other plants act as a sink for carbon dioxide (CO_2) by fixing CO_2 during photosynthesis and storing carbon as biomass. Urban plantings can therefore help attenuate global warming and support the achievement of government targets for GHG emissions.[41]

The benefit from reduced GHG emissions is the amount of reduction in GHG emissions multiplied by the value per tonne of CO_2.

Although other plants can act as a sink for CO_2, we recommend that carbon sequestration for urban open spaces (such as grassland and sports fields) is not applied in this framework due to insufficient evidence. Similarly:

- for mixed projects involving grassland and trees, the area that would be covered by tree canopy once trees are mature should be used and the tree values applied
- there is not sufficient evidence to recommend that practitioners estimate the carbon sequestration by the vegetation and soil within a wetland. Carbon sequestration of trees contained within a wetland can be estimated using the approach detailed below.

5.1.6.1 Recommended approach and values

The key determinant of this benefit is the amount and timing of carbon storage and release for green assets, and is measured as follows:

$$GHG\ reduction\ benefits$$
$$= area\ of\ tree\ planting\ m^2 \times carbon\ sequestered\ per\ m^2 \times\ CO_2\ - e\ sequestered\ per\ unit\ of\ carbon$$
$$\times\ cost\ per\ tonne\ of\ CO_2$$

For most projects, parameters on carbon sequestration can be used as per below. For projects where carbon sequestration is a key objective, specific tools, such as i-Tree Eco models developed as part of carbon farming legislation, should be used.[42]

The recommended parameter values are:

- for the first 20 years, a rate of carbon sequestration per area planted (equivalent to the expected maximum tree canopy) based on Clean Energy Regulator estimates for environmental planting for Kyogle in NSW.[43] This benefit is estimated based on the size of the eventual tree canopy when the trees reach maturity (the planted area). Rates are:
  - 0.24 kg of carbon sequestered per m^2 of area planted with trees for the first 5 years
  - 0.61 kg of carbon sequestered per m^2 of area planted with trees for the second 5 years
  - 0.47 kg of carbon sequestered per m^2 of area planted with trees for years 10 to 20

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[41] See environment.nsw.gov.au/topics/climate-change/net-zero-plan

[42] *Carbon Credits (Carbon Farming Initiative — Reforestation and Afforestation 2.0) Methodology Determination 2015*, www.legislation.gov.au/Details/F2015L00682; and Australian Government Department of Industry, Science, Energy and Resources website, accessed September 2021, industry.gov.au/data-and-publications/full-carbon-accounting-model-fullcam.

[43] Clean Energy Regulator, 2015, Land based projects – return on investment considerations www.cleanenergyregulator.gov.au/ERF/Pages/Want%20to%20participate%20in%20the%20Emissions%20Reduction%20Fund/Planning%20a%20project/Feasibility%20and%20project%20planning/Land-based-projects%E2%80%93return-on-investment-considerations.aspx

- a rate of carbon sequestration of 0.3 kgs per m^2 of tree canopy after the first 20 years. This is based on the ACT estimate of carbon sequestration for its 2018 tree stock and is also the rate estimated for trees along the Pacific Highway in Sydney.

- The above rates would be applied based on the approximate ages of existing trees or the age of new trees when planted.

These rates should be multiplied by (44/12) without rounding to give a CO_2-e impact.[44]

See section 5.1.7.2.2 for maximum canopy cover by selected tree species.

The Technical note to NSW Government Guide to Cost-Benefit Analysis TPG23-08: Carbon value in cost-benefit analysis sets out the method, consistent with the discussion in the NSW Government Guide to Cost-Benefit Analysis (TPG23-08), to calculate carbon values for all initiatives. Table 5.9 outlines the carbon emissions value per tonne to be used in the CBA. See the Technical Appendices for detailed information. This parameter should be sensitivity tested – it may change over time.

Table 5.8 Carbon value per tonne[45]

Financial year	Carbon value real A$/tCO2e 2022 dollars
2023	123
2024	126
2025	128
2026	131
2027	134
2028	137
2029	140
2030	144
2031	147
2032	150

As outlined in section 2, a CBA only considers the incremental change compared to the base case. The estimates above are relative to no green infrastructure. If there is existing green infrastructure in the base case, then the base case has its own level of carbon sequestration that would have to be accounted for.

Note that the GHG reduction benefits may or may not accrue to the NSW community:

- If NSW is seeking to achieve a particular level of GHG abatement and the green infrastructure or public space can be counted towards this, then it would offset costs that others would have

[44] The atomic weight of CO_2 is 44 and the atomic weight of C is 12.

[45] Data source: NSW Treasury, 2023, Technical note to NSW Government Guide to Cost-Benefit Analysis TPG23-08: Carbon value in cost-benefit analysis, www.treasury.nsw.gov.au/sites/default/files/2023-03/20230302-technical-note-to-tpg23-08_carbon-value-to-use-for-cost-benefit-analysis.pdf.

to bear to meet abatement targets. In this case, the benefits can be assumed to accrue predominantly to the NSW community.

- If the impacts are considered as additional, then the majority of benefits accrue outside of the NSW community, as the impacts of global warming are felt across the world.

The framework recommends the full value of GHG abatement as measured by the above real carbon price is accrued to the NSW community. This is consistent with NSW having overall objectives for GHG abatement within which any green infrastructure and public place investments can fit.

5.1.7 Urban cooling benefits

The cooling impacts of green and blue infrastructure are well understood. Lower ambient temperatures can result in health benefits, energy savings (from reduced cooling energy demand) and avoided GHG emissions (from reduced cooling energy demand).

Trees and vegetation provide a cooling effect in 2 ways:

- shading of hard surfaces that would otherwise absorb heat from direct sunlight and then re-radiate it into the air
- through evapotranspiration – as trees release water into the atmosphere from their leaves, surrounding areas are cooled from the evaporation of this water.

Water bodies provide cooling through evaporation and by reducing the extent of hard surfaces.[46] Lower ambient temperatures have 3 key benefits:

- **health benefits** – high temperatures may lead to increased risk of death or disease, especially among the most vulnerable in the community – the very young and elderly. A reduction in urban heat can reduce the risk of heat-related diseases, reducing the number of heat-related deaths and the use of public health resources
- **energy savings** – high temperatures increase electricity demand loads due to the operating of air conditioners. Urban cooling measures may reduce electricity demand, reducing the generation and network energy infrastructure requirements and associated costs
- **avoided energy GHG emissions** – reductions in electricity demand due to urban cooling may result in avoided GHG emissions from electricity generation using non-renewable energy sources, such as coal or natural gas.

The key determinants of urban cooling benefits are the:

- number of houses/people within the catchment, who benefit from the reduced temperatures
- reduction in temperature relative to the base case, which depends on a range of factors including proximity to green assets, climate and tree species
- existing and expected extreme temperature levels – urban cooling benefits will tend to be smaller in areas with milder temperatures.

[46] Natural systems are complex, which can make it hard to isolate relationships between green and blue assets with physical changes such as urban cooling and air quality. For example, water bodies can contribute to increased soil moisture, which has cooling benefits, or water bodies can provide passive irrigation for trees and vegetation. Sufficient evidence is not currently available to identify and include many of these complex relationships in the framework.

For most projects, the parameters set out below can be used. Where a project has the main objective of urban cooling and is examining designs to maximise cooling impacts, specific modelling of how different project options impact temperatures and energy use may be required.

5.1.7.1 Calculating urban cooling benefits

The benefits are calculated as follows:

$$\begin{aligned}&Health\ benefits\ from\ cooling\\&= number\ of\ people\ within\ impacted\ catchment \times no.\ of\ days\ above\ 30\ degrees\ per\ year\\&\times\ reduction\ in\ temperature\ in\ degrees\ (^{o}C)\\&\times\ health\ benefit\ for\ 1^{o}C\ reduction\ in\ temperature\ per\ person\ per\ year\end{aligned}$$

$$\begin{aligned}&Reduced\ cooling\ costs\\&= number\ of\ households\ in\ catchment \times reduction\ in\ temperature\ in\ degrees\ (^{o}C)\\&\times energy\ benefit\ per\ 1^{o}C\ reduction\ in\ temperature\ per\ household\end{aligned}$$

$$\begin{aligned}&Reduced\ GHG\ emissions\\&= number\ of\ households\ in\ catchment \times reduction\ in\ temperature\ in\ degrees\ (^{o}C)\\&\times GHG\ benefit\ per\ 1^{o}C\ reduction\ in\ temperature\ per\ household\end{aligned}$$

5.1.7.2 Parameter values for urban cooling benefits

5.1.7.2.1 Catchment

Areas 1,000 metres from green space or canopy cover are expected to experience cooling benefits. This should be used to guide which geographic areas linked to population data are included. For example, where a project proposes to disperse new trees throughout a park, the catchment can be specified as 1,000 metres from the park's boundary. Alternatively, where new canopy cover is proposed for one site, the catchment can be specified as 1,000 metres from the site.

It is important to note the size of the catchment does not influence the total value of urban cooling impacts, assuming housing and population densities are constant throughout the catchment. The estimated urban cooling impacts are proportional to the additional area covered by green infrastructure. In simple terms, a larger catchment applies a smaller reduction in temperature to a broader base (i.e. population or households within the catchment), while a smaller catchment applies a higher reduction in temperature to a smaller base. For example, one hectare of additional tree canopy cover in a 10-hectare catchment is equivalent to a 10 percentage point increase in the tree canopy. This is estimated to lead to a 1.13 ˚C reduction in temperatures. If a larger catchment was used of 20 hectares, then the one hectare is equivalent to a 5 percentage point increase in the tree canopy. This is estimated to lead to a 0.665 ˚C reduction in temperatures. Hence the temperature effect modelled has halved, while the area to which it is applied has doubled.

5.1.7.2.2 Canopy cover

Canopy cover and growth rates vary by tree species. The department's Street Tree Planting Design Manual (2021) lists the size and growth rates (slow, medium and fast) for selected tree species. Size categories for mature trees are:

- small tree — mature height between 6 and 9 metres with a spread of 6 metres
- medium tree — mature height between 10 and 15 metres with a spread of 8 metres

- large tree — mature height greater than 16m with a spread of 12 metres.

The spread is approximately the diameter of a tree's canopy cover. See Table 2 in the Street Tree Planting Design Manual for a detailed list of tree species.

Table 5.10 shows indicative years to reach mature height for a small, medium and large tree. This is based on indicative annual growth rates for slow-, medium- and fast-growing trees and mature height for small, medium and large trees. These are indicative only and do not reflect the variation in growth rates due to environmental and geographic factors, species type and genetics. Alternative growth rates can be tested in sensitivity analysis if required.

Table 5.9 Indicative years to reach mature tree height

Tree size	Mature height metres	Slow growth rate 30 cm/yr	Medium growth rate 30 cm/yr to 60 cm/yr	Fast growth rate 60+ cm/yr
Small	6 to 9	25	17	13
Medium	10 to 15	42	28	21
Large	16+	53	36	27

The midpoint of mature height ranges is applied as follows:

- 7.5 metres for a small tree
- 12.5 metres for a medium tree
- 16 metres for a large tree.

Midpoint for growth rates is applied as follows:

- 45 cm/yr for a medium growth rate
- 60 cm/yr for a fast growth rate.

5.1.7.2.3 Reduction in temperature

The following temperature reductions may be applied if relevant:

- 1.13 ˚C for every additional 10% of catchment covered by tree canopy, compared to no vegetation
- 0.63 ˚C for every additional 10% of the catchment that converts from green open space to tree canopy cover
- 0.50 ˚C for every additional 10% of the catchment that converts from no vegetation to green open space (not canopy cover).

Values for water are not available. The values for tree and vegetation cover should be applied to the green assets within a wetland.

5.1.7.2.4 Monetised values

The following benefit values (in 2022 dollars) may be applied if relevant:

- health benefit from cooling – $3.0 for each ˚C reduction per person per year per day above 30 ˚C[47]

[47] The parameters are based on the expected health impacts per day above 30 ˚C . See section 9.2.1 in the technical appendices for further detail.

- cooling costs – $13.50 per year per household per ˚C of temperature reduction[48]
- GHG benefits– $3.70 per year per household per ˚C of temperature reduction.[49]

The parameters are linked to tree canopy cover. For new tree plantings, this will initially be small and will increase over time as tree canopy growth occurs.

Population and household data for the specified catchment should be sourced from ABS 2021 Census Data. The Australian Bureau of Statistics website also supplies Digital boundary files. Population projections should be consistent with NSW Government projections such as the Common Planning Assumptions.[50]

5.1.8 Other benefits

There is a range of other potential benefits for public open spaces that do not have recommended parameters. If these benefits cannot be monetised, they should be quantified and/or discussed qualitatively as part of the CBA.

Other benefits from public open space projects include:

- **Aboriginal cultural and heritage value**: – NSW Treasury is developing a framework for considering costs and benefits related to Aboriginal cultural heritage impacts and should be consulted if this is a major component of the project's objectives
- **stormwater management** – Tapsuwan et al 2020 is an example of an approach to monetising stormwater management benefits from public open space[51]
- **reduction in crime** – for example, if public open space or changes to public open space (such as lighting) is expected to reduce the levels of crime
- **option, existence and bequest value** – these may be relevant for a small set of projects
- **improved educational outcomes –** green and public infrastructure may translate to improved educational outcomes by helping to meet desired learning outcomes in curriculums or improving the quality of education[52]
- **noise reduction benefits** – green infrastructure could reduce noise pollution in adjacent houses
- **ecosystem services value** – for example, water filtration, passive irrigation, pollination, seed dispersal and soil regeneration.

Where a project has the main objective of providing a benefit category for which benefit parameters are not available, the project team should consider whether specific modelling, such as revealed preference or state preference modelling, should be undertaken to monetise the benefit. In making

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[48] This is based on the retail electricity price of 30 cents per kwh because green assets are long-lived and will be expected to impact at times of peak demand

[49] This is based on a $100 cost of carbon and 0.81 kg CO_2-e/kWh marginal GHG per unit of electricity and should be scaled across years of the analysis by the recommended cost of carbon and any expected changes in emissions intensity of electricity generation over time. The technical appendices include specific advice about valuation of GHG emissions reductions.

[50] See NSW Treasury website Common Planning Assumptions, treasury.nsw.gov.au/information-public-entities/nsw-common-planning-assumptions.

[51] S Tapsuwan, R Marcos-Martinez, H Schandl, & Z Yu, Valuing ecosystem services of urban forests and open spaces: application of the SEEA framework in Australia, *Australian Journal of Agricultural and Resource Economics,* volume 65, 2021.

[52] Kuo, M, S. Klein, M. Browning, J. Zaplatosch, "Greening for academic achievement: Prioritizing what to plant and where", Landscape and Urban Planning, Volume 206, 2021, doi.org/10.1016/j.landurbplan.2020.103962 .

this decision, the project team should balance the costs of undertaking this analysis against the cost of the investments being considered and whether additional analysis would change the policy recommendations from the CBA.

5.2 Parameter values – public facilities

Public facilities include public libraries, museums, galleries, civic/community centres, showgrounds and indoor public sports facilities.

5.2.1 Use value

At its broadest conceptual level, just as with public open space, the 'use' value of a public facility captures the area under the demand curve for a particular facility. For the purposes of CBA, this is based on the demand curve for a new public facility, or how the demand curve changes from an improvement to an existing public facility. The same concepts as shown in Figure 5.2 are relevant.

Public facilities projects include:

- developing new public facilities, such as libraries, indoor sports facilities, galleries, community centres and museums in greenfield areas, where there may be few existing substitutes
- developing new public facilities, such as new libraries, indoor sports facilities, galleries, community centres and museums in areas where there are existing substitutes
- developing highly unique facilities, such as specialised museums or galleries
- improvements in existing public facilities, such as:
  - refurbishment of an existing museum, gallery or library
  - investment in improving museum, gallery and library collections.

5.2.1.1 Recommended valuation approaches

Until recently there was a large gap in primary studies that estimated the value of new and improved public spaces. Centre for International Economics (2022)[53] estimated the community's WTP for new and improved public spaces for 6 facility types: libraries, museums, galleries, civic/community centres, showgrounds and indoor sports facilities.

We recommend the WTP estimates from the Centre for International Economics (2022) are applied for a new facility and a complete upgrade of an existing facility and removal of an existing facility, as follows.

WTP for a new facility:

[53] CIE, 2022, *Willingness to pay for new and improved public facilities: Stated preference research.* Prepared for Department of Planning and Environment.

- Table 5.11 provides the WTP for a large-sized new facility with parking always being available. WTP differs by the travel time of a household from the new facility.
- These estimates of WTP can be adjusted to reflect new facilities with different attributes based on the adjustments in Table 5.12.
- Table 5.13 lists the bundle of attributes by size category for each facility type.

WTP for a complete upgrade of an existing facility:

- It is recommended the central estimates in Table 5.14 are applied to value complete upgrades of existing facilities.
- Insufficient evidence is available to value partial upgrades of existing facilities or the value of the separate attributes that are enhanced by a complete upgrade.

Willingness to accept the removal of an existing facility:

- All consumer surplus changes should be accounted for, including the change from the loss of one public facility replaced by another. The loss of value associated with existing uses is not implicitly accounted for in the estimated WTP values, so must be separately included.
- The WTP for a new facility should be applied as an estimate of the willingness to accept the removal of an existing facility. This is likely to be a conservative estimate.

An example application of the WTP estimates to a hypothetical new library is provided in Chapter 9 of the Technical Appendices.

Table 5.10 Average WTP for a new, large facility, by travel time and parking[54]

Facility	Travel time	Parking rarely available $/household/year	Parking available for half of visits $/household/year	Parking always available $/household/year
Library	10 min	57.04	59.28	71.56
Library	20 min	23.20	49.32	60.24
Library	30 min	13.44	39.56	50.48
Library	40 min	3.68	29.80	40.72
Library	50 min	0.00	20.04	30.96
Library	60 min	0.00	10.28	21.20
Library	70 min	0.00	0.52	11.40
Library	80 min	0.00	0.00	1.64
Library	90 min	0.00	0.00	0.00
Community centre	10 min	61.68	63.92	76.20
Community centre	20 min	27.84	53.96	64.88
Community centre	30 min	18.08	44.20	55.08
Community centre	40 min	8.32	34.40	45.32

[54] Source: Centre for International Economics, 2022, *Willingness to pay for new and improved public facilities: Stated preference research.* Prepared for Department of Planning and Environment.

Facility	Travel time	Parking rarely available $/household/year	Parking available for half of visits $/household/year	Parking always available $/household/year
Community centre	50 min	0.00	24.64	35.56
Community centre	60 min	0.00	14.88	25.80
Community centre	70 min	0.00	5.12	16.04
Community centre	80 min	0.00	0.00	6.28
Community centre	90 min	0.00	0.00	0.00
Gallery	10 min	53.68	55.92	68.20
Gallery	20 min	19.84	45.96	56.88
Gallery	30 min	10.08	36.20	47.12
Gallery	40 min	0.32	26.44	37.36
Gallery	50 min	0.00	16.68	27.60
Gallery	60 min	0.00	6.92	17.80
Gallery	70 min	0.00	0.00	8.04
Gallery	80 min	0.00	0.00	0.00
Gallery	90 min	0.00	0.00	0.00
Museum	10 min	60.40	62.64	74.92
Museum	20 min	26.56	52.68	63.60
Museum	30 min	16.80	42.92	53.84
Museum	40 min	7.04	33.16	44.08
Museum	50 min	0.00	23.40	34.32
Museum	60 min	0.00	13.64	24.52
Museum	70 min	0.00	3.88	14.76
Museum	80 min	0.00	0.00	5.00
Museum	90 min	0.00	0.00	0.00
Showground	10 min	56.60	58.84	71.12
Showground	20 min	22.76	48.88	59.80
Showground	30 min	13.00	39.12	50.04
Showground	40 min	3.24	29.36	40.28
Showground	50 min	0.00	19.60	30.48
Showground	60 min	0.00	9.80	20.72
Showground	70 min	0.00	0.04	10.96
Showground	80 min	0.00	0.00	1.20
Showground	90 min	0.00	0.00	0.00
Indoor sports facility	10 min	70.16	72.36	84.68

Facility	Travel time	Parking rarely available $/household/year	Parking available for half of visits $/household/year	Parking always available $/household/year
Indoor sports facility	20 min	36.32	62.44	73.32
Indoor sports facility	30 min	26.56	52.64	63.56
Indoor sports facility	40 min	16.80	42.88	53.80
Indoor sports facility	50 min	7.00	33.12	44.04
Indoor sports facility	60 min	0.00	23.36	34.28
Indoor sports facility	70 min	0.00	13.60	24.52
Indoor sports facility	80 min	0.00	3.84	14.76
Indoor sports facility	90 min	0.00	0.00	5.00

Table 5.11 Adjusting average WTP for facility size and surroundings[55]

Adjustment	Impact on WTP $/household/year
Surroundings – 'Shops or cafes' to 'Residential or commercial buildings'	-6.84
Surroundings – 'Shops or cafes' to 'Green space'	-0.56
Size – Large to medium	-2.16
Size – Large to small	-16.60

Note that the size levels (small, medium and large) summarise a range of features specific to each of the 6 facility types. Each level summarises a range of features specific to each of the 6 facility types. For example, a library's size levels were characterised by the number of computers, size of the book collection, availability of services such as meeting rooms and the size of the library measured in terms of the number of houses. A small library is equivalent to the size of an apartment while a medium and large library is equivalent to the size of 5 houses and 14 houses respectively. Table 5.13 contains the description corresponding to each size level for each facility type.

Table 5.12 Bundle of features embedded in the 'size' attribute for each facility type[55]

Type of facility	Size	Description
Library	Small	About the size of an apartment Small book collection 1–4 computers
Library	Medium	Around the size of 5 houses Large book collection 5–10 computers and free Wi-Fi Online library services

[55] Centre for International Economics, 2022, *Willingness to pay for new and improved public facilities: Stated preference research.* Prepared for Department of Planning and Environment.

Type of facility	Size	Description
Library	Large	Around the size of 14 houses 24/7 online access to the entire library collection More than 10 computers and free Wi-Fi Meeting rooms for hire Dedicated areas for children and accompanying programs
Community centre	Small	Around the size of one apartment One small hall/room available for bookings Small kitchen (with stove and fridge) and storage No computers
Community centre	Medium	Around the size of 2 houses One large hall or multiple rooms available for bookings Medium-sized kitchen (with stove and fridge) and storage One or a few computers and Wi-Fi
Community centre	Large	Around the size of 5 houses Halls/rooms available for bookings A fully equipped kitchen, lounge and outdoor amphitheatre/market area Self-service computers and Wi-Fi
Museum	Small	Around the size of one apartment Museum shop or café Conference/convention facilities
Museum	Medium	Around the size of 5 houses Museum shop or café Venue hire with indoor and outdoor space and kitchen Guided tours available Workshops for children during school terms
Museum	Large	Around the size of 10 houses Museum shop and café with click-and-collect option Venue hire with indoor and outdoor space and fully equipped kitchen Self-guided visits (with printed language guides) and group tours with pre-booking options Learning programs/excursions/professional development courses including online resources
Showground	Small	Powered and unpowered campsites Pavilion and a hall Picnic tables and BBQ Stabling facilities Venue hire for community events

Type of facility	Size	Description
Showground	Medium	Powered and unpowered campsites Pavilion and a hall Kitchen, picnic tables and BBQ Stabling facilities and a show ring Venue hire for medium events
Showground	Large	Powered and unpowered campsites Pavilion, concrete and grass outdoor seating areas, stadium and exhibition halls Fully functional kitchen and canteen with indoor and outdoor serving and seating Stabling facilities, equestrian wash bay, dressage area and jumping arena Venue hire for major events
Gallery	Small	Around the size of an apartment Works by local artists with exhibition labels
Gallery	Medium	Around the size of 10 houses Exhibitions and gallery shop Venue hire Guided tour for group and school visits
Gallery	Large	About the size of 25 houses Exhibitions, gallery shop and café/restaurant Venue hire with catering packages Education kits and programs to support school visits Free Wi-Fi
Indoor sports facility	Small	One indoor space suitable for training, yoga or martial arts
Indoor sports facility	Medium	One or 2 indoor courts for basketball, futsal, gymnastics, indoor cricket or squash Change and shower facilities Kiosk Hireable space
Indoor sports facility	Large	Three or more courts for basketball, futsal, gymnastics, cricket and/or squash Change and shower facilities On-site café Venue hire for multipurpose events

Table 5.13 Average WTP for a full upgrade of an existing facility[55, 56]

Adjustment	Conservative WTP $/household/year for 10 years	Central WTP $/household/year for 10 years
Indoor sports facility	7.29	11.43
Showground	9.18	13.66
Gallery	9.50	14.66
Library	5.83	10.01
Museum	8.76	13.05
Community centre	6.79	10.59
All facilities	7.89	12.23

5.2.2 Other benefits

There is a range of other potential benefits for public facilities that do not have recommended parameters. If these benefits cannot be monetised, they should be quantified and/or discussed qualitatively as part of the CBA.

Other benefits from public facilities projects include:

- Aboriginal cultural and heritage value – NSW Treasury is developing a framework for considering costs and benefits related to Aboriginal cultural heritage impacts and should be consulted if this is a major component of the project's objectives.
- GHG impacts if the project impacts energy use or the type of energy consumed
- stormwater management
- urban cooling benefits
- option, existence and bequest value.

Where a project has the main objective of providing a benefit category for which benefit parameters are not available, then the project team should consider whether specific modellings, such as revealed preference or stated preference modelling, should be undertaken to monetise the benefit. In making this decision, the project team should balance the costs of undertaking this analysis against the cost of the investments being considered and whether additional analysis would change the policy recommendations from the CBA.

[56] Estimates of unconditional mean WTP. Incomplete questionnaire responses have been assigned a WTP of zero. Estimates are per household for the facility of that type that they visit most frequently

5.3 Parameter values – streets

5.3.1 Use and amenity value

This section covers the value of improving streets. These are defined in this framework as including streets, avenues, boulevards, squares and plazas, pavements, passages and lanes and bicycle paths. The value of these spaces includes the value for people using them. For example, a pedestrian may value walking down a shaded street higher than walking down an unshaded one, and these places could have visual amenity benefits for users and others. The section has not separated use and amenity, as these are difficult to disentangle for streets.

The key determinants of benefits are:

- the number of people using a street and the time spent there
- the quality and function of the street.

5.3.1.1 Recommended approach

The recommended approaches and parameters for streets are as follows:

- For medium to large projects related to streets, the Pedestrian Environment Review System (PERS) approach should be applied, as used by Transport for NSW[57].
- For very large projects related to streets, a specific stated preference survey could be considered if this assists in decisions about option selection.
- For projects related to street tree canopy, broad hedonic approaches should be applied with the parameters set out below, and where street trees are part of a broader set of changes to a street, the value of street trees may be measured within the PERS approach and in the hedonic approach.[58]
- For projects related to street urban design outside of street trees, if these undergo CBA, PERS should be applied, and an additional value related to street trees should be included as per the above street tree approach.[59]

For small projects related to streets, evaluation using the above is not likely to be cost-effective. These projects are not likely to use CBA in any case. As a guide to what is small and what is large, the NSW Treasury guidance expects CBA for projects with a total cost of $10 million.

In some circumstances, public space investments related to streets will be within broader urban development programs, such as public plazas and walkways undertaken as part of the Barangaroo development. Where the value of the public space is already factored into sale prices for the urban development, it should not be separately measured.

Where a street project has transport-related benefits, such as travel time savings, these should be valued using Transport for NSW guidelines.

[57] In order to apply the PERS approach, data on the pedestrian numbers and minutes in the area are required

[58] This framework considers that these can be added as the PERS approach is based on value for pedestrians, while the street tree amenity value is expected to be mainly related to visual amenity and cooling.

[59] There is a small element of double-counting in this, because a person living near the street tree will be included in the estimation of pedestrian counts. However, the level of overlap is expected to be sufficiently small to be disregarded.

5.3.1.1.1 Applying the PERS methodology

The recommended WTP parameters for streets, based on the PERS methodology, are shown in Table 5.15. Each attribute is scored from −3 to 3 by a minimum of 2 public space auditors, which is then applied to the relevant parameter. For example, moving from a score of −3 for all attributes to a score of +3 for all attributes would have benefits of 2.961 cents per person per minute.

Table 5.14. Amenity benefits for improvements to public space in cents per person per minute, $2022

Attribute	Score −3	Score −2	Score −1	Score 0	Score 1	Score 2	Score 3
Moving in the space	0	0.132	0.266	0.398	0.446	0.492	0.540
Interpreting the space	0	0.030	0.059	0.088	0.117	0.147	0.179
Personal safety	0	0.126	0.252	0.378	0.504	0.621	0.739
Feeling comfortable	0	0.071	0.140	0.211	0.281	0.352	0.422
Sense of place	0	0.038	0.080	0.117	0.144	0.158	0.170
Opportunity for activity	0	0.217	0.433	0.654	0.739	0.824	0.911
Sum	0	0.613	1.231	1.847	2.230	2.594	2.961

To apply the values, the estimated number of pedestrians and the amount of time they spend in a place is required. This could be estimated using pedestrian counts for existing places. For new places, this will be more difficult. The most straightforward approach would be to use estimates for similar existing places.

For projects related to street tree canopy, the values recommended are for every 1% increase in the footpath area that has tree canopy, an increase in the property value in the project area of 0.1% would be applied.

- The project area's total property value should be calculated by multiplying the NSW average property value for established houses and attached dwellings (Table 5.16) with the number of detached and attached dwellings in the project area.
- Where this value is applied, no air pollution benefits should be included or private benefits from urban cooling (health and energy saving). Other public benefits related to street trees such as carbon sequestration and GHG reductions related to urban cooling would continue to be included separately.

Table 5.15 NSW weighted average value of an established house and attached dwelling

House type	NSW weighted average median price (2022)[60] ($'000)
Established house	971
Attached dwelling[61]	732

[60] NSW weighted average median price for 2022 based on median price and number of transfers of established houses and attached dwellings in Sydney and Rest of NSW. Data source: ABS, 2022, 6432.0 Total Value of Dwellings, Table 2: Median Price and Number of Transfers (Capital City and Rest of State).
[61] Attached dwellings includes flats, units and apartments plus semi-detached, row and terrace houses

5.3.2 Other benefits

Street projects will have other benefits including:

- **a range of benefits related to tree canopy**, such as improved air quality, reduced GHG emissions urban cooling and biodiversity. These values should be included using the approaches set out for public open spaces. To avoid double-counting, they should not be included where street tree amenity is measured
- **transport-related benefits**, for example, changes to a street may lead to reduced travel times, or lead people to change their mode of travel. These impacts should be measured using the parameters in the Transport for NSW guidelines. Active transport values should be included through the approaches set out for public open space.

5.4 Changes in parameters over time

Intergenerational equity is a key concern when valuing environmental impacts that occur well into the future. In a CBA, the valuation of environmental impacts involves converting monetised values into a monetary equivalent relevant to that period by applying a discount rate.

However, the value of environmental services may vary through time due to changes in key parameters such as:

- increased scarcity of environmental assets
- climate change (which may increase the value of canopy and other types of green cover)
- the density of urban living (the value of open space may increase as a larger proportion of people live in apartments with limited private open space)
- changing demographics (that is, the value of open space may change depending on age etc.)
- increasing age and maturity of the green infrastructure.

In these cases, the valuation of environmental impacts should be adjusted directly throughout the evaluation period in the CBA to accommodate these issues. For example, the parameter value for GHG impacts increases over time to reflect the maturing process of a tree. The parameter values for air quality and urban cooling benefits relate to tree canopy. Any change in tree canopy over time should be included in the analysis to accurately estimate the air quality and urban cooling benefits over the evaluation period.

The same discount rate should be applied to all impacts valued in the CBA. As discussed above, sensitivity analysis must be conducted on the discount rate. The distribution of costs and benefits over time should be considered in cases where the CBA result differs substantially, depending on the discount rate applied.

5.5 Qualitative and non-monetised benefits

Where possible, costs and benefits should be monetised, but monetisation may not always be possible. This may be due to a lack of evidence for parameter values, not being able to measure a specific impact due to data limitations or it may be costly to measure and monetise impacts.

In such cases, qualitative analysis of the benefits and costs should be presented alongside the CBA results. They may provide important information for decision-makers to fully understand the impacts of the option being considered.

In general, monetised impacts will be preferred. If impacts cannot be monetised, impacts should be quantified. Where benefits cannot be monetised or quantified, impacts should be qualitatively described as a last resort. This process is described below.

5.5.1 Quantifying non-monetised benefits

When there are difficulties monetising specific costs and benefits, the impact should be quantified where possible (such as where the necessary evidence base has not been developed for valuation). Quantification helps decision-makers understand the scale of the impact, such as the kilometres of waterway impacted. When impacts are quantified but not monetised, it is useful to provide benchmarks for comparison. For example, where a project increases accessibility to cultural facilities in Sydney, a benchmark such as the average accessibility across Sydney provides a metric against which the outcomes of a project can be compared.

5.5.2 Qualitative descriptions of impacts

Providing a qualitative description of the impact should only be used as a last resort. It can provide information on societal impacts relevant for decision-makers but will require the decision-maker to make their judgements about both the size of impacts and the value of these. A logic model can help identify and explain the impacts that are directly attributable to the project.

5.6 Approaches to measure project-specific parameters

The framework provides guidance on parameters that can be applied to a range of projects. However, in some cases, project-specific parameters should be used for particular projects.

The use of project-specific parameters will often be warranted for large, unique projects. For example, the general parameters provided in the framework would not be appropriate to undertake an evaluation related to the Sydney Opera House.

In deciding whether to use project-specific parameters, the accuracy of CBA needs to be balanced against the costs of developing project-specific parameters.

The key methods of measuring project-specific parameters are:

- revealed preference valuation methods, including:
  - hedonic analysis
  - travel cost method
  - defensive and corrective expenditure
  - experimental studies
- stated preference methods, including:
  - contingent valuation
  - choice modelling.

Further guidance on these approaches is provided in section 6 of this framework.

6 Undertaking sensitivity analysis

Decision-making for projects, programs and policies can involve significant uncertainty. For example, demand uncertainty for a proposed new museum may make it difficult to weigh the economic merits of the investment – if demand is significantly lower than expected, the project may not be economically justified.

Sensitivity testing can be used to assess the impact of risks on economic results. CBA should always test the sensitivity of results to key risks or changes in key assumptions or parameters.

The purpose of sensitivity testing is to assess the robustness of the proposal to movements (up/down or positive/negative) in the variables that determine its viability, such as demand or capital costs. Sensitivity analysis is most effective where is it used to assess project-specific uncertainties, as opposed to generic sensitivity tests (such as increasing all benefits by 30%).

For further information on sensitivity analysis and dealing with risk in CBA, see NSW Government Guide to Cost-Benefit Analysis (TPG23-08).

6.1 Key sources of risk and uncertainty for green infrastructure and public spaces

6.1.1 Climate change

Climate change presents clear and potentially intensifying risks and uncertainties that may affect the benefits and costs associated with public spaces and green infrastructure. For example, climate change may:

- **increase the frequency and duration of heatwaves**, affecting the magnitude of urban cooling benefits from canopy cover and vegetation (such as ill health effects avoided due to green infrastructure). This may also affect the types of vegetation that can survive in those conditions and irrigation requirements. Higher temperatures may also affect future demand for outdoor plazas and squares during summer months
- **change rainfall patterns**, such that some areas experience higher rainfall, increasing the frequency and severity of flood events, while others may experience lower rainfall. Higher future rainfall may increase returns from green infrastructure that provides stormwater services. Lower future rainfall may increase the returns from green infrastructure that keeps water in the environment or supports lower water demand.

Careful consideration of climate change is required for each project. For more guidance refer to the disaster framework that is expected to be published by NSW Treasury in late 2023.

6.1.2 Land use and demand

A key benefit for many of the green infrastructure and public space asset classes relates to demand. Holding substitutes and characteristics constant, a lower population within an infrastructure catchment will generally correspond to lower demand.

Within government demographic projections, there may be considerable forecast errors in:

- aggregate projections for Sydney or the state due to unexpected shocks (such as COVID-19)
- the distribution of growth due to a range of factors including planning constraints or changing preferences.

6.1.3 Ecosystem services

Benefits related to ecosystem services may rely on outcomes beyond the scope of the business case. For example, to realise benefits nearby, properties may be required to appropriately maintain their land. If surrounding properties are not properly maintained, this may affect biodiversity or water quality within the project area.

6.2 Typical sensitivity tests

Table 6.1 shows a range of sensitivity tests typically undertaken as part of a CBA. These sensitivity tests should be presented as part of the CBA results, in addition to project-specific sensitivity tests.

Project-specific sensitivity tests are generally of greater value to a decision-maker than typical sensitivity tests. Project-specific sensitivity tests require understanding the specific issues of greatest important to the individual project. Furthermore, testing a range of changes together can give a broader indication of the range of uncertainty than testing parameters individually.

Table 6.1. Typical sensitivity test[62]

Test	Ranges used
Discount rate	3% and 7% (around a central value of 5%)
Under/over estimation of capital costs	±20% of value used (Expected value is a central estimate), or Expected value, P50 or P90[63]. If P50 is used, test P90 as a sensitivity
Under/over estimation of maintenance and operating costs	±20% around the central estimate
Under/over estimation of benefits	±20% around the central estimate
Best-case sensitivity tests	Simple: Assume -20% total costs and +20% benefits Complex: Assume upside adjustments for 4 to 5 key variables
Worst-case sensitivity tests	Simple: Assume +20% total costs and -20% benefits. Complex: Assume downside adjustments for 4 to 5 key variables

[62] Source: NSW Treasury, NSW Government Guide to Cost-Benefit Analysis, TPG23-08, p 94, treasury.nsw.gov.au/finance-resource/guidelines-cost-benefit-analysis, 2023 and Infrastructure Australia 2021, Guide to economic appraisal

[63] P50 refers to there being a 50% probability that the actual cost will be below the P50 cost. P90 refers to there being a 90% probability hat the actual cost will be below the P90 cost.

7 Reporting results of CBA

This section outlines the key information that should be included in a CBA report.

7.1 Net social benefit

The measures of the net social benefit of a project or program will include:

- NPV of the project benefits – the difference between the present value of benefits and the present value of costs
- BCR – the ratio of the present value of total benefits to the present value of total costs.

The NPV and BCR both show, for a given discount rate, when the benefits exceed the costs of an initiative. An initiative is potentially worthwhile if the NPV is positive or the BCR is greater than 1.00.

7.2 Key costs and benefits of options

Complete a summary table showing key categories of benefits and costs in the base case, the options assessed and the dollar values and percentage contribution of each benefit (cost) to total benefits (costs) in each option, relative to the base case. Table 7.1 provides an example.

For projects where green space and public space are elements of the project (but not the entire project), we recommend that green space and public space benefits are reported separately from the total benefits in the CBA results table.

Table 7.1. Example table presenting results of a CBA

Impacts	Value of impacts - Option 1 $NPV	Value of impacts – Option 2 $NPV
Costs	n/a	n/a
Capital costs	n/a	n/a
Operating costs	n/a	n/a
Total costs	n/a	n/a
Benefits	n/a	n/a
Benefit 1	n/a	n/a
Benefit 2	n/a	n/a
Total benefits	n/a	n/a
NPV (applying a 5% discount)	n/a	n/a
BCR	n/a	n/a

7.3 Project central estimate and sensitivity tests

CBAs may have a range of possible results, depending on the range of projects and CBA assumptions. Detailed results for the central case should be reported, as well as results from sensitivity analysis. Based on the key dependencies identified, the key assumptions and inputs should be analysed.

7.4 Project assumptions

All critical assumptions should be made explicit and be supported by evidence. This includes transparency of the key drivers, inputs, risks and assumptions used in constructing the base case and the options considered. Where assumptions are based on NSW Government Guide to Cost-Benefit Analysis (TPG23-08), or sector-specific guidance such as this document, this should be clearly documented and referenced in the CBA. Critical assumptions include:

- demand forecasts and drivers
- benefits included or excluded from the analysis
- assumptions to measure project impacts
- parameter values
- discount rates
- evaluation periods.

7.5 Distribution of costs and benefits

Where possible, the distribution of benefits or costs among different groups should be systematically presented to decision-makers. This should include a summary of the distributional impacts, noting any transfers between different groups. Detailed guidance on undertaking distributional analysis is provided in NSW Government Guide to Cost-Benefit Analysis (TPG23-08).

7.6 Qualitative impacts

Where possible, costs and benefits should be monetised, but this may not always be possible. This may be due to a lack of evidence for parameter values, not being able to measure a specific impact due to data limitations, or it may be costly to measure and monetise impacts.

In such cases, qualitative analysis of the benefits and costs should be presented alongside the CBA results. They may provide important information for decision-makers to fully understand the impacts of the option being considered.

In general, monetised impacts will be preferred. If impacts cannot be monetised, impacts should be quantified. Where benefits cannot be monetised or quantified, impacts should be qualitatively described as a last resort:

- **Quantify, but not monetise impacts** – used when there are difficulties monetising specific costs and benefits, in particular where the necessary evidence base has not been developed for valuation. Quantification helps decision-makers understand the scale of the impact. For example, this might cover the kilometres of waterway impacted. When impacts are quantified but not monetised, it is useful to provide benchmarks for comparison.
- **Qualitative description of the impact only** – used as a last resort, it provides information on societal impacts relevant for decision-makers but requires the decision-maker to make their judgements about both the size of impacts and the value of these.

Quantitative and qualitative information is not easily comparable like monetised costs and benefits as applying monetary values weights the relative importance of impacts. Quantitative and qualitative information is inherently subjective and its interpretation will depend on the judgement of decision-makers.

7.7 Decision-making criteria

The decision-making criteria are the basis on which an analyst can make a recommendation about a CBA. The key results of a CBA are generally presented through:

- NPV of benefits
- BCR.

These should both be reported for each option.

NPV and BCR both indicate whether an option's benefits exceed its costs in present value terms for a given discount rate (NPV above zero; BCR above one). Options in which costs exceed benefits in present value terms (NPV below zero; BCR below one) indicate that overall social welfare is reduced.

NSW Government Guide to Cost-Benefit Analysis (TPG23-08) and the appendix provide further information about how to use these measures in ranking project options.

While CBA is a powerful decision-making tool, it may not be able to capture all the relevant project impacts. In this case, qualitative information should be provided alongside CBA results.

8 Challenges and limitations of using economic valuation for green infrastructure and public spaces

There are many challenges in developing a CBA. NSW Treasury's CBA guidelines set out how to best approach these challenges.[64] This section sets out specific areas where these challenges are particularly relevant to CBA of green infrastructure and public places, including examples of common mistakes.

8.1 Unclear objectives and missing options

Green infrastructure and public places, more than other projects, are often seeking to meet many objectives at the same time, ranging from providing space for recreation and reducing urban heat to increasing or protecting biodiversity. Establishing these objectives clearly, and with some level of hierarchy of importance, can help in developing and refining options.

A CBA is only as good as the set of options that it is analysing. If there are missing options that could provide higher benefits or lower costs, these should be brought into the analysis. For green and public places, this could include options:

- that can provide more services within the same space, such as using stormwater detention as recreational ponds or providing pathways that increase the recreational value of biodiversity areas
- to stage delivery of infrastructure to align changing needs (that is, align infrastructure and services to the population)
- to improve the uses of existing public spaces as compared to providing new public spaces.

8.2 Setting the base case

The key aspects of the base case for a CBA of a green and public space project include:

- the people within relevant catchments of the project and, if possible, their use of green infrastructure and public spaces
- the type, quality and availability of existing green infrastructure and public spaces, which provide substitutes for the project being evaluated.

[64] NSW Treasury, *NSW Government Guide to Cost-Benefit Analysis*, TPG23-08, section A3.3, treasury.nsw.gov.au/finance-resource/guidelines-cost-benefit-analysis, 2023

The base case for a green infrastructure and public space project will often involve making decisions about what others are doing because many organisations are involved in providing these services. For example, developers and/or councils will have a role in providing green infrastructure and public spaces, which may be relevant for a NSW Government project. This is particularly the case in new development areas. A range of NSW Government agencies and others will also potentially interact with green and public space projects, including utility providers.

The base case should be documented providing views on what is expected to happen without the project, as a starting point for the CBA. From a governance perspective, involving other relevant stakeholders in this process is helpful.

8.3 Confusing costs and benefits

Some CBAs present increases in employment as an economic benefit. However, this would be the case only if the labour resources employed by the project were previously unemployed or underemployed or if the actual wage increased above the reservation wage (labour surplus).[65] Where this is not the case, any employment would represent a displacement of otherwise employed resources, which is a cost and therefore should not be considered as a net increase in social welfare.

8.4 Benefit transfer

The parameter values set out in this framework are based on benefit transfer. Past studies are used to develop more general parameters that can be applied to other green and public space projects. The recommended parameters in the framework have been specified to minimise mistakes in undertaking benefit transfer.

Benefit transfer may be undertaken for other benefit categories for which there are not currently available parameters specified in this framework. In undertaking benefit transfer, the approach should:

- be based on previous projects with similar nature and characteristics, site conditions, context and affected population
- be based on robust and valid measurement methods in the original study
- ensure that the benefits measured using transfer are consistent with the benefits measured explicitly or implicitly in the study used for benefit transfer
- ensure application to the correct denominator, such as the number of people within a particular catchment or the number of users
- be adjusted where appropriate to control for differences in attributes (for example, population size or density, educational attainment and sociodemographic characteristics)
- be based on comprehensive, accurate and reliable data.

[65] NSW Treasury, *Guide to Cost-Benefit Analysis TPG23-08*, page 28, treasury.nsw.gov.au/finance-resource/guidelines-cost-benefit-analysis, 2023

8.5 Double-counting and treatment of transfers

Double-counting, which means counting a benefit or cost twice, is a common mistake in CBA, particularly with green infrastructure and public space projects because of the plethora of different approaches used for valuation. Treating transfers as a benefit, such as where people spend money at one location that they would have spent somewhere else, can also occur where a project is not focused on the direct benefits of the project. Furthermore, some approaches to valuation are not explicit in what is actually being measured. Common examples of double-counting and problems in the treatment of transfers include:

- measuring the value of services (such as user benefits from being next to a park) and then measuring the impact on property prices (such as being located near a park) – the property price premium reflects the cumulative value of the future services impacted by being close to a park. Including both is therefore double-counting of the benefits
- including a WTP measure that implicitly incorporates use and non-use values, and then separately including use values
- measuring the benefits to one group but not including the costs to another group. For example, measuring a benefit derived from spending in a geographic area of the project[66], but not including any cost for an area where people are now spending less
- measuring different ways that a benefit could occur. For example, if extra trees reduced urban heat, this could lead to reduced cooling costs to achieve a given comfort area for nearby buildings or less comfortable buildings with the same cooling cost. A benefit should only be included for one of these 2 impacts.

To assist in reducing double-counting, the parameters recommended above clearly specify what benefits are being measured by each parameter and how each parameter should be applied.

8.6 Confusing economic impacts and benefits

A CBA is distinct from an economic impact assessment. The latter seeks to identify economic changes that result from a project, such as changes to economic output, value-added and employment. These show how a project may impact economic measures but are not measures of benefit and are not relevant to CBA.

Some CBAs also seek to include specific aspects of economic impact, such as expenditure from interstate and international visitors resulting from a project, as a benefit. Expenditure is not a benefit. There may be some positive benefits arising from this expenditure, such as a higher producer surplus for NSW businesses. If so, this needs to be measured specifically rather than seeking to measure expenditure.

We consider it a useful cross-check that the benefits that NSW can obtain from economic flow-on, such as set out above, should be less than the magnitude of benefits to the interstate and

[66] Spending is not in itself a benefit, but there may be benefits related to this, such as impact on business producer surplus.

international visitors themselves.[67] Note that when a CBA seeks to divide users into NSW, interstate and international for the purposes of measuring flow-on economic benefits, the benefits to interstate and international visitors would not be included because they are not part of the NSW community.

8.7 Using marginal and average values

As set out in section 5, the value of public spaces depends on the substitutes available and the existing level of provision of public spaces. Where there is a high level of existing provision, the value of additional public spaces will be lower and vice versa. Although, at this stage, the exact magnitude of this decline in value is not overly clear from the evidence available.

In most cases, public space projects will increase the quantity or quality from some existing level of provision of public space. The measure of benefits is related to the **marginal** value of the additional public space and the **marginal** value of the improvement in the quality of public open space.

There are other studies that are concerned with the **average** or **total** value of public spaces, such as identifying the value of all public spaces in a particular region. These studies are useful to highlight the contribution that public spaces make but are not typically useful for CBA. This is because the average value of public spaces is not a good indicator of the marginal value of changes to the spaces.

8.8 Separating stocks and flows

Depending on the benefit being valued and the approach being used, benefits may be valued based on a stock or a flow. For example, a project may change the amount of public open space in a particular catchment area in year 3. That is, the stock of open space in the project option is higher than the base case from year 3 onwards. The flow of services provided is also higher from year 3 onwards.

If the benefit parameter is based on a household willingness to pay a one-off amount, then this is applied once in year 3. If the benefit parameter is based on a household's WTP on an annual basis, then this is applied in each year from year 3 onwards.

In general, the opportunity cost of land used for green and public places is captured as the value of the capital stock. That is, the purchase price of the land, which reflects the value of the capital stock, which in turn is the discounted future value of the flow of services that the land could provide in its alternative use.

The main complication of measuring some benefits using a stock and others as a flow is that the discount rate being used may implicitly be different across benefits and costs. For example, the capital value of the land may implicitly value future flows of services at a much lower discount rate than the NSW Government's central case discount rate assumptions. Similarly, stated preference studies that use a once-off payment mechanism have an implicit discount rate embedded in this

[67] This is because the change in price received for NSW businesses is always less than the change in value received by interstate and international visitors. Supply is upwards sloping and demand is downward sloping. If there was some evidence of excess capacity in NSW businesses not being reflected in their prices, then this may not be the case.

parameter that may or may not be similar to the NSW Government's central case discount rate assumptions. Where these differences are likely to be material, this should be discussed with NSW Treasury.

The concept of ‘natural capital’ is also an example of measuring a stock. The environmental benefits set out in this guideline are focused on the flows of services that natural capital provides. The discounted sum of these environmental benefits is equivalent to the value of the natural capital generated by a project.

8.9 Confusing real, nominal and discounted prices

Costs and benefits can be calculated in real, nominal or discounted terms.

8.9.1 Real value

A real value is one that does not include the effects of general price inflation (such as measured by the consumer price index). Using a real value does not mean that the unit price or value has to be constant. There could be specific increases related to a particular variable, such as an expectation that the value of the environment will increase more rapidly than general prices or that land costs will escalate faster than general prices. The real value should include these changes relative to general prices, but not the impact of general price inflation itself.

8.9.2 Nominal value

A nominal value includes general price inflation. It is what is expected to be actually experienced in the year.

8.9.3 Discounted value

A discounted real value is the value of a future cost or benefit from the perspective of today.

For example, suppose that a public space is to be improved in 5 years. The cost to do this in 5 years, based on prices at the time of work being undertaken, is expected to be $5 million. General prices are expected to have risen by 10% over this period. The real cost is therefore $5 million/1.1, equal to $4.55 million. The discounted real cost is $4.55/(1.07)^5, for a social discount rate of 7%, to give the cost equivalent today. This gives a real discounted cost of $3.2 million.

The costs and benefits over time are typically reported in real values. The overall costs and benefits are reported in real discounted terms. For financial analysis, the nominal costs are typically reported.

9 Case study – valuing a new district/regional park

In this section, we present a case study of a CBA of a new 5-hectare district park. This shows how the framework is intended to be used.

9.1 Define the base case

To enable the modelling of costs and benefits, the key base-case assumptions are summarised in Table 9.1.

The number of dwellings within the 1.6-km catchment is required to estimate user benefits, while assumptions around the number of dwellings and population within a 1 km catchment of the proposed park are required to estimate urban cooling benefits. Under the base case, we assume that land use remains unchanged in the study area and assume other committed and funded infrastructure developments occur.

Under the base case, the site of the proposed park is assumed to remain vacant and have no vegetation coverage.

Table 9.1. Base case assumptions

Characteristics	Assumption
Area within 1.6 km of the edge of the park	Based on the park being 500 metres long and 100 m wide, the area within the catchment of 1.6 km from the edge of the park is 996 hectares.[68]
Dwellings within a 1.6 km catchment of the park	20,000
Dwellings within a 1.0 km catchment of the park	8,716
Dwelling average annual growth rate	0.05%
Population within a 1 km catchment of the park	26,148
Population average annual growth rate	0.05%
Average property price	$900,000
Average annual real property price escalation	0.3%

[68] 2 rectangles of 500 m*1,600 m, 2 rectangles of 100 m*1,600 m and the four segments from the corners equal to Pi()*1,600 m*1,600 m.

9.2 Develop options

For this case study, one option has been considered. This consists of the construction of a 5-hectare park in an urban area. The new park is assumed to consist of:

- 75% grassed areas
- 25% canopy cover.

The project will result in the following impacts:

- Within the 1.6-km catchment, the share of open space will increase by 0.5 percentage points. This is 5 hectares divided by 996 hectares. Note that, the base level of public open space is important. However, the evidence available does not provide guidance about how much the value of a new park will depend on the value of existing parks. It is still useful to present the base level of open space as part of the business case.
- Within the 1-km catchment:
  - the share of canopy cover will increase by 0.3%
  - the share of grassed open space will increase by 0.9%.

We assume the park will be owned and operated by a NSW Government entity and consider the capital and land acquisition costs required to establish the park, as well as operating costs over the evaluation period.

The park is assumed to be constructed in year 1, with all capital costs incurred in that year, followed by operating costs over the life of the project.

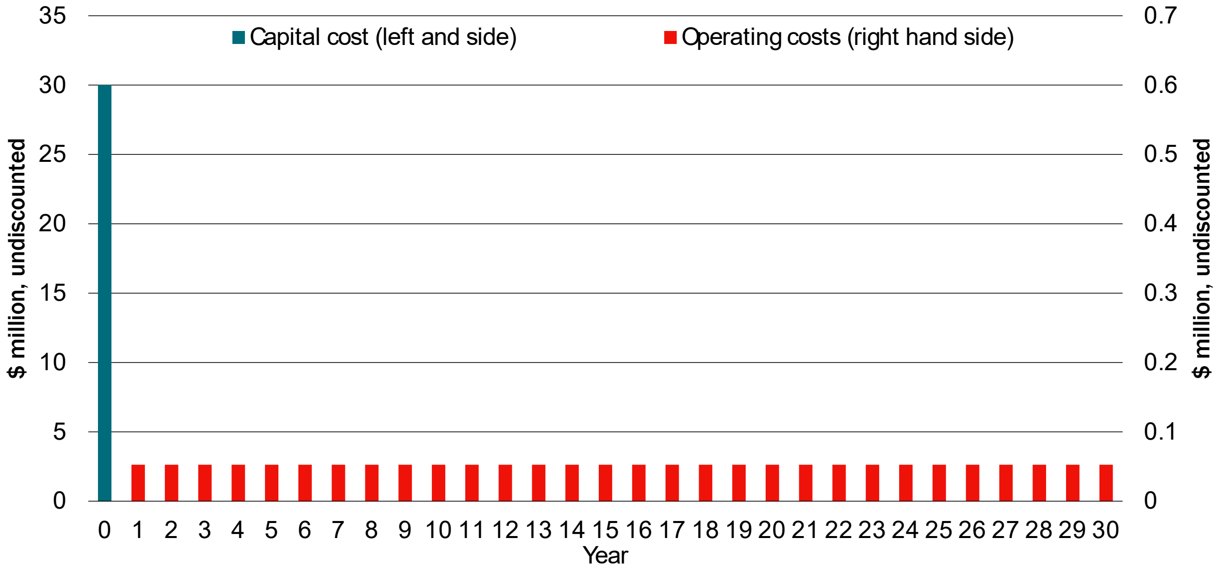
9.3 Project costs

The key costs for the CBA include:

- capital costs, which are incurred in year 1 including:
  - construction, design and development and site remediation costs, which are assumed to be $200/m^2$ and are based on cost benchmarks. The total undiscounted construction cost is $10 million
  - land costs, which are assumed to be $400/m^2$. This represents the opportunity cost of developing the land and measures the value of the land required for the project at its next best use. It is based on market values for land in the area. The total undiscounted land cost for the project is $20 million
- ongoing maintenance and operational costs, which is assumed to be $1.05/m^2$ per year. The total annual undiscounted operating cost is $52,000 per year and is incurred from year 1 onwards.

The profile of costs is shown in Figure 9.1. Most of the costs are capital costs.

Figure 9.1: Project costs



9.4 Project benefits

The project benefits and the approach to measure each benefit is shown in Table 9.2.

Table 9.2. Benefits included in CBA

Benefit	Approach to measure benefit
User benefit (recreational value)	0.3% increase in property values per percentage point increase in the share of open space within a 1.6 km catchment
Urban cooling (health)	$3.0 per degree reduction per person per day above 30 ˚C
Urban cooling (cost of cooling)	$13.50 cooling cost saving per household per degree of temperature reduction per year
Urban cooling (avoided GHG)	$4.55 GHG benefit per household per degree of temperature reduction per year (based on an assumed carbon price of $123 per tonne CO_2)
Health benefits from increased activity	Average of $929 and $789 per person per year moving from an inactive individual becoming sufficiently active or an insufficiently active individual becoming sufficiently active This is applied to 6% of people on the basis that there is no large regional park in the area in the base case.
Air quality impact (canopy cover)	$0.109 per m^2 canopy cover
GHG sequestration	$123 per tonne CO_2 and the following CO_2 sequestration rates per m^2 canopy cover: • years 1 to 5: 0.9 kgs CO_2/year/m^2 (0.24 kgs of carbon per year) • years 6 to10: 2.2 kgs CO_2/year/m^2 (0.61 kgs of carbon per year) • years 11 to 20: 1.7 kgs CO_2/year/m^2 (0.47 kgs of carbon per year) • years 20+: 1.1 CO_2/year/m^2 (0.30 kgs of carbon per year)

Benefit	Approach to measure benefit
Residual value of land and capital	Land is assumed to have no real price escalation over the evaluation period. Its residual value is therefore its cost today discounted by 30 years. Capital is assumed to have no residual value.

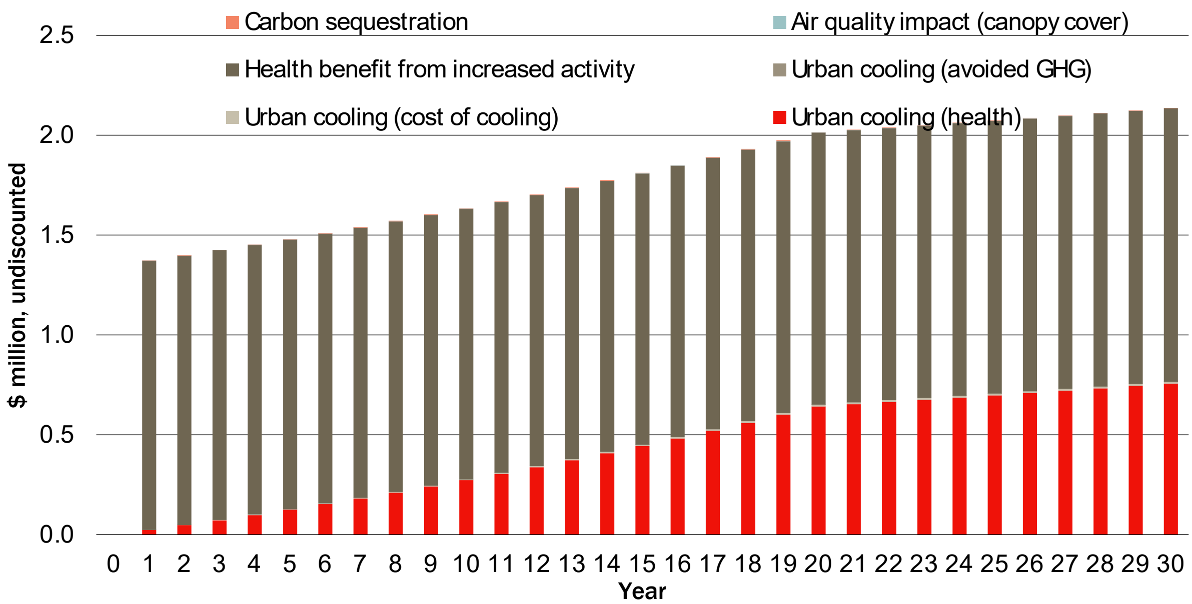
The cooling benefits are based on the following assumed impacts of canopy cover and vegetation on temperature:

- an additional 10% of catchment covered by tree canopy, compared to no vegetation, reduces temperatures by 1.13 ˚C
- an additional 10% of catchment covered by green open space (not canopy cover), compared to no vegetation, reduces temperatures by 0.50 ˚C.

This means that, in total, the new park reduces temperatures within its urban cooling catchment of 1,000 m by 0.08 ˚C.

The profile of benefits excluding the user benefit (recreational value) is shown in Figure 9.2. Note that air quality and carbon sequestration benefits are small and not visible in Figure 9.2. The user benefit (recreational value) is included in the CBA in the first year of the operation of the park.

Figure 9.2: Project benefits excluding user benefit (recreational value)



9.5 Results

Results of the CBA are shown in Table 9.3, using a discount rate of 5% and measuring the impacts of the project over 30 years.

This results in a net benefit of $26 million and a BCR of 1.84. If a project has a BCR greater than 1.0, the project is expected to deliver a positive NPV to the NSW community.

The most significant benefits are use value (recreational), use value (health) and urban cooling (health). Benefits related to air quality improvements and reduced GHG emissions are very small for an urban park.

Table 9.3. CBA results: 5 ha district park measured over 30 years using a 7% discount rate.

Item type	Impacts	Value of impacts – Option 1 ($NPV over the evaluation period, relative to the base case)
Cost	Capital costs	30,000,000
Cost	Operating costs	804,253
Cost	Total costs	30,804,253
Benefit	User benefit (recreational value)	26,020,593
Benefit	Urban cooling (health)	5,348,315
Benefit	Urban cooling (cost of cooling)	75,993
Benefit	Urban cooling (avoided GHG)	2,322
Benefit	Health benefits from increased activity	20,838,264
Benefit	Air quality impact (canopy cover)	11,524
Benefit	GHG sequestration	34,993
Benefit	Residual value of land	4,627,549
Total	Total benefits	56,959,553
Total	Net benefit (applying a 5% discount rate)	26,155,300
Total	BCR	1.85

10 Non-market valuation methods

Previous sections have outlined benefit-transfer approaches for valuing benefits for green infrastructure and public space projects. There will be projects where these parameters are not appropriate, either because of the large investment expected or the unique characteristics of the project. In this case, specific primary valuation studies may be required.

This section provides descriptions of the methodologies that could be used and instructions on how to apply the valuation methods regarding green infrastructure and public spaces projects.

Where market values are available, such as for the cost of inputs such as labour and land, these would be used in the CBA. This section covers valuation where market prices are not available.

The 2 broad techniques for putting a dollar value on environmental impacts that are not traded in a market are 'revealed preference' and 'stated preference' techniques. Both seek to measure WTP. The key difference between the 2 is that revealed preference techniques estimate WTP based on households' preferences that are revealed by choices made in real markets and stated preference methods assess households' preferences through their choices stated in a survey context.

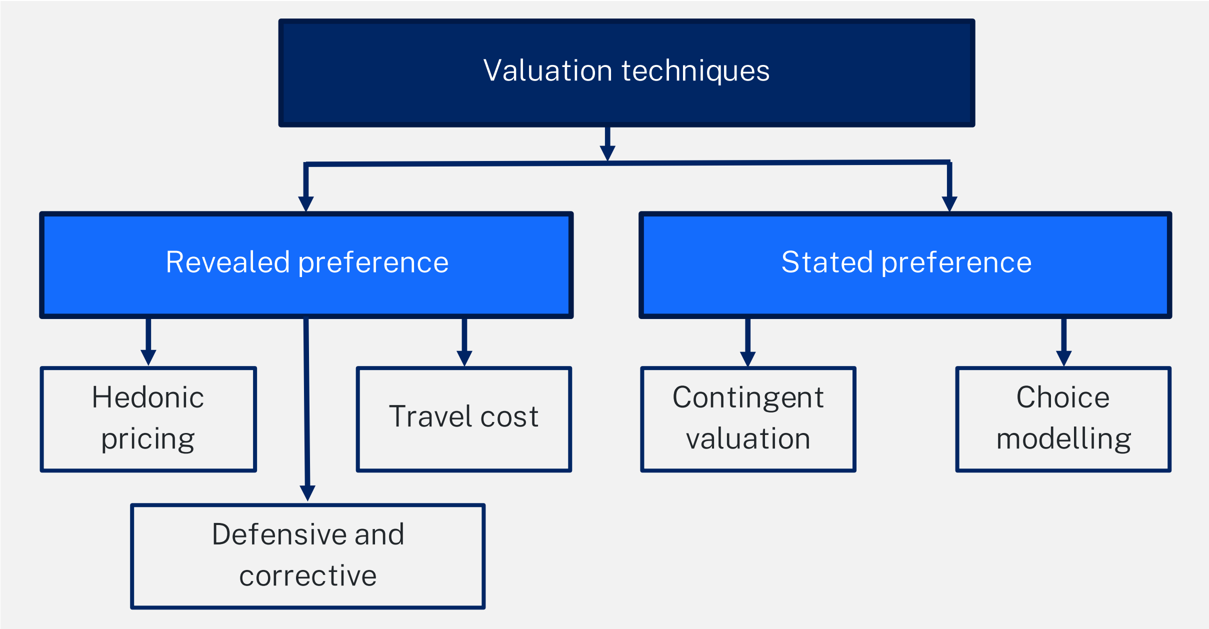
The revealed preference technique is applied to data from real markets where variants of a good or service are traded. For example, different home locations have more or less noise and air pollution from traffic. The value of homes traded in the market, therefore, reveals how much people care about these differences if the effect of these specific characteristics can be isolated. Hedonic pricing and the travel cost methods are the 2 key revealed preference techniques used to estimate the value of environmental goods and services (Figure 10.1).

The stated preference technique, in contrast, uses data from a hypothetical market gathered using a survey and can therefore measure demand for goods and services that have not yet gone to market or that are not traded in a market. The 2 most commonly stated preference techniques are contingent valuation and choice modelling (Figure 10.1). A realistic payment mechanism, such that respondents consider their budget constraints as per any traditional market transaction, is critical to attaining robust results from stated preference surveys.

Revealed preference methods are generally preferred to stated preference methods, all else equal, as revealed preference methods tend to be more reliable.[69]

[69] NSW Treasury, *NSW Government Guide to Cost-Benefit Analysis*, TPG23-08, p 50, treasury.nsw.gov.au/finance-resource/guidelines-cost-benefit-analysis, 2023

Figure 10.1: Techniques for valuing a non-market good



10.1 Revealed preference methods

Revealed preference methods derive consumers' WTP by examining their actual behaviour in real markets. The 2 key revealed preference methods for valuing environmental impacts are hedonic pricing and travel cost method. This section also provides information on defensive and corrective expenditures.

10.1.1 Hedonic pricing

The hedonic pricing method is based on the premise that the price of a good represents the value consumers place on each of the attributes that comprise the good. Hedonic pricing is often applied to house prices to estimate the value consumers pay for individual attributes of housing, such as environmental values.

This approach uses house or land prices versus a range of explanatory variables (including public space variables and control variables) to understand the impact of public space on house or land values. Statistical regression analysis is used to determine the value (implicit prices) consumers place on each of these individual attributes of a house (explanatory variables) by looking at the variation in prices of houses and the variation in the attributes of the houses. The parameter for public open space will then measure whether being near public space or having more public space is of value to people living in an area.

The types of use value and benefits included in the hedonic price method are summarised in Table 10.1 and Table 10.2.

The quality of hedonic price parameters depends on the specification used to estimate parameters and the quality of data available. all relevant variables that may have a significant impact on house or land prices, such as land size, house characteristics (for example, size, quality and age) and location, to avoid omitted variable bias.

Table 10.1. What is measured by hedonic analysis – users?

Component of value – types of users	Description
For all users	No. Only captures value for people living very close to a public open space, for example, a local park
For new public spaces and improved public spaces	The method is based on existing public spaces. A benefit-transfer approach is required to apply to new and improved public spaces.
Accounts for quality of facilities, available substitutes and capacity	Measures will reflect 'average' quality, capacity and substitutes unless specific explanatory variables are included in the hedonic analysis that relates to these characteristics.
Provides a value per user or a value per person in the catchment	Value per property or as a share of property value, rather than a value per user

Table 10.2 What is measured by hedonic analysis – benefits

Component of value – types of benefits	Description
Visual amenity of public open space to non-users	Yes
Private component of urban cooling and air pollution impacts	Yes, in theory, but will depend on whether people understand these factors
Other non-use values (biodiversity, avoided GHG emissions)	No

10.1.1.1 Case study

Greater London Authority (GLA) 2003 uses a hedonic pricing model to estimate the value of public open space.[70] The paper estimates a hedonic price model that estimates average house prices by London ward using a range of characteristics. The study estimates the following function:

$$\ln(house\ prices_i) = \beta_0 + \beta_1 Percent\ Green\ open\ space_i + \sum_j \beta_j X_{ji} + \varepsilon$$

Where $house\ prices_i$ are average house prices for wards i, $Percent\ Green\ open\ space_i$ is the percentage of green space in ward i and X_{ji} is a vector of ward characteristics (control variables). Ward characteristics include density, income support, education and crime.

From the model, the β_1 parameter describes how dwelling prices change depending on that share of green open space, capturing the WTP for people to live near green space.

This model applies a hedonic model to estimate average house prices in an area. However, a hedonic model can also be applied to individual properties, depending on data availability.

[70] Greater London Authority Economics, 'Valuing Greenness: Green spaces, house prices and Londoner's priorities', www.london.gov.uk/sites/default/files/valuing_greenness_report.pdf 2010

10.1.2 Travel cost method

Travel cost studies infer the value of public open spaces such as recreational sites from the relationship between visitation rates and the travel costs visitors incurred in the form of time and money.

The travel cost method is the most robust method for measuring the use value of existing public open space because it:

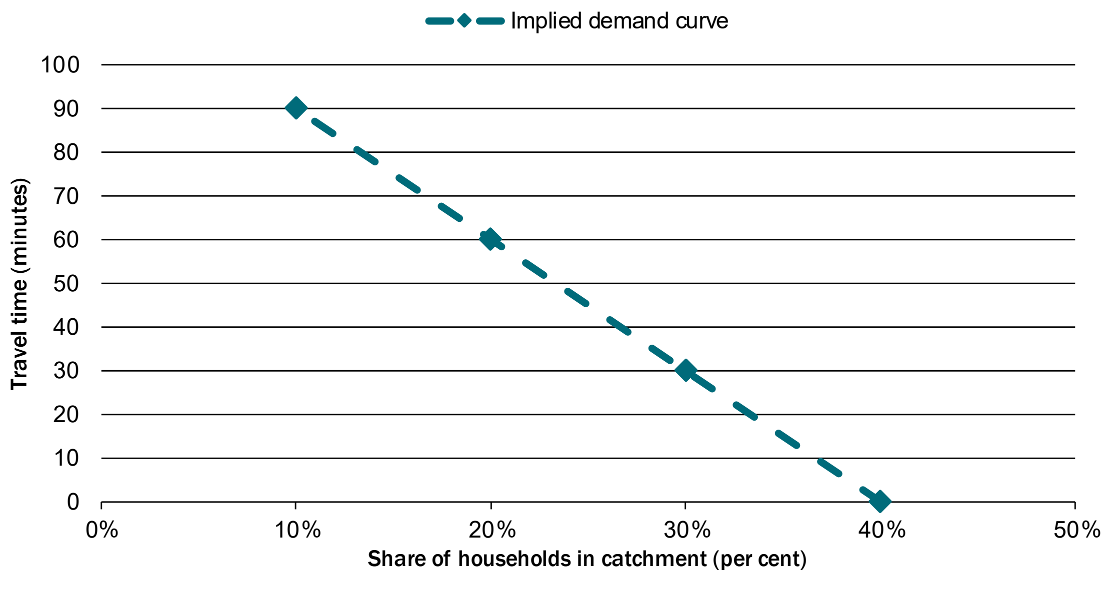
- only measures use value, rather than also including other types of benefits
- measures the use value for all users
- relies on people's actual decisions.

For example, suppose:

- 40% of households right next to a facility visit it each year
- 30% of households within 30 minutes of a facility visit it each year
- 20% of households within 60 minutes of a facility visit it each year
- 10% of households within 90 minutes of a facility visit it each year.

Using this information, a demand curve can be constructed below for a household next to the facility (Figure 10.2). To measure the benefit, the travel time is then converted into a cost. The consumer surplus is the area below the demand curve. This is estimated for the set of households at each distance from the facility.

Figure 10.2. Estimating a demand curve using the travel cost method



Difficulties with this method can emerge when the trip does not have a single purpose, such that a person visits one site and then subsequently visits additional sites. The travel cost then needs to be allocated to the respective sites. This can be particularly important if values for people making longer multi-night trips are being used.

The travel cost method can only be used for measuring the value of existing public open space. The methodology relies on having data on current visitation. If this is to be used in ex-ante CBA, values from existing public open space would have to be applied in some way to new or improved public open space. In some cases, such as the example presented below, travel cost uses multiple destinations with different characteristics. This allows for a much broader use of the method in applying it to possible future projects.

10.1.2.1 Case study

Heagney et al 2019 present a travel cost method that is used to measure the value per visit to national parks in NSW.[71]

The analysis was based on the following data and assumptions:

- 62,000 telephone survey respondents were questioned about their recent use of NSW national parks, including which sites they had visited and how often they had visited those sites in the preceding 4 weeks.
- Travel costs for each were estimated based on the most direct route from the respondent's postcode to the national park or parks they reported visiting:
  - round trips below 4 hours were assumed to be single-purpose day trips
  - trips above this threshold were assumed to be overnight trips.
- Travel costs are estimated based on:
  - the opportunity cost of time (that is, travel time)
  - average fuel costs
  - costs of overnight accommodation (for overnight trips).
- 65% of travel costs are included in the model to account for multipurpose trips. This is based on the proportion of respondents who reported visiting a national park was the only or primary purpose of their trip.

Heagney et al 2019 then estimate a random utility model, which models the choices of individuals and accounts for substitution effects from alternative national park sites. The model controls for a range of national park attributes considered likely to influence visitation, including size, remoteness, conservation status, natural values (such as Aboriginal heritage and high biodiversity value) and built infrastructure (such as paths, parking and amenities).

Consumer surplus per visitor trip can then be calculated using the estimated model coefficients from the random utility model. Results from the model can then be used to inform CBA benefit parameters.

Because this model used a range of alternative national park sites with different characteristics, its use is broader than a study focused on one single site. This is because it can provide a guide as to the value of the characteristics of the different sites.

[71] Heagney, E.C., Rose, J.M., Ardeshiri, A., & Kovac, M., 'The economic value of tourism and recreation across a large, protected area network' (2019) 88 *Land Use Policy*.

10.1.3 Defensive and corrective expenditure

Defensive and corrective expenditure is the amount spent to mitigate or even eliminate the effect of a negative externality. If a project eliminates that externality, the benefit can be measured as defensive and corrective expenditure avoided.

This approach generally assumes that the benefit arising from the defensive expenditure is greater than the value of the defensive expenditure (as otherwise customers would not be willing to incur the expenditure). As such, these expenditures do not necessarily correspond to the environmental benefits resulting from the defensive measures.

In some sense, defensive expenditure is akin to undertaking a cost-effectiveness analysis of a new option relative to options currently available. Where the project option is less costly than other options available, then the cost incurred is smaller than the defensive expenditure avoided.

10.1.3.1 Case study

Tapsuwan et al. 2019 evaluated the benefits of reducing stormwater through public urban forests and irrigated areas (as well as other benefits and costs).[72] This used a defensive and correctional expenditure approach. The benefits of reduced stormwater run-off were estimated through the avoided costs of projects to build stormwater wetlands or retention ponds in the ACT. A selection of 6 stormwater management options were included and the costs per cubic metre of stormwater run-off managed were evaluated. The benefit of reducing run-off was then measured as the avoided cost of having to undertake similar projects.

A second example is the NSW Biodiversity Offsets Scheme. Under this scheme, the replacement cost of biodiversity is represented by the price of biodiversity credits.

In NSW, the Biodiversity Offsets Scheme creates a market price for biodiversity through the requirement to purchase offsets. Where markets are efficient, the market value of a good or service reflects a range of factors including community preferences (on the demand side) and the cost of production (on the supply side). It is therefore generally assumed in economic analysis that the market price of a good or service reflects its value to society. However, in the market for biodiversity credits, demand is driven by the government-imposed requirement to offset biodiversity lost through (some) development, rather than the community's 'willingness to pay' for biodiversity. As such, the price of credits reflects the cost of managing land to an agreed standard to offset impacts to biodiversity elsewhere and the opportunity cost of the land, rather than underlying community preferences for biodiversity.

Using the replacement-cost approach, the value of biodiversity primarily reflects the land value at the offset site and associated management costs. Based on current land markets, this is likely to result in biodiversity values being higher in urban areas relative to rural and regional areas, even for similar types of biodiversity.

[72] S Tapsuwan, R Marcos-Martinez, H Schandl, & Z Yu, 'Valuing ecosystem services of urban forests and open spaces: application of the SEEA framework in Australia' (2021) 65 *Australian Journal of Agricultural and Resource Economics.*

10.2 Stated preference methods

Stated preference methods observe choices relating to alternatives presented to people through a survey. These options can include characteristics of options that are not observable in an actual market by creating a hypothetical market. It relies on asking people hypothetical questions to see how they respond to a range of choices, and thus to establish the extent of collective WTP for a particular attribute or benefit.

The primary disadvantage of stated preference methods is that potential bias can occur when participants do not feel obligated by the financial constraint constructed in the hypothetical market or do not consider the full range of choices or their budget constraint when answering the survey.

Stated preference valuation techniques are complex and generally need to be undertaken by specialists. Using a sound methodology, including extensive testing of the questionnaire, is critical to ensure the credibility of the results.[73]

10.2.1 Contingent valuation

Contingent valuation estimates how much consumers are willing to pay to retain (or avoid) something. The survey format is typically binary with a yes/no response applied to a single, specified policy change, but may also be in response to a range of specific prices.[74]

Respondents are directly asked for their WTP for a clearly defined good or willingness to accept a loss. Questions take the form 'what are you willing to pay?' or 'are you willing to pay $X?'.[75]

10.2.1.1 Case study

Library Council of NSW (2008) used contingent valuation to estimate the value of libraries.[76] The following survey question was put to respondents:

> *Thinking from the broader community perspective, if the public library was not funded by government, how much would you be willing to pay to maintain the community's access to the current services?*

Responses were collected for both library users and non-users. The responses were expected to include both use and existence values for libraries.

The average WTP was $58.20 per annum per library user (2008 values) for existing libraries in NSW ($61 per year in metropolitan areas and $54 for regional areas) and $19 per year for non-users.

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[73] A summary of key issues is provided in D Fujiwara and R Campbell, Valuation Techniques for Social Cost-Benefit Analysis: Stated Preference, Revealed Preference and Subjective Well-Being Approaches A Discussion of the Current Issues. assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/209107/greenbook_valuationtechniques.pdf, 2011

[74] NSW Treasury, 2023, NSW Government Guide to Cost-Benefit Analysis, TPG23-08, p. 52 treasury.nsw.gov.au/finance-resource/guidelines-cost-benefit-analysis, 2023

[75] Pearce D. and Özdemiroglu E. (2002) Economic Valuation with Stated Preference Techniques Summary Guide, www.gov.uk/government/publications/green-book-supplementary-guidance-stated-preference-techniques.

[76] Library Council of New South Wales 2008. Enriching communities: the value of public libraries in New South Wales, www.sl.nsw.gov.au/sites/default/files/Enriching%20Communities%20-%20the%20value%20of%20public%20libraries%20in%20New%20South%20Wales%20Full%20Report.pdf.

10.2.2 Choice modelling

Choice modelling studies can be used to estimate separate values for changes in multiple attributes of a good or service. Survey respondents are presented with several choice questions. Each choice question presents 2 or more hypothetical scenarios with specified costs and asks the respondent to indicate their preferred option.

The scenarios are described by multiple attributes and the levels assigned to attributes vary over scenarios and questions. This variation is designed to support statistical estimation of the value placed by respondents on changes in each attribute. The choices and trade-offs made by respondents across the range of options provide a monetary valuation of individual attributes.

10.2.2.1 Case study

Bennett et al. (2015) used choice modelling to estimate the benefits of environmental flow for the management of the Hawkesbury–Nepean River.[77] The study explored where there are non-linearities in WTP response and thresholds in the community's preferences for specific environmental attributes.

The 4 attributes used to characterise the condition of the river environment were:

- suitability for swimming – length of the river (km) which has water quality meeting minimum quality standards for direct contact recreation such as swimming
- time taken to catch a bass fish – used as an indicator of the total number of native fish in the river
- riverside vegetation – length of the river (km) with native vegetation growing on both banks, an indicator of native plants and animal diversity, including birds that depend on the river
- clear of non-native water weeds – the length of the river (km) that is not infested with invasive water weeds, . Weeds can be unsightly, a nuisance to recreational swimming and boating and one of the reasons for reduced native plant and animal life in the river.

Respondents were provided with a range of different waterway management options with different levels of the condition of the river environment for each attribute and cost. The cost attribute was specified as an increase in water bills over 10 years.

Table 10.3. The environmental condition of the Hawkesbury–Nepean River[77]

Environmental attribute	Current level (2012)	Future level (2024) with no new government actions
Suitable for swimming	70 km (40%)	50 km (30%)
Time to catch a bass fish	90 min	180 min
Riverside vegetation	85 km (50%)	50 km (30%)
Weed-free river	90 km (55%)	70 km (40%)

Table 10.4 outlines the estimated WTP for each attribute and attribute level change. The results suggest diminishing marginal utility for 2 attributes – suitability for swimming and river clean of

[77] J Bennet, J Cheesman, R Blamey, and M Kragt, *Estimating the non-market benefits of environmental flows in the Hawkesbury-Nepean River*, Journal of Environmental Economics and Policy, 2015

non-native water weeds. However, the trend is not clear for riverside vegetation with a value of $0.67 per kilometre for improvements between 50 kilometres to 85 kilometres, increasing to $2.28 per kilometre for improvements between 85 kilometres to 100 kilometres, and then falling to being not significantly different from zero for improvements greater than 100 kilometres.

The presence of WTP thresholds was another key finding from the study. Households are willing to pay for river improvements up to 100 kilometres of river suitable for swimming and 100 kilometres of riverside vegetation, but not for river improvements beyond these threshold levels.[77]

Table 10.4. Willingness to pay for attribute improvements in the Hawkesbury–Nepean River[78]

Attribute	Attribute change	Average WTP per year for 10 years
Suitability for swimming	50 km to 70 km	$2.92/km
Suitability for swimming	70 km to 100 km	$2.24/km
Suitability for swimming	100 km to 150 km	Not significant
Time to catch one bass fish	180 min to 90 min	Not significant
Time to catch one bass fish	90 min to 60 min	$0.70/min
Time to catch one bass fish	60 min to 30 min	$0.98/min
Riverside vegetation	50 km to 85 km	$0.67/km
Riverside vegetation	85 km to 100 km	$2.28/km
Riverside vegetation	100 km to 120 km	Not significant
Clear of non-native water weeds	70 km to 90 km	$2.19/km
Clear of non-native water weeds	90 km to 120 km	$0.77/km
Clear of non-native water weeds	120 km to 150 km	Not significant

10.3 Benefits transfer

Revealed preference and stated preference methods can be data- and time-intensive and expensive to conduct. The benefit transfer method provides an alternative to estimating the economic value of an environmental attribute in cases where a primary study is not warranted nor possible to complete. This method transfers values from existing revealed and stated preference studies to the project under analysis.

The robustness of the benefit-transfer approach increases when there is a high level of comparability between the previous study's context and that of the project being analysed, including the base levels of environmental qualities. Value estimates should not be transferred to another study context where there are significant differences. As noted by the Productivity Commission (2014), transferring value estimates from one site to another is likely to be very imprecise (and possibly misleading) unless there is a high degree of similarity between the 'study'

[78] Source: J Bennet, J Cheesman, R Blamey, and M Kragt, Estimating the non-market benefits of environmental flows in the Hawkesbury-Nepean River, *Journal of Environmental Economics and Policy*, 2015

and ‘policy’ contexts (in terms of the environmental features, policy outcomes and population characteristics).[79]

Benefit transfer is useful when ‘order of magnitude’ estimates are required and/or for small-scale projects. Benefit transfer should be used with caution where the net benefit of the project is highly dependent on the impact being valued using benefit transfer. For large unique projects, in many cases, it will be preferable to undertake primary valuation studies.

Some forms of benefit transfer are more robust than others. For example, applying a cost per tonne of GHG emissions is robust because the impacts of GHG emissions will be the same regardless of where the emissions occur.

The recommended parameters presented in the framework are based on benefit transfer.

[79] Productivity Commission, *Environmental Policy Analysis: A Guide to Non-market Valuation*, Staff Working Paper, January 2014, p 6