CRC for Water Sensitive Cities

INFFEWS Value Tool: Guideline (Version 3)

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1 Introduction

The purpose of this document is to provide a readily accessible guideline on how to adjust existing non-market values for application in a new context. It also provides step-by-step rules on how to use the CRCWSC Value tool. This guideline and the tool will support practitioners and others who are interested in assessing and quantifying non-market (intangible) benefits of water sensitive systems and practices in monetary terms.

In many real-world applications, the business case for investment in water sensitive systems and practices is strengthened when benefits that do not have a clear market price are included, for example, environmental benefits. But, obtaining estimates of the non-market benefits flowing from investment in water sensitive systems and practices is complex. In some cases, non-market benefits are considered in a qualitative manner only. In other cases, the specific evaluation framework used to guide investment decisions means that non-market benefits are not considered at all. In situations where the non-market benefits are excluded from the investment decision evaluation, or only considered qualitatively, it is possible that the evaluation will lead to investments that are not socially optimal.

Incorporating non-market outcomes (benefits or disbenefits) in formal policy analysis depends on several factors: the importance of non-market outcomes to the policy decision, the cost of undertaking a non-market valuation study, and the type of analysis that can be conducted. Baker and Ruting (2014) provide steps to decide when to include information about non-market benefits in policy analysis (Figure 1).

- The expected non-market outcomes (e.g. changes in water quality) for different policy options would need to be clearly identified and estimated.
- The relative benefit of incorporating information on non-market outcomes in the policy analysis should be higher than the cost of collecting the information. This situation is most likely to occur when the financial or environmental stakes are high and non-market outcomes have the potential to influence the choice of policy option.
- In some cases, information about how various groups are likely to respond to the policy is also needed (e.g., how farmers are likely to respond to incentives to use more environmentally friendly practices). This information does not need to be precise, but the degree of uncertainty should be documented. In such cases, executing a primary non-market valuation study using various methods described in this section would be useful. However, if suitable non-market value estimates are available, then benefit transfer methods could be considered.
- When efficiency improvement is the main criteria to assess policies, and non-market outcomes are important, then incorporating non-market outcomes quantitatively or qualitatively is necessary. When cost-effectiveness is the main criterion for policy assessment, monetisation of non-market outcomes may not be essential and indirect assessment techniques (e.g. expert elicitation) could be used.

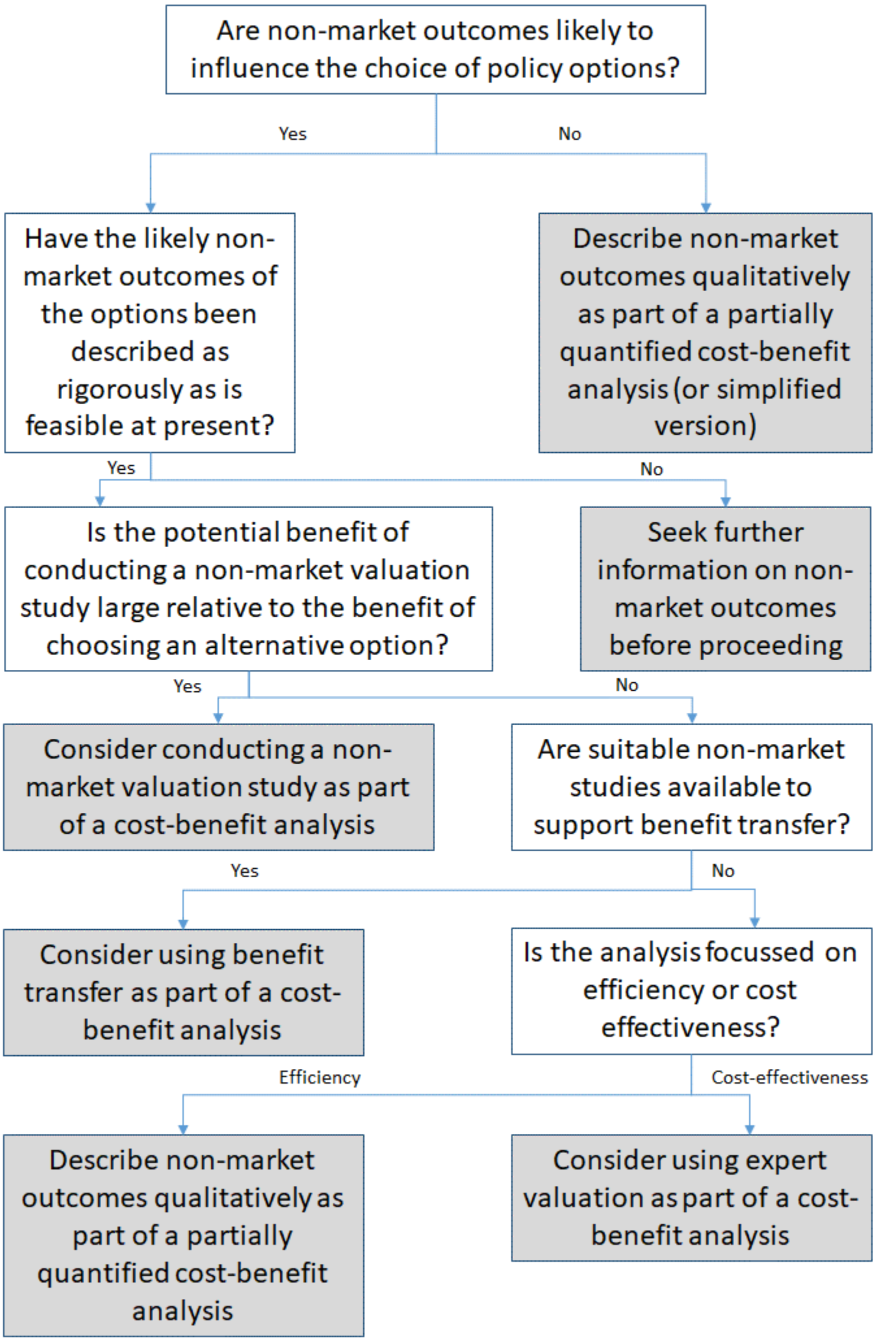

Figure 1: Steps to include non-market outcomes in policy analysis. Source: Baker and Ruting (2014).

Conducting primary research to estimate non-market values can require significant resources and time. When resources are limited, and/or decisions must be made quickly, the benefit transfer method can be used. The benefit transfer method involves using dollar estimates from existing primary research (with reasonable adjustments) to estimate non-market benefits in a new context. This method can be as simple as extrapolating values from existing studies or as complex as developing a statistical function with a range of parameters extracted from multiple primary studies (Bergstrom and Taylor, 2006).

In many circumstances, the benefit transfer method can provide an accurate approximation of non-market benefits, and has been used effectively in many areas of environmental policy decision making, especially in the United States, Europe and Australia (Newbold et al., 2018). Iftekhar et al. (2017) present a brief overview of some existing national and international non-market value databases and benefit transfer tools. These existing tools all do some things well, but they have not been specifically designed to evaluate water sensitive systems and practices in the Australian context, or they have limited data. So, they do not meet the needs of those seeking to include quantitative information on non-market benefits in business cases.

To fill this gap, the CRC for Water Sensitive Cities (CRCWSC)'s Integrated Research Project 2 (IRP2) developed a Value tool that allows users to identify and use existing estimates of non-market values of water sensitive systems and practices in Australia:

Iftekhar, M.S., Gunawardena, A. and Fogarty, F. (2020). **INFFEWS Value tool: IRP2 Comprehensive Economic Evaluation Framework (2017 – 2019)**. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities.

This document provides guidelines on how to use the Value tool and transfer existing estimates to a new context. The data contained in the Value tool reflects the information collected as part of an extensive review of the Australian and international literature on non-market values of water sensitive systems and practices. The review identified more than 180 studies. For full details of the review see Gunawardena et al. (2017).

The main entries in the Value tool relate to estimates of the value of green space; water supply and pricing; and ecological and environmental value of water. Australian studies are most relevant. The current version of the Value tool contains information on 2,005 non-market values from 164 Australian studies. The remaining studies are being added progressively, after considering their relevance and robustness. The focus will be on finding more relevant Australian studies; they will be most suitable for benefit transfer due to the contextual similarities between the original study sites and the application sites. It is strongly recommended that users read this and related benefit cost analysis (BCA) guidelines before using the Value tool.

The following section presents a brief description of the non-market valuation methods based on Gunawardena et al. (2017). Section 3 presents a summary description of the different categories of benefits of water sensitive systems and practices. Section 4 describes different benefit transfer methods, based on Johnston et al. (2015b). This is followed by a description of the Value tool structure in section 5, guidelines on how to use the Value tool in section 6, and an example of benefit transfer using the Value tool in section 7. The final section outlines the steps to regularly update the Value tool and the guideline document.

2 A brief overview of non-market valuation methods

In most applications, the market price for a good or service would be a basic building block in the economic evaluation process. The market price provides clear information on the extent of private benefits to purchasers of a good. The social and environmental costs and benefits would then be used to augment this initial market-derived value. However, even the market price can be an unreliable indicator of value, because it does not account for factors such as government supply subsidies, and/or restrictions on where water can be sourced from.

In the absence of reliable market prices, economists use various non-market valuation methods to capture the monetary value of environmental goods and services. There are several different conceptual approaches, but the two main groups of non-market valuation methods are: revealed preference methods, which include the travel cost method and the hedonic price method; and stated preference methods, which include the contingent valuation method and choice experiments (Figure 2). The main difference between revealed preference methods and stated preference methods is that the former estimates the value of environmental goods and services based on observed real-world consumer behaviour, while the latter relies on information from community surveys in which respondents are asked about hypothetical scenarios. In some cases, the third group of methods that rely on different types of measurements (such as avoided costs and averting behaviour) is used.

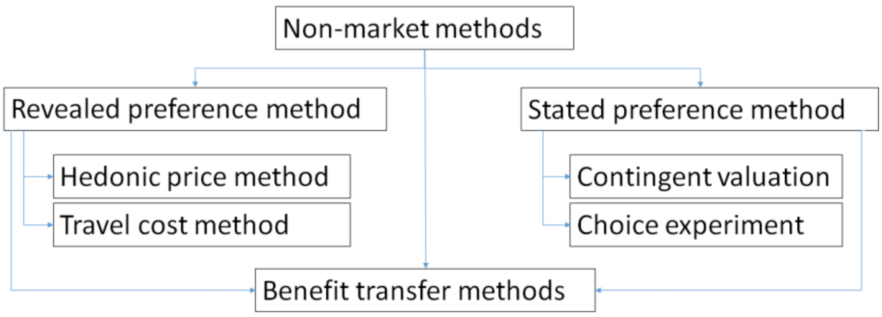

Figure 2: Main non-market valuation methods

All three groups of methods have been used to a varying extent to estimate non-market values of water sensitive systems and practices. Gunawardena et al. (2018) in their systematic review of the literature found that stated preference methods have been used in more than half of the studies (58%), revealed preference methods in 18% of the reviewed studies, and the remaining studies used various other methods. These results may suggest the ease with which stated preference methods could be applied. Further, stated preference methods allow estimation of both use and non-use values, whereas revealed preference methods are useful to capture mainly use values (Bennett and Blamey, 2001). Among the individual methods, the contingent valuation method is the most common method (41% of the studies). The second most popular method appears to be choice experiments (17%). The hedonic pricing method, where non-market values are estimated using market information, is also common, accounting for 16% of the studies. However, across the records stored in the Value tool, almost half of the estimates (54%) were derived using the choice experiment method, followed by the hedonic analysis method (14%) and the travel cost method (12%). A brief overview of each group of methods is presented below.

2.1 Revealed preference methods

Hedonic price method

The premise of the hedonic price method is that the price of a market good is related to its characteristics, or the services it provides. It is the most commonly applied revealed preference method to estimate the value of local environmental attributes, by modelling the variation in house prices. The value of a house can be decomposed into a set of main characteristics, such as size of lot, building area, number of bedrooms, or distance to the city centre; and social and environmental characteristics such as the crime rate, whether there are schools and universities nearby, proximity to environmental assets such as wetlands, etc. The method assumes the environmental value is built into house prices. The hedonic regression approach treats the hedonic good as weakly separable in the consumer utility function, to obtain consistent estimates of an implicit price for each attribute.

Travel cost method

The travel cost method is especially popular for estimating recreational values (Ward and Beal, 2000). It converts the physical and social benefits produced by outdoor recreation, such as river, dam, and beach visits, into monetary terms (Ward and Beal, 2000). The travel cost is the implicit price visitors pay for their trip to access sites or to be able to take part in particular activities (Becker et al., 2005, Phaneuf and Smith, 2005). Through analysing the relationship between the travel costs (price) in accessing a recreational site and the number of visits per year to this site (demand), a demand curve relating the two can be estimated.

2.2 Stated preference methods

Choice experiments

Choice experiments, as applied to non-market valuation scenarios, is a technique that comes from the conjoint analysis literature of marketing. In marketing applications, conjoint analysis is used to determine the attributes of goods that consumers see as important. In environmental economics applications, choice experiments may be thought of as a generalisation of the contingent valuation method (Snowball et al., 2008).

With choice experiments, consumers are not asked directly how much they would be willing to pay to achieve some specific environmental improvement. Instead, respondents are asked to choose their preference from a series of alternatives that differ in terms of the attributes and the levels of attributes (Bateman et al., 2002a). A representative choice experiment question is: *Which one of the following schemes do you favour and which one would you be least likely to choose? Please keep your financial conditions in mind while answering.* One of the options presented to respondents is the example below of a choice set (as shown in Figure 3). A status quo option that allows the respondents to select the option of no change in environmental conditions at no cost is a feature of all choice sets.

There are 4 different land use categories below to consider in each option	Option 1 (Current situation)	Option 2	Option 3
Nature conservation areas 	No change: 30%	10%	50%
Commercial / industrial areas 	No change: 30%	20%	10%
Agricultural areas 	No change: 30%	50%	30%
Sporting and recreation areas 	No change: 10%	20%	10%
There is an increase in your service provider's bill (e.g. water bill) for each option (in $ per **quarter**)	$0	$21	$39
Most preferred option	□	□	□
Least preferred option	□	□	□

Figure 3: Illustrative example of a choice set used in the CRCWSC wastewater buffer zone survey. Source: Iftekhar et al. (2018).

Contingent valuation method

The contingent valuation method, which is a specific type of stated preference technique, relies on creating hypothetical market scenarios that seek to uncover individual preferences for changes in the quantity or quality of a non-market good or service in the format of an individual's willingness to pay (WTP). Using this method, respondents are asked directly about their WTP for an environmental good. Historically, the contingent valuation method has been the most commonly used stated preference method in environmental economics research (Carson et al., 2001). A representative question format typical of the contingent valuation approach is: *Would you pay $X every year, through a tax surcharge, to support a program to improve water supply services?*

Both the choice experiments method and the contingent valuation method utilize survey techniques and have specific strengths and weaknesses. An advantage common to both techniques is that they involve public opinion in the decision making process. The main difference between these two methods is that choice experiments allow the valuation of the characteristics or attributes of the environmental good or service whereas the contingent valuation method arrives at an estimate of the environmental good or service as a whole (Bateman et al., 2002a).

2.3 Other methods

The other methods that are often used for non-market valuation are averting behaviour methods, the cost of illness method and the stage damage method.

Averting behaviour

The averting behaviour or averting cost approach estimates values through examining the costs that consumers incur if a service is not available. For example, if the quality of tap water is not at the drinking level standard, averting behaviour would include purchasing bottled water, installing purification devices in the home and office, and regularly boiling tap water. If tap water was raised to the drinking standard, the value of these activities would represent the costs averted by increasing the quality of tap water to the drinking standard. Consumers may, however, have been willing to pay an amount substantially greater than this for the convenience of having drinking quality water available in the home. The averting behaviour approach can, therefore, be seen as finding the lower bound estimate of consumers' willingness to pay for improving environmental goods and services.

Cost of illness

The cost of illness method has been used to evaluate the economic benefits of reduced illness from water pollution, by estimating the direct medical costs associated with an illness (Van Houtven et al., 2008).

Stage damage

The stage damage method provides a relationship between the depth of water and the monetary value of damages to properties, which can then be used to estimate flood damage based on understanding the physical processes of flooding (Smith, 1994).

For further details of different non-market valuation methods, please see Bateman et al. (2002b), Baker and Ruting (2014) and references therein. The next section briefly describes the main categories of benefits for which non-market values are available.

3 Non-market values of water sensitive systems and practices

Water sensitive systems and practices provide various tangible and intangible benefits, which could be broadly classified into 20 benefit types (Table 1). It is possible to estimate the values of some of these services using existing market prices. For example, the economic value of water-saving measures could be estimated using the current price of water. However, determining the value of many of these benefits requires non-market value estimation techniques, because markets do not exist for them. For some of the benefits, such as improved management of wastewater, multiple methods (e.g. market price, cost-saving measures, and/or non-market benefits) can be used to capture different aspects of a benefit (Table 1). The last two columns in Table 1 show the distribution of relevant value estimates from Australian studies in the current version of the Value tool. The most frequent estimates are available for improved opportunities for recreation (19%), followed by ecological improvement and biodiversity (18%), and improved security of water supply (18%). Descriptions of individual benefit types are expanded below.

Table 1: Key market and non-market benefits from water sensitive systems and practices

	Benefit types	Broad benefit group	Estimates available in the Value tool	
			Number	Proportion (%)
1	Reduced water consumption	Market		
2	Reduced or delayed investment in infrastructure (e.g. water treatment plant)	Cost savings	4	0
3	Reduced recurring costs (e.g. energy for cooling)	Cost savings	65	3
4	Improved management of wastewater	Market, cost savings, non-market	47	2
5	Increased business profits (e.g. from sewer mining)	Market		
6	Increased work productivity (e.g. from less extreme heat)	Market	86	4
7	Increased tourism	Market and non-market	8	0
8	Improved aesthetics	Non-market	112	5
9	Improved opportunities for recreation	Market and non-market	458	19
10	Reduced crime, increased community cohesion	Market and non-market	16	1
11	Reduced mortality (e.g. from reduced extreme heat)	Non-market and market (health system costs)	30	1
12	Reduced morbidity, improved health (e.g. from reduced extreme heat)	Non-market and market (health system costs)	293	12
13	Reduced greenhouse gas emissions, increased CO_2 sequestration	Market and non-market	19	1
14	Groundwater recharge (e.g. for potable extraction or wetland enhancement)	Market and non-market	18	1
15	Ecological improvement, biodiversity	Non-market	432	18
16	Improved air quality	Non-market	28	1
17	Enhancing water quality in a water body	Market and non-market	36	2
18	Reduced flood risk	Risk reduction	13	1
19	Reduced risk of poor water quality due to fire	Risk reduction		
20	Improved security of water supply	Non-market	418	18
21	Other		287	12

Gunawardena et al. (2017) provide a comprehensive review of the different benefit types,[1] but each is described briefly below, along with selected examples of non-market value estimates:

1. **Reduced water consumption**: This benefit could be generated, for example, by using water-saving technologies in the home (e.g. low-flow showerheads, water-efficient washing equipment), installing rainwater tanks, installing improved irrigation systems, or using water recycling systems. For the community as a whole, the benefit is the marginal cost of providing a unit of water. This may or may not equal the price that people are actually charged for the water. The value of water savings from reduced water consumption is often calculated using the opportunity cost of supplying the water from an alternative source (i.e. value set at the price of scheme water). For example, Mennen et al. (2018) calculated the value of irrigation efficiency improvements to manage water allocation reductions in some public open space in Perth. They found the cost of water savings from using various irrigation systems could be as low as \$0.28/kL[2], which was only 12% of the price of an alternative source (scheme water).

2. **Reduced or delayed investment in infrastructure (e.g. water treatment plant)**: A project may reduce the cost of a particular investment, or delay the time when the outlay will be necessary. It may also affect the maintenance costs following the investment. For example, a project to exclude livestock from a water catchment may mean that, when an existing water treatment plant is replaced, a cheaper replacement plant may be sufficient, relative to what would be required without the project. Or the same water treatment plant may be needed, but its installation can be delayed by 10 years, which would generate large savings in interest costs. If the project results in different infrastructure, then it may also result in different maintenance costs. These kinds of benefits are often estimated using market prices.

3. **Reduced recurring costs (e.g. energy for cooling)**: Some international examples estimated the savings in recurring costs from using water sensitive systems and practices. For example, Pandit and Laband (2010) examined the effects of trees on electricity use in Auburn, Alabama. For every 10% of shade coverage, on average, electricity consumption reduced by 1.29 kW h/day. For a house with mean shade coverage of 19.3% during the summer months, this reduced daily electricity consumption by 9.3%. In another study, Bianchini and Hewage (2012) estimated the annual economic benefit of green roofs in heating was CAD[3]\$0.22/m^2; for cooling, the benefit varied between CAD \$0.18/m^2 to CAD \$0.68/m^2.

4. **Improved management of wastewater**: This benefit could include investment in improved systems, processes or technologies for water treatment or wastewater recycling. It could increase water availability, or reduce the cost of providing a given amount of water. Evidence suggests people are willing to pay for a smoother operation of wastewater recycling. For example, Hensher et al. (2005) found people in Canberra were willing to pay \$16.83/annum/household to reduce the frequency of wastewater service interruption from once in 10 years to once in 20 years.

[1] There could be higher level benefits, such as community connection to and understanding of urban water—water literacy and cultural connection to water. These are often most difficult to quantify in economic terms.

[2] The estimates have been converted to 2017 Australian dollars.

[3] CAD = Canadian Dollar.

5. **Increased business profits (e.g. from sewer mining)**: Water sensitive urban cities promote economic growth and opportunities for increased business profits by enhancing the liveability and wellbeing of residents/communities (Joye et al., 2010). However, there is currently a lack of studies estimating the effect of water sensitive systems and practices on economic growth.

6. **Increased work productivity (e.g. from less extreme heat, nature)**: The link between green space and work productivity has been studied to some extent. For example, Lee et al. (2017a) observed that taking green microbreaks (brief breaks spent viewing nature) can help employees top up their mental resources during the workday, providing booster breaks for the brain and improving work productivity, which has a market benefit.

7. **Increased tourism**: Some tourism is supported by commercial activities, and so provides a market benefit. Other tourism benefits arise from non-commercial recreation, generating non-market benefits. For example, water-related projects that enhance landscape or waterscape aesthetics may contribute to increased tourism benefits of either of these types.

8. **Improved aesthetics**: Many studies examine the amenity benefit of green space and liveability improvement projects in Australia. For example, Polyakov et al. (2017) found the median price of a house within 200 m of an urban drainage restoration project (Bannister Creek) had increased in value by 4.7% (2.9%–6.58%) after eight years. In another study, Plant et al. (2017) found a 1% increase in tree cover along the footpath, within 100 m of a property, results in an increase in property values of between 0.08% and 0.1% in Brisbane. Recently, Iftekhar et al. (2018) found the respondents in a choice experiment survey on land use management options within buffer zones of treatment plants in Western Australia expressed a higher willingness to pay for nature conservation land use compared with agriculture and industrial land uses. The weighted mean estimate was $8.18 /household/year/percentage point increase in the allocation of land to nature from industrial. The mean estimates for recreation and agriculture were $3.40 and $1.13 respectively.

9. **Improved opportunities for recreation**: The recreation benefit is one of the most frequently monetised services. For example, Mahmoudi et al. (2013) is a hedonic study that was conducted in the Adelaide metropolitan area using property sales data from 2005 to 2008. The study found that being 1 m closer to a linear park, golf course, green space sports facilities, and the coast increased property prices by $0.42, $0.65 $1.91 and $6.05 respectively.

10. **Reduced crime, increased community cohesion**: Evidence suggests physical and mental wellbeing and community cohesion are interlinked. For example, Maas et al. (2009) found less green space in people’s living environment is positively linked with feelings of loneliness and with a perceived shortage of social support. Lack of social support then leads to deprived mental and physical wellbeing. However, the links between green space and the prevalence of crime are not clear yet (Bogar and Beyer, 2016). There could be confounding factors with the socioeconomic condition of a suburb.

11. **Reduced mortality (e.g. from reduced extreme heat)**: Several studies estimated the ‘value of a statistical life’ (VSL). These are based on the expenditures that people are willing to make to reduce their own risk of dying. One VSL is equivalent to the value of one life saved. Lives could be saved, for example, through mitigating extreme heat, or through providing recreational

opportunities that improve health. The main benefit of reduced mortality is clearly a non-market benefit, but associated with this could be reduced healthcare costs, which is a market benefit.

12. **Reduced morbidity, improved health (e.g. from reduced extreme heat)**: The impact of green and blue space on people's health and wellbeing is widely recognised. For example, Ambrey and Fleming (2014) used self-reported life satisfaction data from the 2005 Household Income and Labour Dynamics in Australia (HILDA) survey to estimate the willingness to pay for urban green space in Australian capital cities. Households in Australian capital cities are willing to pay $1,570 per annum for a 1% increase (approximately 143 m^2) in open public space in their local area.

    Sugiyama et al. (2008) examined the link between green space and both physical and mental health in Adelaide. Those who perceived their neighbourhood as highly green had a 1.4 and 1.6 times higher chance of having better physical and mental health respectively, compared with those who reported living in a neighbourhood with the lowest level of perceived greenness.

    A Wisconsin study also found higher levels of neighbourhood green space were associated with lower levels of depression among residents after controlling for relevant factors (Beyer et al., 2014). A similar study in Perth from a cross-sectional survey of residents in 2003 and 2005 concluded residents in neighbourhoods with high quality public open space had, on average, lower levels of psychosocial distress than residents of neighbourhoods with low quality public open space (Francis et al., 2012).

13. **Reduced greenhouse gas emissions, increased CO_2 sequestration**: Many of the direct benefits mentioned above provide climate change adaptation benefits. For example, the value of carbon sequestration by urban forests in Canberra during 2008–2012 was estimated at $70–$236 / tree (Brack, 2002). In addition, a few studies in Australia looked at people's willingness to pay to implement climate change mitigation options. For example, Akter and Bennett (2009) found respondents in Canberra were willing to pay $191/household/month to support a national emissions trading scheme known as the Carbon Pollution Reduction Scheme (CPRS).

    Even though there are some numbers reported in the value tool, it should be noted that this is one of the most complex benefit types to quantify. The following text from Pannell (2019) highlights the issue.

    "If there had been a cap on emissions (as was previously planned in Australia) and the emissions being evaluated in the project were counted as part of that cap, then there would have been no need to count emissions reductions as a benefit, as they would have been offset by increases elsewhere in the economy to get back to the cap. In the absence of a cap, the inclusion of benefits related to CO2 emissions or sequestrations depends on whether the project organisation wishes to define the scope of the analysis as including international benefits. If so, it makes sense to count emissions reductions as a benefit.

    Even if it is clear that these benefits should be included, quantifying them is difficult, due to uncertainty. Most commonly, researchers argue for using the Social Cost of Carbon (SCC), which is the total present value of all future market and non-market costs from emitting one extra tonne of CO2. The value to use for the Social Cost of Carbon is subject to debate, with widely varying proposals having been put forward, ranging from a few dollars to a few hundred dollars. It depends in part on the discount rate assumed, with higher discount rates resulting in a lower SCC.

There is no standard value for the Social Cost of Carbon specified in any of the Australian BCA Guidelines. According to Johnson et al. (2013), the US Government at that time used SCC values of US$11, US$33 and US$52 per tonne of CO2-e, based on discount rates of 5, 3 and 2.5% respectively. Note that the higher discount rates recommended by all Australian Departments of Treasury and Finance (7% in most cases) would result in a SCC below US$11.

An alternative approach, advocated by Mandell (2011) for example, is to use the shadow price of carbon emission as a result of government policies. In other words, we would use the carbon tax, or the price of carbon in a carbon market or a carbon emissions permit auction, as the price of CO2 in our BCA.

In the absence of clear guidelines from the government, this latter approach is perhaps the simplest and most practical. It implies using a value for CO2-e of around A$25 per tonne (based on the carbon tax that was previously in place) or perhaps of A$14 (based on the results of reverse auctions under the Emissions Reduction Fund policy – see https://theconversation.com/infographic-emissions-reduction-auction-results-at-a-glance-40728).

When valuing carbon that has been sequestered, it is also necessary to account for the fact that sequestration may be temporary and somewhat insecure. This means that the value of sequestered carbon should be reduced to some extent."

14. **Groundwater recharge (e.g. for potable extraction or wetland enhancement)**: Water sensitive systems and practices could reduce pressure on groundwater resources, freeing groundwater for higher value uses and/or for the environment. The return on higher value water use could be used to calculate the value of groundwater. For example, using the opportunity cost method, the value of groundwater from the Gnangara groundwater system was estimated at $1.90/kL for public water supply use and at $1.61/kL for public open space (PoS) use (Marsden and Whiteoak, 2006).

15. **Ecological improvement, biodiversity**: Most of the information on non-market values of biodiversity and ecology relates to protecting native flora and fauna, endangered species and unique ecosystems. People usually expressed a positive willingness to pay to protect biodiversity and ecology. For example, a choice experiment study found people in Tasmania were willing to pay, on average, $4.70 for a km increase in native riverside vegetation and $10.00 per species to protect rare native plants and animals (Kragt and Bennett, 2011). Morrison and Bennett (2004) valued the environmental attributes of NSW rivers, finding people were willing to pay $11/ household for an additional fish species in the rivers.

16. **Improved air quality**: International examples show clear benefits of air quality improvement. For example, in the United States, Nowak et al. (2013) estimated the total amount of PM2.5 removed annually by trees in cities of different sizes, with the annual value of pollutants removed ranging from USD1.1 million in Syracuse to USD60.1 million in New York City. The average health benefit value per hectare of tree cover was estimated at USD1,600 but varied with city size, population density, and pollution load. The highest value estimated was for New York City, where the health benefit value was estimated at USD3,800 per hectare of tree cover.

17. **Enhancing water quality in a water body**: Many studies have found a positive willingness to pay for a higher quality of water in Australia and abroad. For example, Crase and Gillespie (2008) estimated the recreational values of visitors to Lake Hume under different water quality and water level scenarios using the contingent valuation method. The recreational benefits were increased by about $47.20 per visit when the storage level was increased from 50% capacity to near full. The consumer surplus derived from recreational users of the lake was reduced by about $25.88 per visit during an algal bloom.

18. **Reduced flood risk**: There is some information on people's willingness to pay to reduce flash flooding in Australia. For example, Brent et al. (2017) found people in Melbourne and Sydney were willing to pay $87/annum/household and $90/annum/household respectively to eliminate flash flooding completely. However, more often, damage cost functions are used to estimate the value of different flood management options.

19. **Reduced risk of poor water quality due to fire**: In vegetated water catchments, water quality may fall if a fire event is followed by a rainstorm. However, we do not have any relevant non-market value estimates available for this benefit type.

20. **Improved security of water supply**: Evidence shows people are willing to pay to avoid water restrictions and improve the reliability of water supply. For example, Tapsuwan et al. (2007) conducted choice experiments to assess the preferences of residents in Perth for water resource development options to avoid outdoor water restrictions (i.e. watering gardens). At the time of the survey, residents faced restrictions using water outdoors. Residents were willing to pay 22% more on their annual water bills to be able to use their lawn and garden sprinklers on three days per week rather than one day per week. In Melbourne, Brent et al. (2017) found people were willing to pay $162/annum/household and $253/annum/household to eliminate water restrictions in Melbourne and Sydney respectively. Zhang et al. (2015) also found the presence of a rainwater tank on a property would increase the house price by around 3.76% of a typical house in Perth.

3.1 Overlaps in benefit types and risk of double counting

There are three potential interlinked sources of overlaps when applying non-market values in economic assessment: multi-functional nature of benefits from water sensitive systems and practices; overlaps between the various benefit types; and using benefit transfer values that include more than just the specific benefit being valued. The types of services and benefits from these systems differ for each individual. They often find it difficult to differentiate their motives and reasons for preferring these systems. If the original studies do not clearly mention or identify the explicit reasons for preferring different types of services, it is possible to *double count* the benefits in economic analysis. Therefore, analysts should be conscious of potential overlaps.

Table 2 presents the extent of possible overlaps between benefit types. There are potential strong overlaps among some benefit types. For example, reduced water consumption could be linked with reduced or delayed investment in infrastructure, reduced recurring costs, groundwater recharge and improved security of water supply. If a non-market valuation study provides people's willingness to pay for reduced water consumption, analysts must be conscious that such estimates may implicitly include values for other types of services. Similarly, willingness to pay estimates on improved aesthetics (e.g. from green space) may incorporate values for recreation, biodiversity and health benefits. Values for improved water quality could be linked with improved aesthetics, tourism, and recreation. On the other hand, people's values for improved security of water supply could be positively linked with delayed investment in infrastructure, reduced recurring costs and business profit.

One way to deal with double counting when the risk is high (e.g. amenity, recreation, and biodiversity) is to ignore all but one of these categories (that with the largest monetary value) as part of sensitivity analysis, and then check the impact on the conclusions. If the conclusions remain unchanged then the impact of double counting is less (Horton et al., 2016).

Table 2: Potential for overlaps between categories

	Benefit type (Direction of overlap →)	**Benefit type**																				**Indicative number of potential overlaps that need to be investigated**
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
1	Reduced water consumption		+	+											+						+	4
2	Reduced or delayed investment in infrastructure (e.g. water treatment plant)			+																		1
3	Reduced recurring costs (e.g. energy for cooling)					+																1
4	Improved management of wastewater		+	+		+									+						+	5
5	Increased business profits (e.g. from sewer mining)																					0
6	Increased work productivity (e.g. from less extreme heat)					+																1
7	Increased tourism					+																1
8	Improved aesthetics					+	+	+		+	+		+			+						7
9	Improved opportunities for recreation					+		+					+									3
10	Reduced crime, increased community cohesion			+		+	+					+	+									5
11	Reduced mortality (e.g. from reduced extreme heat)			+		+	+															3
12	Reduced morbidity, improved health (e.g. from reduced extreme heat)		+	+		+	+					+										5
13	Reduced greenhouse gas emissions, increased CO_2 sequestration																+					1
14	Groundwater recharge (e.g. for potable extraction or wetland enhancement)		+	+																	+	3
15	Ecological improvement, biodiversity							+	+	+	+		+									5
16	Improved air quality											+	+									2
17	Enhancing water quality in a water body							+	+	+						+						4
18	Reduced flood risk		+	+								+	+			+		+				6
19	Reduced risk of poor water quality due to fire																	+				1
20	Improved security of water supply		+	+		+																3

4 Benefit transfer methods

A major issue with all non-market valuation methods is that studies almost invariably relate to a specific site at a specific point in time. Yet because non-market valuation studies are expensive and time consuming to complete, there is a strong temptation to apply values obtained from one case study to other contexts. This is particularly true when there are resource and time constraints, or the project is not large enough to warrant conducting an original study. In such cases, benefit transfer techniques offer alternatives to conducting an original study. These techniques have been commonly used in large scale benefit cost analyses in the United States and Europe (Rolfe et al., 2015).

Benefit transfer techniques allow economists to predict values for a 'project site', a 'case study site' or an 'application site' by extrapolating the results of non-market values estimated for original 'study sites' (Johnston et al., 2015b). An application site is defined as the area/project for which the user is interested to apply the values, whereas, the study site is the area/site/project for which the original study was executed (Figure 4). A benefit transfer may be conducted in a variety of ways depending on the availability of information, level of accuracy and expertise required. Two of the most common methods are unit value transfer and benefit function transfer (Boyle et al., 2010). Each is summarised briefly below.

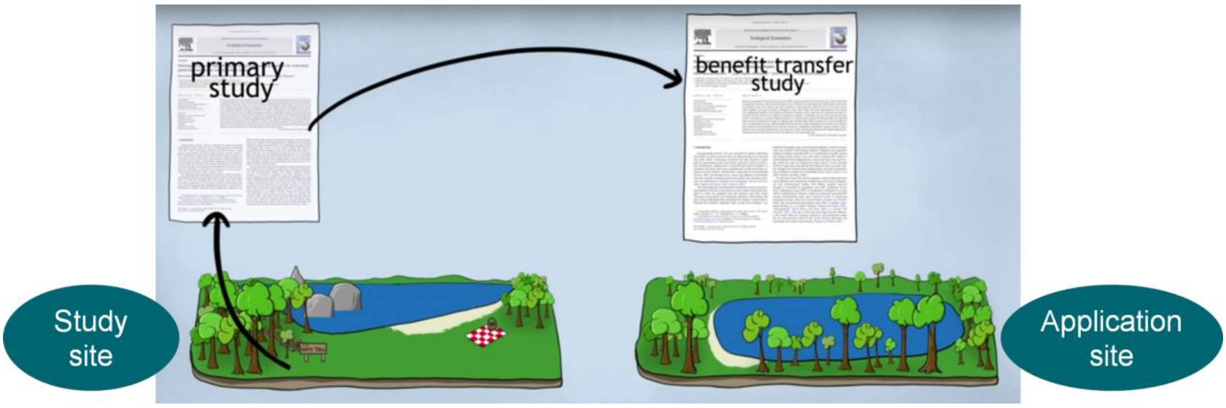

Figure 4: Schematics of study and application sites Source: Conservation Strategy Fund, https://www.youtube.com/watch?v=xpXvnbNeOEo.

4.1 Unit value transfer

Unit value transfers apply an estimate or a set of estimates from the study sites to the application sites (Johnston et al., 2015c). There are two main forms of unit value transfer: simple and adjusted unit value transfer. Simple unit value transfer is the easiest and the crudest approach of all. It assumes the marginal value to an average individual at the study site and application site are the same, and so a direct transfer of the mean willingness-to-pay (WTP) estimates from the study site to the application site is possible. The original unit values could be from a single study or from a set of studies.

By contrast, the adjusted unit value transfer adjusts the estimates according to the policy context and/or using expert opinion.

In combinations, four main types of unit value transfer methods could be identified:

1. a single unadjusted value
2. a value somehow adjusted according to the attributes of the policy context or using expert opinion
3. a measure of central tendency such as a mean or median value from a set of studies
4. a range of estimates from a set of prior studies (Johnston et al., 2015c).

Adjustments could be based on various factors such as income, socio-demographic condition, etc. (Navrud and Ready, 2007). Several factors must be considered to apply benefit transfer using unit value transfer types 2, 3 or 4.

Defining the context and matching study sites to application sites

The application site context must be clearly defined in terms of its biophysical conditions, the nature, and magnitude of the proposed change, the socioeconomic characteristics of the relevant population, and the project setting in which the valuation is being made (Rolfe et al., 2015).

These same considerations then must be applied to the study site(s) sourced from the literature. Ideally, the study and application contexts should be similar across all of these criteria. However, this is often not possible in practice, which makes it critical to be transparent in the benefit transfer process. *If limitations are foreseen and assumptions are made, they should be documented clearly*. The checklist in Table 3 provides a non-exhaustive list of specific items that should be considered when matching the study and application site contexts (Johnston et al., 2015c).

Table 3: Checklist to consider for matching study and application sites

Serial	Items	Description
1	Broad policy context	This information will help when selecting relevant primary studies. For example, if the project is about water conservation then primary studies on water conservation would be more relevant.
2	Definition of the entity (e.g., wetland, stormwater system, green space) being valued	The quantity or quality of the good or service must be similar, but so must the impact of the scenario on the entity, and the intended use of the entity. For example, if a study provides a willingness to pay (WTP) estimate for protecting public open space (PoS) for recreation benefit, applying those WTP estimates for PoS protection for biodiversity benefit may not be suitable. It is important to be clear about the base case (the business as usual scenario) against which the change is being valued. (Unfortunately, some studies are unclear about the base case for valuation, reducing our ability to transfer them to other contexts.)
3	The similarity of the economic framework	Any measure of economic value is tied to a specific context, characterised by a baseline and a particular quantity or quality change; in other words, it is the measurable difference that becomes the value. The definition of non-market values must be checked carefully. For example, if the original study measures WTP to gain something then it cannot be applied to measure values in the context of compensation for losing something.
4	The quality of the original study	The quality of data collection and estimation will affect the transferred values.
5	General socio-demographics of the population	Analysts must compare the socio-demographics of the new context to check whether they are sufficiently similar to those for the original study. Check key socio-demographic factors such as age, gender, income levels, income distribution, and education.
6	International differences	If the original study is international, then consider currency, wealth and cultural differences.
7	Scale differences while aggregating the values	Analysts must consider if there are scale differences between the benefits being valued in the original study and the new context, or between the population sizes? The latter may be addressable by expressing values on a per head basis and aggregating to the relevant population size.
8	Scope effect	The issue of scope arises when a WTP estimate is applied to a change that exceeds that for which it was estimated. For instance, the value that an individual places on a new PoS in the suburb depends on how much PoS is already existing in the suburb. As a result, the value of a given resource change cannot simply be estimated by multiplying a value from the literature for a specific resource change by the ratio of the resource changes of the policy and the study sites (Richardson et al., 2015).

Conducting the transfer

Unit value transfers can be made, both adjusted or unadjusted, involving estimates from single or multiple sources (Johnston et al., 2015c).

Unadjusted transfers

A single unit value unadjusted transfer involves taking the original WTP estimates and aggregating for the application site. On the other hand, a multiple unit value transfer is required when there are reliable estimates from multiple sites/studies on the same commodity (good or service). It would involve estimating a measure of central tendency (e.g. the mean or median of the values) and applying it to the application site.

Aggregating the value by the relevant population size requires judgement about what the relevant population should be: e.g. local, regional, state or national, or in some cases potentially global.

Adjusted transfers

For an adjusted transfer, the WTP estimates (from a single source or a central tendency measure in case of multiple sources) must be adjusted for the application site to reflect relevant differences between the two contexts, potentially including:

- Bio-physical context. For example, has the water supply condition become more restricted? If so, WTP to avoid water restriction might need to be adjusted upwards.

- Substitution effect. For example, is the proportion of public open space (PoS) much higher in the application site compared with the study site? If so, WTP for PoS must be adjusted lower, because the marginal value of an additional proportion/area of PoS will be lower if the proportion/area of PoS is already high.

- Distance decay effect. Is the project (e.g. PoS) closer (or further) relative to the target population in the application site compared with the study site? If so, WTP for PoS must be adjusted lower, because, in general, the marginal value of an additional proportion/area of POS will be lower as people live further from a PoS.

- Inflation. Use an inflation index (typically the consumer price index) to adjust values to the present time.

- Real income. Have real incomes changed over time, or do they vary between regions (where the study is being transferred across regions) or between countries (where the study is being transferred across countries)? If it is an international transfer, per capita gross domestic product (GDP) in purchasing power parity dollars could be used.

- Demographic changes. The demographic characteristics of a population can vary. If the study provides details of WTP values for different demographic groups, the average value can be adjusted. For example, if the application site has high income people compared with the study site, then their WTP could be adjusted higher or vice versa.

- The value is then aggregated by the relevant population size, as for an unadjusted transfer.

Advantages and limitations of unit value transfer

The unit value transfers are relatively easy to implement because they require limited information. However, their reliability depends on finding appropriate study sites that are ‘close’ to the application site in terms of biophysical, geographical and socio-demographic attributes. Adjusted unit value transfers could be less erroneous compared with unadjusted transfers if adjustments are made carefully. Errors are often introduced by scaling values. Scaling of values can occur over three dimensions (as explained in the next three sub-sections), but the general principle is the same: the scale of the study site should be as close as possible to that of the application site (Johnston et al., 2015c).

Valuing quantity or quality of the commodity (good or service)

The implicit assumption behind applying unit value transfer is linearity in utility.[4] However, declining marginal utility is more commonly observed in practice. Therefore, in cases where the scale of quantity or quality at the study and application sites is different, the transferred value could be under- or over-estimated (Johnston et al., 2015c). For example, if the study site estimates a value of $10/person for a wetland with a 1-hectare area, and the value is being transferred to the application site with a wetland of 100 hectares, a transferred value of $1,000/person is likely to be too high.

Aggregating for the population size

Aggregating for the population size would require identifying the relevant population for the application site. If the WTP estimates relate to a certain socioeconomic group, then aggregation would be necessary for only the relevant population in the application site (Rolfe et al., 2015).

Aggregating for the distance decay

Distance decay relates to the empirical observation that people's PoS is influenced by the distance from the amenity: the further people live from an amenity (e.g. a PoS), the lower they are willing to pay for that amenity. There are potentially two reasons for this: individuals might assign a lower use value because the further the site the costlier it is to access it, and there may be substitute sites that are more closely located. Substitutability and distance effects are interdependent. As the distance from the site or the geographical scale of the study increases, the number of substitutes is likely to increase too. Similarly, distances among multiple alternatives and/or between alternatives and respondents' locations influence the substitutability of sites in the same geographical market. Empirical evidence suggests that both the extent of available substitutes and distance from a project side have negative effects on people's marginal WTP (Figure 5).

[4] Irrespective of the base or starting point, a unit change in consumption would provide the same amount of utility as for all other (preceding or subsequent) units consumed.

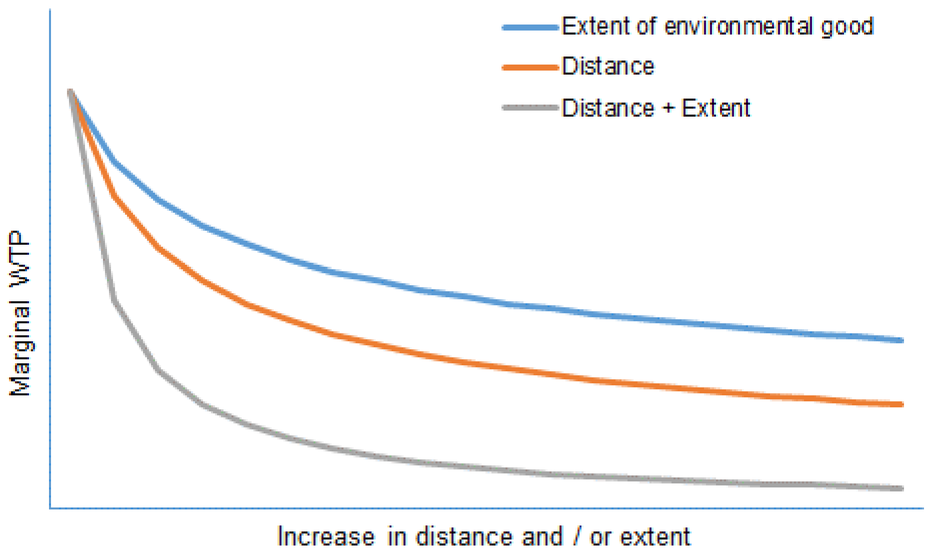

Figure 5: Expected effect of distance and substitutes on people's willingness to pay

Let's take an example of the transfer of value of a new PoS. Let's assume the WTP is $10 per person for the park and the number of people who could access the park is 1,000. There is no other park in the catchment area. The aggregate value is $10 X 1000 = $10,000. Let's assume that in the application site the number of people who could access a park is 2,000, implying the total value to be $20,000 using an unadjusted WTP estimate. However, if the people in the application site already have access to other parks, then their WTP would be lower and the aggregation would be an over-estimation. So the WTP estimates must be adjusted downwards at the application site.

4.2 Benefit function transfer

Values can be transferred from study sites to application sites by using a benefit function (Johnston et al., 2015c). The benefit function is an estimated relationship between non-market value (benefit value) and a set of variables. The set of variables usually includes the quantity and quality of the commodity being valued, characteristics of the site, and characteristics of the population. Using a benefit function, a value estimate can be calibrated to the selected characteristics of an application site (Loomis and Rosenberger, 2006).

The benefit function accounts for observable differences between the study and application sites, by including variables that describe characteristics of the study site (e.g. socio-demographic variables, the number of substitute sites available, etc.) and making adjustments appropriate for the application site based on these variables.

Benefit function transfers have two main requirements:

1. a parametrised function (a regression model) to calculate the empirical outcome of interest (WTP), as a function of variables (such as distance, socioeconomic condition, house price, etc.) that include conditions observable at the application site

2. information on at least a subset of variables for the application site (to adjust the values being transferred from the study site context to the application site context).

There are four main types of benefit function transfers:

1. single site

2. multiple sites

3. meta regression analysis

4. preference calibration or structural benefit transfer.

The primary difference between these alternative forms of benefit function transfer is the source of the benefit function. The benefit function can be derived from a best suited single study or multiple studies.

Single site benefit function transfer

This simplest form uses an estimated function from the study site to calibrate the benefit estimate to the application site. The underlying assumption in single site benefit function transfer is that the parameterised benefit function is identical for both study and application sites.

Multiple site benefit function transfer

If there are multiple studies available, then it is possible to get a set of individual benefit functions for each study site. One may conduct multiple site benefit function transfers with calibrated values derived independently from each benefit function specific to each study site. The calibrated values from multiple study sites provide a feasible range of values for the application site. This approach differs from meta analysis, although both approaches use multiple studies (Johnston et al., 2015c).

Meta analysis

Meta analysis can be defined as a study of multiple studies. Data for meta analysis is collected from relevant published and unpublished original studies containing estimates of similar empirical magnitudes of a commodity being valued. In cases where closely matching study and policy contexts are not available, a parametrised meta analysis benefit function can be estimated using regression analysis of study results from multiple primary studies.

In the case of environmental management, the meta analysis function is estimated by regressing WTP for one unit of an environmental good against several explanatory variables. The explanatory variables include characteristics of the commodity being valued, valuation and survey administration methods, human population and sample characteristics of primary studies. The main advantage of meta analysis is its ability to control statistically for heterogeneity, methodological differences, and biases among primary studies (Johnston et al., 2015a).

The validity of using a meta analysis benefit function to transfer values to a new policy context depends on the quality, relevance, and unbiasedness of the primary studies. Stanley et al. (2013) provide useful reporting guidelines for conducting quality meta analysis in a transparent manner.

Preference calibration or structural benefit function transfer

This is the most advanced method of benefit function transfer. It uses a structural utility function that describes an individual’s choice over a set of goods for a given budget (Smith et al., 2006). The utility structure combines and integrates information drawn from multiple studies. Given the complexity of this approach, implementing benefit transfer using a structural utility function requires expertise in welfare theory and mathematical economics (Johnston et al., 2015a). Therefore, there has been a limited application of this method in policy analysis.

Limitations and potential errors in benefit function transfer

There can be two main types of errors associated with benefit function transfers: measurement errors and generalisation errors. Measurement errors are due to errors in original primary studies, such as a lack of adequate information, inappropriate survey design or poor methodology. Generalisation errors relate to the benefit transfer process. For example, commodity inconsistency, benefit scaling and lack of site similarity can cause these errors (Johnston et al., 2015a). Finding an appropriate functional form to conduct the benefit function transfer could also be a problem (Czajkowski et al., 2017).

Benefit function transfers could be more accurate compared with unit value transfer when the study and application sites are dissimilar to some extent (Bateman et al., 2011). The ability to account for differences between the sites in the adjustment process means that there is less error associated with the transferred value. Unit value transfers can be reliable if the study and application sites are sufficiently similar (Bateman et al., 2011). While benefit function transfers are typically more accurate than unit value transfers, they still require a reasonably high degree of similarity between the study and application sites to minimise transfer errors. They are also more difficult to implement, generally requiring an experienced analyst to conduct the transfer. Accordingly, we focus on the unit value transfer approach, which can be implemented more easily.

4.3 Suitability of benefit transfer

Measuring intangible benefits quantitatively can be challenging. Economists acknowledge that techniques including non-market valuation and benefit transfer are not perfect (Hausman, 2012, Kling et al., 2012). An important aspect to consider when discussing the existing literature is the transferability of the results. The estimated values may be localised and it may reflect only the value of a particular service at a particular point in time. According to Brouwer (2000), the benefit transfer errors from unadjusted unit value transfer can be as high as 50%, and more than 200% in the case of adjusted value transfers. In a separate study, Kaul et al. (2013) found that benefit transfer errors ranged between 0% and 172% with a mean error of 42% and a median of 33%. Therefore, it is important to spend considerable time working through whether or not it is appropriate to transfer specific results to new locations. However, for well-defined goods or services (such as air quality improvement or water savings) the transfer errors could be much lower compared with other, not so well defined, goods or services (such as water quality or biodiversity benefit) (Newbold et al., 2018). It might be preferable to include some information about non-market values in the decision process, rather than none at all. Based on many simulations of environmental decisions, Pannell and Gibson (2016) recommended including variables even when there is a degree of uncertainty about their accuracy, which can be the case for non-market values, rather than to ignore them.

However, when applying benefit transfer methods the users need to be very cautious about the similarities/dissimilarities between the study and application sites. Akter and Grafton (2010) recommended applying an adjusted unit value transfer if the contexts are similar and suggested conducting sensitivity analysis with a ±40% error. On the other hand, if the contexts are dissimilar they suggested using the benefit function transfer and conducting simulations with a very high range (say, ±90% error). Analysts should record their assessment of the data accuracy, fit and the estimates' uncertainty when used in the formal benefit cost analysis.

5 INFFEWS Value tool

Based on a review of existing tools and consultations with industry partners and experts, we identified a set of desirable features/needs of the Value tool (Iftekhar et al., 2017). The features and the extent to which the current version of the Value tool satisfies those needs are set out in Table 4.

Table 4: Desirable features of CRCWSC Value tool and the current status. Source: Iftekhar et al. (2017)

Desirable features of CRCWSC Value tool	Current status
1. Good explanation of data provided, however, the tool should be robust and not dumbed down	Yes
2. A reasonable interpretation of values/check values quantified in a meaningful way (i.e. clear description of what each study is trying to measure)	Yes
3. Marginal changes reported (i.e. the definition of willingness to pay estimates)	Yes
4. Appropriateness of values for different context reported (e.g. the scale of the project, types of values, etc.)	Yes for types of values and scale
5. Assessment of the quality of the original studies included in the database	Yes
6. Some attributes can overlap—should avoid double counting	The guideline, training courses
7. Link to the original paper/source included for more details and cross-checking by the users	Yes
8. Some control features included to keep built-in values unchanged	The sheets are protected
9. Estimates from international studies may be required, given the data gaps—the tool should have the flexibility to add practitioners' own values. It should also provide guidance to any practitioners regarding cons/pros/pitfalls from adopting international values.	In the first instance check the review report. Discuss it with the researchers if required.
10. Good guidance on how to use values included—full-day training courses could be organised	The guideline, training courses
11. The tool should not be very specialised—the tool should be accessible to a range of users. The use of MS-Excel might be convenient for users.	Yes
12. Users should undertake their own risk assessment when using these values	The guideline, training courses

This section describes the structure of the Value tool developed for water sensitive systems and practices. The Value tool is a series of MS Excel worksheets.

Worksheet 1 (Cover page)

The title page provides details on the current version of the Value tool.

Worksheet 2 (Index)

The second worksheet provides links to various worksheets of the tool.

Worksheet 3 (Decision tree)

The third worksheet presents the flow-chart users should follow to use the tool.

Worksheet 4 (Overlap)

The fourth worksheet presents information on potential overlaps among various benefit categories (see section 3.1).

Worksheet 5 & 6 (Data)

The sixth worksheet, entitled 'DATA', comprises the core information on each existing study that has been collected and approved for use in the Value tool. Because there are multiple entries for some studies, the language used to describe an entry in the Value tool is a 'record'. Each record listed in the Value tool provides information on the monetary (or, non-monetary) values of the specific commodity being valued (goods or services) as well as a range of related information. The information in this worksheet is grouped into colour coded sections and follows a left-to-right structure.

The specific structure (see worksheet 5) is explained below:

- **Study identification** (light green block, column A to column D). This section contains:
    - Column A (Obs. ID): A unique record ID number (runs from 1,2,…)
    - Column B (Paper ID): A unique study ID number (runs from 1,2…)
    - Column C (Citation): Abridged citation details for each study, e.g. Zhang et al (2015)
    - Column D (Title): The title of the paper, e.g. 'The economic value of improved environmental health in Victorian rivers'.

- **Value classification** (light purple block, column E to the column I). Individual records have been classified in several ways across multiple columns, which sometimes overlap. These columns are particularly useful for searching for relevant records in various ways. This section contains:
  - Column E (Value location): The location of the marginal change value e.g. 'Victoria'. The benefit transfer literature often refers to the location as the 'study site'.
  - Column F (Benefit Type): The benefit type e.g. improved aesthetics. These benefit types are in line with the CRCWSC's INFFEWS Benefit Cost Analysis tool.
  - Column G (Theme): The broad theme of the value e.g. Green Space, Stormwater, etc.
  - Column H (Value type): The key types of value that the record relates to e.g. Recreation, Amenity, etc.
  - Column I (System / Service / Context): The system / commodity/ context in which the value was estimated e.g. Public Open Space, Wetland etc.
- **Marginal change measures** (light blue block, column J to column X). This section contains:
  - Column J (Type of marginal change): Indicates the type of marginal change, e.g., consumer surplus, willingness to pay, cost, cost savings, implicit price, market value, price, market value, etc.
  - Column K (Definition of marginal change): Details on how the changes in the commodity are measured, e.g. Household willingness to pay for 1% (143 square metres) increase in public green space in the resident's local area, defined at the level of the Collection District (the mean area of the Collection Districts in the sample is 1.85 square km).
  - Column L (Unit of measurement): The specific unit of measurement, e.g. per square metre (sq/m), per household, etc.
  - Column M (Frequency of payment): What type of payment frequency was used, e.g. annual, one-off, etc.
  - Column N (Adjusted estimate): The original willingness to pay estimate (Column N) converted to 2020 Australian dollars (AUD) using the CPI from the time of the study. It should be noted that only records with monetary values have been adjusted.
  - Column O (Original estimate): The original estimate reported in the study.
  - Column P (The year used to adjust the estimates): In most of the cases, this corresponds to the year the survey was conducted. In some cases, where the survey has been spread over multiple years, the latest year has been used to adjust the original

willingness to pay. In rare cases, when it was not possible to identify the survey year, then the year of publication was used as a proxy.

- Column Q (Mean or median estimate): Whether the estimate is a mean or median estimate
- Column R (CI–Lower): The lower end of the confidence interval (CI) for the original estimate, if reported
- Column S (CI–Upper): The upper end of the CI for the original estimate, if reported
- Column T (Standard deviation): The standard deviation of the original estimate, if reported
- Column U (Payment method): The payment method used in the survey, if reported, e.g. non-discretionary addition to annual council rates.
- Column V (Survey year): The year the survey was conducted. This is also the year the original willingness to pay values correspond to.
- Column W (CPI ratio): CPI ratio used to adjust original estimates to 2020 figure
- Column X (Currency): The currency in which the estimates have been reported

- **Sample characteristics** (brown block, column Y to column AH). This information is useful when considering the adjustments that might be needed to match the existing study site information to the application site application. It contains:
  - Column Y (Country): The country of the study
  - Column Z (State): The state of the study location, where relevant
  - Column AA (Study location): The location where the study was carried out. In most cases, it is the same information as in the 'value location' in column E, but in some cases, they differ
  - Column AB (Population): The population of the study site, if reported
  - Column AC (No. of respondents): The number of respondents from whom data was collected. For surveys (such as contingent valuation, choice experiment, life satisfaction survey, and travel cost) it is the number of respondents. For hedonic analysis, it is the number of properties or houses. This is not the same number of respondents whose information was used in the statistical analysis—please refer to column AL

    - Column AD (Response rate): The proportion of the people who completed the survey or provided information, if applicable
    - Column AE (Sample age): The average age of the respondents, if reported. Sometimes the median age or proportion is reported
    - Column AF (Percentage of male): The proportion of respondents who were male
    - Column AG (Mean sample income): The average annual income of the respondents, if reported. The currency is in the original currency reported in the study
    - Column AH (Education level): The average year of schooling, if reported. In some cases, the proportion of respondents with certain education level is reported

- **Methodology** (gold block, column AI to column AM): This section provides information on the data collection method and estimation techniques used in the study:
    - Column AI (Method): The kind of valuation method used
    - Column AJ (Broad category): The broad category of method
    - Column AK (Data collection method): The kind of data collection method used in the study, e.g. main survey, online survey, etc.
    - Column AL (No. of valid respondents): The final number of respondents whose information was used in the estimation models
    - Column AM (Estimation models used): The type of model used for statistical analysis and generation of WTP estimates, e.g. ordinary least squares, nested logit model, etc.

- **Publication characteristics** (green block, column AN to column AP): This section provides information on the type of publications:
    - Column AN (Reference): The full reference to the study
    - Column AO (Link): The link to the original source of the study
    - Column AP (Type of publication): Whether the study was a journal article, working paper or a research report.

- **Quality assessment** (grey block, column AQ to column AU): This is a subjective assessment of the quality of the record based on information reported, survey design and methodology used. The following four criteria were used to prepare a combined quality score:

- Column AQ: Whether the study was peer reviewed or not. This adds credibility to the findings in the study
- Column AR: Whether the definition of marginal change was clear enough to understand the commodity being measured. For example, many studies define willingness to pay as a percentage change of something without clearly defining the base value from which the percentage should be calculated. In the absence of such information, the willingness to pay estimates are difficult to transfer to a new location.
- Column AS: Whether the study clearly specified variability of estimates or not
- Column AT: Whether there was sufficient background information on the study site or not. It is necessary to have background information to be able to adjust the willingness to pay estimates to the application site properly.
- Column AU: The combined (aggregate) score based on the above mentioned four criteria. The higher the score, the better the quality of the estimates.

Chart 1: Adjusted Estimate

This chart displays a bar chart of adjusted (i.e., in 2020 AU$) monetary estimates against the definition of the marginal change for selected (filtered) records. The selection of the records has to be conducted in the data worksheet. If the filtered records do not contain any adjusted monetary values the chart will be empty.

Chart 2: Original (unadjusted) Estimate

This chart displays a bar chart of unadjusted (original) monetary and non-monetary estimates against the definition of the marginal change for selected (filtered) records. The selection of the records has to be conducted in the data worksheet. Since the monetary estimates are not adjusted to a single year value (i.e., in their original years) be cautious during plotting of non-monetary estimates. This chart is particularly suitable to display non-monetary estimates.

The Value tool also has an additional set of worksheets on functions for specific values:

Worksheet 7 (Wetlands value function sheet)

This worksheet provides percentage changes in property prices from proximity to a wetland based on Pandit et al. (2014). The user enters information on the mean area of the wetland and the mean distance from the wetlands. The percentage increase in median property price will be automatically calculated. The functions already capture the distance decay effect.

To capture the substitution effect, the user enters the values twice—one without the increment (or additional wetland) and one with the wetland. The difference in % increase estimates between the two scenarios would be the value of the additional wetland.

For example, imagine a residential area has 10 hectares of existing wetlands, and the mean distance from the wetlands to the houses is 400 m. Entering these values in the green cells in the worksheet shows the medium impact on house prices is 0.92%. Assume a potential investment would add another 5 hectares of wetlands (in total 15 hectares). This investment would bring the average distance between houses and wetlands down to 300 m. The percentage impact on house prices would change to 1.87%. Therefore, the increment in house price due to an additional 5 hectares of wetland is 0.95% (1.87% – 0.92% = 0.95%). However, you might have to consider other types of adjustments, which we discuss in the following section.

Worksheet 8 (Bushlands value function sheet)

This worksheet provides the percentage changes in property prices from proximity to a bushland based on Pandit et al. (2014). Data entry and the adjustment procedure is similar to the wetland value function described above.

Worksheet 9 (Golf course value function sheet)

This worksheet provides the percentage changes in property prices from proximity to a golf course based on Pandit et al. (2014). Data entry and the adjustment procedure is similar to the wetland value function described above.

Worksheet 10 (Salinity reduction benefit from stormwater management—Industry)

This worksheet provides functions for estimating salinity reduction benefits from stormwater management for industry use based on Kandulu et al. (2014). It assumes using water with higher salinity damages commercial and industrial equipment, for example, cooling towers and boilers used in heating. Using less saline stormwater for commercial and industrial water use may generate water quality regulation benefits for commercial and industrial water users, by reducing the cost of replacing industry equipment damaged by salinity. In this worksheet, to estimate the benefit from using less saline stormwater, the user enters information on salinity levels for harvested water (stormwater), alternative sources (e.g. river water) and total volume of treated stormwater used in the industry.

Worksheet 11 (Salinity reduction benefit from stormwater management—Household)

This worksheet provides functions for estimating salinity reduction benefits from stormwater management for residential use based on Dandy et al. (2014). High salinity levels can damage household plumbing fixtures and fittings, hot water systems, water filters, and water softeners. Using less saline stormwater for residential use may generate water quality regulation benefits for residential water users. In this worksheet, to estimate benefit from using less saline stormwater, the user enters information on salinity levels for harvested water (stormwater), alternative sources (e.g. river water) and the number of affected households.

Worksheet 12 (Flood stage-damage function: Internal damage)

This worksheet provides stage-damage (internal damage) relationships for five different types of houses of three different sizes. Internal damage refers to damage to the contents of the main building(s) on a property. This information is based on The State of Queensland (2018). See the datasheet for the details of the study.

Use the filter option available on row 12 to find suitable information. The numbers in columns E and F show the potential damage per affected property of different sizes for different levels of a flood (column D). For example, for a small fully detached single storey (slab on the ground) house the internal damage is likely to be $22,596 for a flood event with 0.20-meter water above floor level. On the other hand, the damage would be much higher ($50,075) for an event with 1.10-meter water above the floor level.

If you cannot find the information on potential damage for the exact depth level you are looking for, select the two closest depth levels (low and high of the desired level) using the filter options. Copy/type the depth level and the damage values in columns C-E in rows 7-8. You will also have to enter information about the expected depth level in cell C9. The sheet will then automatically calculate the damage value for the desired level (blue cells: D9 and E9).

For example, imagine that you are interested to estimate the potential damage of a small fully detached single storey (slab on the ground) house for a flood incidence with 0.04-meter depth. Using the filter options we can see that there is not a single value for the expected level. However, we could find the closest values at 0.03 (Low) and 0.06 (High) meters depth. Enter the relevant values in the respective green cells. The blue cells will generate the expected damage for the expected flood depth.

During a BCA you will need to add indirect cost on top of the direct cost. Following the advice provided by The State of Queensland (2018) the indirect cost could be assumed to be 15% of direct damage cost.

Worksheet 13 (Flood stage-damage function: Structural damage)

This worksheet provides stage-damage (structural damage) relationships for five different types of houses of three different sizes. Structural damage refers to the damage sustained by the fabric of a building (foundations, floors, walls, doors, windows, etc.) and the damage sustained by permanent fixtures in the building such as built-in cupboards, benches, etc. This information is based on The State of Queensland (2018). See the datasheet for the details of the study.

Use the filter option available on row 12 to find suitable information. The numbers in columns E and F show the potential damage per affected property of different sizes for different levels of a flood (column D). For example, for a small fully detached single storey (slab on the ground) house the structural damage is likely to be $48,444 for a flood event with 0.18-meter water above floor level. On the other hand, the damage would be much higher ($66,144) for an event with 0.97-meter water above the floor level.

If you cannot find the information on potential damage for the exact depth level you are looking for, select the two closest depth levels (low and high of the desired level) using the filter options. Copy/type the depth level and the damage values in columns C-E in rows 7-8. You will also have to enter information about the expected depth level in cell C9. The sheet will then automatically calculate the damage value for the desired level (blue cells: D9 and E9).

For example, imagine that you are interested to estimate the potential damage of a small fully detached single storey (slab on the ground) house for a flood incidence with 0.06-meter depth. Using the filter options we can see that there is not a single value for the expected level. However, we could find the closest values at 0.04 (Low) and 0.08 (High) meters depth. Enter the relevant values in the respective green cells. The blue cell will generate the expected damage at the desired level.

During a BCA you will need to add indirect cost on top of the direct cost. Following the advice provided by The State of Queensland (2018) the indirect cost could be assumed to be 15% of direct damage cost.

Worksheet 14 (Flood stage-damage function: External damage)

This worksheet provides stage-damage (external damage) relationships for five different types of houses of three different sizes. External damage refers to damage to items external to the main building (motor vehicles, fences, gardens, the contents of sheds or outbuildings, etc.). This information is based on The State of Queensland (2018). See the datasheet for the details of the study.

Use the filter option available on row 12 to find suitable information. The numbers in columns E and F show the potential damage per affected property of different sizes for different levels of a flood (column D). For example, for a small fully detached single storey (slub on the ground) house the external damage is likely to be $2,454 for a flood event with 0.18-meter water above floor level. On the other hand, the damage would be much higher ($3,862) for an event with 0.25-meter water above the floor level.

If you cannot find the information on potential damage for the exact depth level you are looking for, select the two closest depth levels (low and high of the desired level) using the filter options. Copy/type the depth level and the damage values in columns C-E in rows 7-8. You will also have to enter information about the expected depth level in cell C9. The sheet will then automatically calculate the damage value for the desired level (blue cells: D9 and E9).

For example, imagine that you are interested to estimate the potential damage of a small fully detached single storey (slub on the ground) house for a flood incidence with 0.20-meter depth. Using the filter options we can see that there is not a single value for the expected level. However, we could find the closest values at 0.18 (Low) and 0.25 (High) meters depth. Enter the relevant values in the respective green cells. The blue cell will generate the expected damage at the desired level.

During a BCA you will need to add indirect cost on top of the direct cost. Following the advice provided by The State of Queensland (2018) the indirect cost could be assumed to be 15% of direct damage cost.

Worksheet 15 (Flood stage-damage function: Small and medium businesses)

This worksheet provides stage-damage (total damage) relationships for five different value classes of small (<186 sq m) and medium (186 to 650 sq m) sized businesses. Examples under individual value classes include: 1: Florist, garden centres, sports pavilions, consulting rooms, vehicle sales areas, schools, churches; 2: Cafes / takeaway, service stations, pubs, second hand goods, clubs; 3: Chemists, musical instruments, printing, electronic goods, clothing; 4: Bottle shops, cameras, and; 5: Pharmaceuticals, electronics. This information is based on The State of Queensland (2018). See the datasheet for the details of the study.

Use the filter option available on row 12 to find suitable information. The numbers in columns E and F show the potential damage per affected businesses of different value classes for different levels of a flood (column D). For example, for a small business from VC1 class, the total damage is likely to be $16,401 for a flood event with 0.16-meter water above floor level. On the other hand, the damage would be much higher ($25,641) for a flood event with 0.26-meter water above the floor level.

If you cannot find the information on potential damage for the exact depth level you are looking for, select the two closest depth levels (low and high of the desired level) using the filter options. Copy/type the depth level and the damage values in columns C-E in rows 7-8. You will also have to enter information about the expected depth level in cell C9. The sheet will then automatically calculate the damage value for the desired level (blue cells: D9 and E9).

For example, imagine that you are interested to estimate the potential damage of a small business from VC1 class small business for a flood incidence with 0.20-meter depth. Using the filter options we can see that there is not a single value for the expected level. However, we could find the closest values at 0.16 (Low) and 0.26 (High) meters depth. Enter the relevant values in the respective green cells. The blue cell will generate the expected damage at the desired level.

During a BCA you will need to add indirect cost on top of the direct cost. Following the advice provided by The State of Queensland (2018) the indirect cost could be assumed to be 55% of direct damage cost.

Worksheet 16 (Flood stage-damage function: Large businesses)

This worksheet provides stage-damage (damage per square meter) relationships for five different value classes of large (>650 sq m) businesses. Examples under individual value classes include: 1: Florist, garden centres, sports pavilions, consulting rooms, vehicle sales areas, schools, churches; 2: Cafes / takeaway, service stations, pubs, second hand goods, clubs; 3: Chemists, musical instruments, printing, electronic goods, clothing; 4: Bottle shops, cameras, and; 5: Pharmaceuticals, electronics. This information is based on The State of Queensland (2018). See the datasheet for the details of the study.

Use the filter option available on row 12 to find suitable information. The numbers in columns E and F show the potential damage per affected businesses of different value classes for different levels of a flood (column D). For example, for a business from VC1 class, the damage per square meter is likely to be $34 for a flood event with 0.22-meter water above floor level. On the other hand, the damage would be much higher ($50/sq meter) for a flood event with 0.30-meter water above the floor level.

If you cannot find the information on potential damage for the exact depth level you are looking for, select the two closest depth levels (low and high of the desired level) using the filter options. Copy/type the depth level and the damage values in columns C-E in rows 7-8. You will also have to enter information about the expected depth level in cell C9. The sheet will then automatically calculate the damage value for the desired level (blue cells: D9 and E9).

For example, imagine that you are interested to estimate the potential damage of a large business from VC1 class for a flood incidence with 0.25-meter depth. Using the filter options we can see that there is not a single value for the expected level. However, we could find the closest values at 0.22 (Low) and 0.30 (High) meters depth. Enter the relevant values in the respective green cells. The blue cell will generate the expected damage at the desired level.

During a BCA you will need to add indirect cost on the top of the direct cost. Following the advice provided by The State of Queensland (2018) the indirect cost could be assumed to be 55% of direct damage cost.

Worksheet 17 (CPI Info)

This worksheet provides information on the CPI index used to adjust value estimates. In the current version of the database, 2020 has been set as the year to adjust the values. However, it is possible to adjust to a new CPI estimate once they become available. In order to adjust to the new year enter CPI information in the green cells (J41 to J46) against the respective years. The calculations will be updated automatically.

Worksheet 18 (Key terms)

This worksheet provides a definition of key terms used in the tool.

6 Using the Value tool

Users must assess or understand the types of non-market benefits or services that could be generated by the proposed changes in the policy or implementation of a project. Once the need for non-market value estimates is established, the Value tool could be used to identify the relevant information. The steps to follow to use the Value tool are presented in Figure 6 and described below.

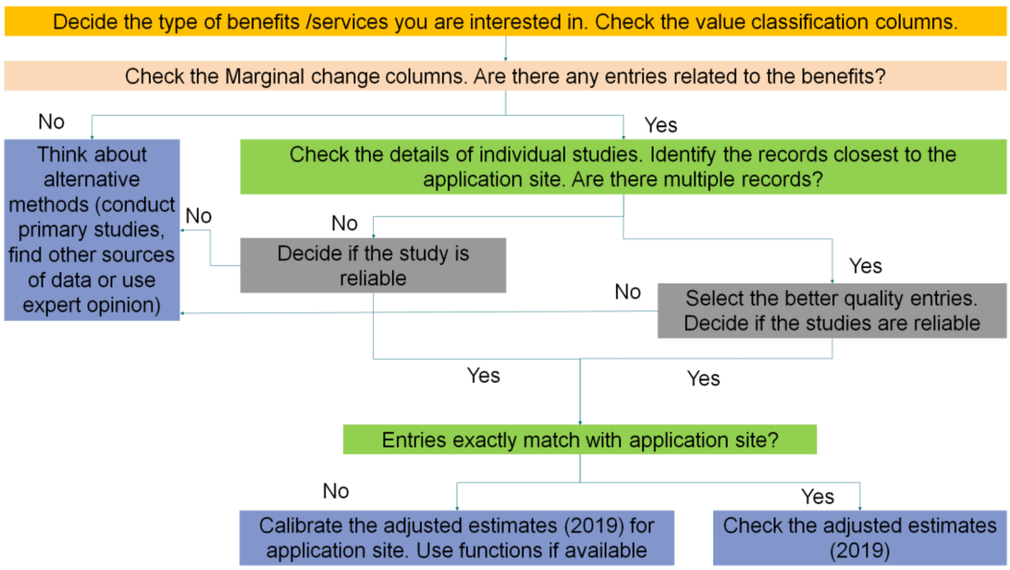

Figure 6: Decision tree to use the Value tool

Step 1: Understand the application context/site for which you will apply benefit transfer

Have a clear understanding of the application site, the project aims and outcomes, and the context that surrounds it. For example, You are interested in conducting a project to improve water supply. Reducing the frequency or intensity of water restrictions could be one of the potential benefits.

Step 2: Identify the relevant key benefits/services

Check the value classification columns (Value location, Benefit type, Theme, Value type, and System / Service / Context) to identify any records that might be relevant for benefit transfer. In some cases, you may need to check the definition of the marginal change to assess if the record is relevant or not.

Step 3: Understand details of the primary studies

Individual studies must be examined carefully to understand an order of prioritisation in terms of selecting appropriate numbers. The following aspects should be considered while exploring these studies:

Description of marginal change (Commodity/service being valued): Check whether the marginal changes are relevant / matched for the application context or not. Some studies will be more relevant than the others.

Study method: Check the study methods. If the potential benefit is use value, then estimates derived from revealed preference methods might be useful. On the other hand, if non-use values are likely to be important, then estimates from studies using stated preference method would be more suitable.

Study details: Check the details of the data collection procedure. For example, if there is socio-demographic information available from the study site, then compare this with similar information available for the application site.

Step 4: Check the quality assessment

The Value tool provides an in-built quality score of each study based on availability of information. Select the records with a better quality score. In some cases, you may want to check the original source (e.g., the journal) to ensure you have selected the best quality and best matched record.

Step 5: Use the adjusted willingness to pay estimates

Where possible, we recommend using the adjusted willingness to pay estimates (Column M). However, these willingness to pay estimates have been adjusted only for inflation using consumer piece indices for 2020.

Step 6: Adjust WTP estimates for differences in socio-demographic conditions and contextual differences

Several types of adjustments should be considered:

Inflation

Use an inflation index (typically the CPI) to adjust the original WTP estimate to the present. In the Value tool, such adjustment has already been provided to 2017, using the following formula:

$$WTP_{CPI-Adjusted} = WTP_{Original}\left(\frac{CPI_{adjustment\ year}}{CPI_{study\ year}}\right)\ldots (1)$$

Differences in real income

Keeping all other things constant, we expect those with higher incomes will have higher stated WTP.

A commonly used way to adjust unit value transfers is to assume constant income elasticity of WTP, according to the following relationship:

$$WTP_{Income-Adjusted} = WTP_{CPI-Adjusted} \left(\frac{Income_{application}}{Income_{study}}\right)^{elasticity} \ldots (2)$$

Some studies have shown that elasticity[5] of WTP ranges between 0 and 1. However, other studies have shown that arbitrarily setting income elasticity of WTP to 1 performed well when adjusting WTP estimates in the presence of high income differences.[6] Therefore, it is often suggested to use unit value of elasticity (Czajkowski et al., 2017, Andreopoulos and Damigos, 2017).

Differences in demographic condition

There is no clear rule on how to adjust for demographic conditions while aggregating the benefits. If information on the proportion of people under different income groups is available for both study and application sites, then weighted average income could be used to adjust WTP, using the formula mentioned above.

Substitution effect

If the number / area / proportion of substitutes available in the application site is larger / higher than that of the study site, then the WTP estimates must be adjusted downwards. On the other hand, if they are lower, then WTP estimates could be adjusted upwards. Original studies should be checked for any existing functional forms. In the absence of any functional form, a linear adjustment could be carried out.

Distance decay

Information on distance decay function is available in some studies. If available, we recommend using those functions.

If absent, distance decay estimates could be adjusted based on a generalised assumption that the further the site is from the commodity, the lower the value is. This adjustment is based on the following formula:

$$WTP_{Distance-Adjusted} = WTP_{Income-Adjusted} \left(\frac{Distance_{study}}{Distance_{application}}\right)^{elasticity} \ldots (3)$$

In this case, the distance elasticity could be set equal to 1, which would mean the relative rate of change in WTP would depend only on the distance measures.

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[5] Elasticity is a measure of responsiveness. For example, income elasticity of demand refers to the sensitivity of the quantity demanded for a certain good to a change in real income of consumers who buy this good, keeping all other things constant.

[6] Assuming a constant (unit) income elasticity has a convincing interpretation—respondents' WTP for a particular good is a constant share of their income, irrespective of what their income levels are. See CZAJKOWSKI, M., AHTIAINEN, H., ARTELL, J. & MEYERHOFF, J. 2017. Choosing a Functional Form for an International Benefit Transfer: Evidence from a Nine-country Valuation Experiment. *Ecological Economics,* 134**,** 104-113.

Correction for non-respondent bias while aggregating the willingness to pay estimates

Non-market valuation studies provide average per person (or per household) value estimates that are then aggregated across the relevant population (which may be a region, state or country) to produce a total figure that can be used in benefit cost analysis. For the total figure to be valid, the survey should target a representative sample of the population. However, even when this is done, an assumption must be made about the WTP of non-respondents.

At one extreme, we could assume those who chose not to participate did so because they do not care about the issue and so have a zero WTP. At the other extreme, we could assume non-respondents have similar preferences to respondents. The assumptions made can have a large impact on total value estimates, especially when response rates are low—for example, estimates could differ by a factor of four or more when response rates are lower than 25% (Baker and Ruting, 2014).

Non-response biases can be addressed using several techniques. These include: 1) estimating WTP for non-respondents using available socioeconomic data; and 2) assuming a particular proportion of non-respondents have similar preferences to survey participants but the remainder do not value the outcome (Morrison, 2000). To support the latter technique, Morrison (2000) used a follow-up survey to estimate that around 30% of non-respondents are likely to share similar values to survey participants. Some other practitioners have followed this lead and also used the 30% figure (Baker and Ruting, 2014).

7 Using non-market values for benefit transfer—an example

We will use a case study on a residential development project with water sensitive urban designs in Bellevue in Perth, Western Australia to demonstrate the Value tool. The main water sensitive urban design (WSUD) features that provide intangible benefits are the constructed wetlands, a living stream and the rain gardens. For this example, we assumed the constructed wetlands and living stream cover around 6 hectares of land. We will estimate private benefits to the residents due to: 1) a public open space (PoS) which includes four constructed wetlands; and 2) a living stream (Figure 7).

Figure 7: Location of living stream and constructed wetlands in the application site. Source Iftekhar and Polyakov (2019).

Step 1: Understand the application site

The target number of dwellings in the residential development is 348, resulting in a residential density of 14.1 dwellings/hectare. The population is expected to be 731 people (2.1 / persons / dwelling). We assumed the socioeconomic conditions of the future residents will be similar to the current socio-demographic profile in Bellevue.

Because we are interested in amenity benefits of WSUD (wetlands and living stream), the presence of similar features (such as PoS) could influence people's willingness to pay (WTP) for additional services.

There is a neighbourhood park (0.50 hectares) and a local park (0.25 hectares), but there are no other wetlands or living streams close to the site.

Step 2: Use the Value tool to find relevant benefits

By searching relevant columns, we found four records of non-market values on wetlands from Western Australia (Table 5) and three records on a living stream (Table 6).

Table 5: Studies related to the values of wetlands. Source: INFFEWS Value tool.

Study identification				Value classification					Marginal change measure
Obs. ID	Paper ID	Citation	Title	Value location	Benefit Type	Theme	Value Type	System / Service / Context	Definition of marginal change
146	26	Pandit et al. (2014)	Valuing public and private urban tree canopy cover	Perth	Improved aesthetics	Green Space	Amenity	Wetlands	Implicit price of 1% increase in gravity index (which considers size of the wetlands and the distance) for lakes based on Manski model (median is 1.8% and median house sale price $800,000)
207	41	Tapsuwan et al. (2009)	Capitalized amenity value of urban wetlands: a hedonic property price approach to urban wetlands in Perth, Western Australia	Perth	Improved aesthetics	Green Space	Amenity	Wetlands	Household willingness to pay for moving one meter closer to the edge of a wetland nearest the property (mean distance is 943.35 meter and mean house sales price in 2006 is $794,922)
208	41	Tapsuwan et al. (2009)	Capitalized amenity value of urban wetlands: a hedonic property price approach to urban wetlands in Perth, Western Australia	Perth	Improved aesthetics	Green Space	Amenity	Wetlands	Household willingness to pay for an additional wetland within close proximity (within 1.5 kilometre) to the property (mean number is 2.37 and mean house sales price in 2006 is $794,922)
209	41	Tapsuwan et al. (2009)	Capitalized amenity value of urban wetlands: a hedonic property price approach to urban wetlands in Perth, Western Australia	Perth	Improved aesthetics	Green Space	Amenity	Wetlands	Household willingness to pay for a 20 hectare wetland (approximately the mean size of wetlands in the study area) based on an average density of 5.3 properties per hectare

Table 6: Studies related to the values of living streams. Source: INFFEWS Value tool.

Study identification				Value classification					Marginal change measure
Obs. ID	Paper ID	Citation	Title	Value location	Benefit Type	Theme	Value Type	System / Service / Context	Definition of marginal change
156	30	Polyakov et al. (2017)	The value of restoring urban drains to living streams	Bannister Creek catchment in Perth	Improved aesthetics	Green Space	Amenity	Urban drains and streams	Increased property value within 200 meter of the restoration site (mean house sale price is $238,749), mean impact 4.7%
157	30	Polyakov et al. (2017)	The value of restoring urban drains to living streams	Bannister Creek catchment in Perth	Improved aesthetics	Green Space	Amenity	Urban drains and streams	Increased property value within 200 meter of the restoration site (mean house sale price is $238,749), low impact 2.9%
158	30	Polyakov et al. (2017)	The value of restoring urban drains to living streams	Bannister Creek catchment in Perth	Improved aesthetics	Green Space	Amenity	Urban drains and streams	Increased property value within 200 meter of the restoration site (mean house sale price is $238,749), high impact 6.5%

Step 3: Understand details of the primary studies

After exploring the characteristics of study site options with the application site, we selected the following records as the best matching studies (Table 7).

Table 7: Best matched studies

Citation	Title	Value location	Sub-category of value	Definition of the marginal change
Pandit et al. (2014)	Valuing public and private urban tree canopy cover	WA	Amenity	% increase of property price for having wetlands within 300 m
Polyakov et al. (2017)	The value of restoring urban drains to living streams	WA	Amenity	% increase of property value within 200 m of the restoration site

We estimated the benefits for wetlands based on values derived in Pandit et al. (2014). The first step is to compare the characteristics of the study site and application site. Table 8 shows the variations between the two sites.

Table 8: Comparison of the main characteristics of the application site with the study site used. Source: Pandit et al. (2014).

Context	Study site	Application site
Location	Perth, Western Australia	Perth, Western Australia
Setting	Urban (established)	Urban (new)
Nature of wetlands	Mix of natural, man-made or extensively modified	Man-made or extensively modified
Size	0.3–329 ha	6 ha
Average house price	$1,000,000 (2009)	$380,000 (2018)
Average distance to wetlands from properties	943 m (Tapsuwan et al., 2009)	300 m

To estimate the potential impact of wetlands on house prices, we used the parameterised function of the original study. In the Value tool, the parametric functions of the impact of wetlands on house prices have been presented for three different levels (low, medium and high impacts). The area of the wetland is 6 hectares and the mean distance to wetlands is 300 m. By entering the distance to the wetlands and the area of wetlands in the relevant cells of the Wetland Value function, we obtained the percentage change of property value (Figure 8).

Mean area of the wetlands		Area (sqm)	60000
Mean distance to wetlands		Distance (m)	300
% increase of median property price	Low impact		0.48%
% increase of median property price	Medium impact		0.97%
% increase of median property price	High impact		1.46%

Figure 8: Calculation of the impact of wetlands on house price

The percentage increase in median property price for wetlands with a 6 hectare area and at a 300 m distance could range from 0.48% to 1.46%. By multiplying the percentage increase in median property price with the number of properties within 300 m and average property price, we obtain the potential total amenity values to the residents due to wetlands. The total value could range between $0.60 million to $1.94 million (Table 9).

Table 9: Total amenity benefit due to wetlands

Features	Impact		
	Low	Medium	High
The percentage increase in property value (%)	0.48	0.97	1.46
Number of properties within 300m distance	348	348	348
Average property price ($)	380,000	380,000	380,000
Total amenity value ($) for residents due to wetlands	634,752	1,282,728	1,943,928

To estimate benefits from a living stream, we used the findings from Polyakov et al. (2017). A brief comparison of the main contextual characteristics shows the two sites are not too dissimilar (Table 10).

Table 10: Comparison of the main characteristics of the application site with the study site. Source: Polyakov et al. (2017).

Context	Study site	Application site
Location	Perth, Western Australia	Perth, Western Australia
Setting	Urban (established)	Urban (new)
Nature of living stream	Restoration site	Restoration site
Average house price	$238,749 (2013)	$380,000 (2018)

Polyakov et al. (2017) measured the impact of living stream improvement as the percentage change of property price within 200 m of the site. They also observed that there is not much amenity benefit of living stream projects on houses located more than 200 m from the site. Within 200 m, the impact on house prices could range from 2.9% to 6.5% (Table 11).

As above, by multiplying the percentage increase with the number of properties within 200 m and average property price, we obtained the potential total amenity values to the residents due to the living stream. The total value could range between $1.8 million to $4.2 million (Table 11).

Table 11: Total amenity benefit due to living stream

Features	Impact		
	Low	Medium	High
Percentage increase of property value (%)	2.9	4.7	6.5
Number of properties within 200m distance	170	170	170
Average property price ($)	380,000	380,000	380,000
Total amenity value ($) for residents due to living stream	1,873,400	3,036,200	4,199,000

For both of the studies, we did not have to adjust estimates to income differences, because house prices captured the income differences. Since the change in house prices was estimated as a percentage of house prices, we did not adjust the values for inflation/time differences.

Finally, we compared the amenity values to local residents of PoS - wetlands and the living stream (Figure 9). Since both features (wetlands and the living stream) are located in the same area, the benefits of one feature could overlap with the other. Therefore, we cannot add up to both values. Depending on the estimation, the total amenity benefit[7] of investing in a wetland and a living stream for this particular residential development would range between $1 million and $4 million**.**

[7] We have not included other types of benefits, such as, biodiversity benefit, pollution benefits, etc.

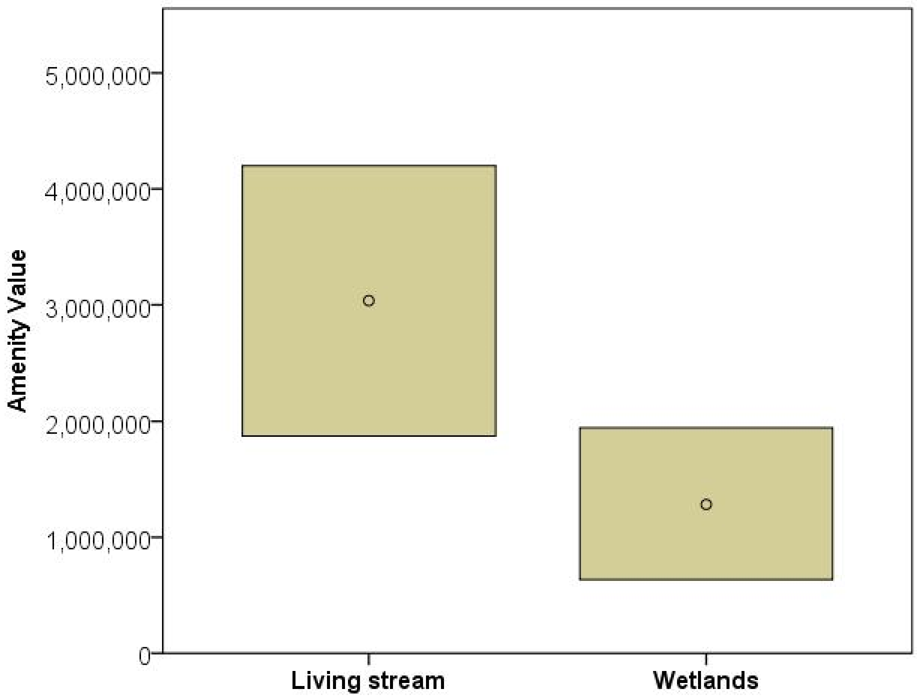

Figure 9: Total amenity value from wetlands and living stream

8 Concluding remarks

Our extensive literature search reveals that not all types of non-market benefits of water sensitive systems and practices have been studied in Australia. This result may make it difficult to transfer non-market benefit estimates of some services from a study site to an application site when primary studies are not available. However, the next steps are to keep updating the Value tool as new information becomes available and to test the benefit transfer guidelines through selected case studies.

In the interim, the recommendations are:

1) Conduct primary non-market valuation studies to estimate benefits if resources are available.

2) If the study and application sites match reasonably well, it is possible to apply for the adjusted unit value benefit transfer. The Value tool is suitable for this kind of benefit transfer, however, proper adjustment and sensitivity analysis must be performed.

3) If the sites do not match, seek expert support to conduct a more sophisticated benefit transfer.

It is important to record all the assumptions made for any adjustment. During the formal reporting of the analyses, the procedure, data sources, assumptions, and functions used for adjustment must all be clearly documented. This will help ensure the estimation process is transparent and allow the users to assess the quality of the values.

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Appendix A: Definition of key terms

Age-standardised rate: A method of adjusting the crude rate to eliminate the effect of differences in population age structures when comparing crude rates for different periods of time, different geographic areas and/or different population sub-groups (e.g. between one year and the next and/or States and Territories, Indigenous and non-Indigenous populations). Adjustments are usually undertaken for each of the comparison populations against a standard population (rather than adjusting one comparison population to resemble another). Sometimes a comparison population is referred to as a study population (Australian Institute of Health and Welfare, 2005).

Ambient temperature: Temperature of the air at the measurement site (Department of Agriculture and Water Resources, 2008).

Annualized value: The amount one would have to pay at the end of each time period so that the sum of all payments in present value terms equals the original stream of values (US EPA, 2010).

Attribute non-attendance: The tendency to ignore one or more of the attributes in an experiment (Hole et al., 2013).

Avoided cost: The expected change in the present value of expenditure from the temporary or permanent deferral of costs (IPART, 2011).

Benefit Transfer: A class of approaches that uses estimates from an original non-market valuation study conducted at a particular site and transfers the information to a new policy site (Mekala et al., 2015).

Choice Experiment (CE): A non-market valuation technique where willingness to pay is elicited by surveys in which people can choose between different bundles of goods with varying characteristics. The goods could be market or non-market goods (Meyer et al., 2014).

Conjoint Analysis: A stated preference technique in which respondents are required to rate alternatives rather than make a commitment to a particular option (NSW Department of Environment and Conservation, 2005).

Consumer surplus: A measure of the net benefit that a consumer receives due to the fact that their willingness to pay for a good or service exceeds the amount they actually pay (the price) (AECOM, 2012).

Contingent Valuation (CV) method: A non-market valuation technique where people are asked in surveys about their willingness to pay to avoid (or gain) a given decrement (or increment) of a particular non-market good, or about their willingness to accept its deterioration by receiving a certain amount of compensation (Meyer et al., 2014).

Control or prevention costs, averting behaviour: This method relies on the assumption that it is possible to quantify the economic value of externalities in terms of the avoidance costs of implementing actions that prevent the damage produced (Holguín-Veras et al., 2016).

Cost of Illness approach: This approach uses costs of health impacts (such as medical costs and lost wages due to illness) to estimate the value of a good or project (Meyer et al., 2014).

Damage (restoration) costs approach: This approach relies on quantifying the value of the impacts as the cost required to repair the damage, and restore things to their original condition (Holguín-Veras et al., 2016).

Direct Cost: A measure of the monetary value of resources, goods, or services that could be used for other purposes (Lee et al., 2017b).

Disability Adjusted Life Year: A measurement equivalent to the loss of one year of healthy life and it allows the burden of disease in a population to be measured as the gap between current health and an ideal situation where everyone lives to old age, free of disease and disability (Medibank Private, 2008).

Ecosystem service value: The monetary value of benefits and services people obtain from the ecosystem. Examples of ecosystem services include the provision of food and water, the regulation of flood and disease control, and the provision of recreational, spiritual and cultural services (Infrastructure Victoria, 2016).

Hedonic pricing approach: This technique uses existing market price information to estimate the impact of a project or services. For example, by comparing the prices of similar houses in different areas of a city it is possible to estimate the capitalized amenity values of green infrastructures.

Implicit price: The price of a non-market good estimated by valuing its attributes using market values for those attributes. For example, in the case of housing, these attributes could be the number of rooms, types of views and proximity to amenities (Infrastructure Victoria, 2016).

Inferred valuation: A stated preference method in which survey respondents are given choices between multiple attributes with associated values. The value of the goods is implied by the monetary trade-offs made in the respondents' choices (Abelson, 2008).

Kessler Psychological Distress Scale (K10) score: The Kessler Psychological Distress Scale is a questionnaire that measures symptoms of psychological distress experienced over the four weeks prior to completion of the questionnaire, including feeling tired for no reason, nervous, hopeless, restless, depressed, sad and worthless. Participants had five choices for each of the ten questions (none of the time = 1, a little of the time = 2, some of the time = 3, most of the time = 4, all of the time = 5) and these were summed to give the overall score from 10 to 50 (Astell-Burt et al., 2013).

Levelized cost: The annualized cost per unit output in which the unit of output is usually discounted in the same fashion as the cost (Black, 1984).

Life Satisfaction Analysis: Welfare estimations of public goods (health, environment) are estimated based on life satisfaction surveys (Meyer et al., 2014).

Mental component summary score: The Mental Component Summary score represents the aggregation of a subset of eight scales, vitality, social functioning, role emotional and mental health, derived from 36 items, transformed to a 0-100 index using 1995 Australian Bureau of Statistics population norms (Ambrey, 2016).

Mental health score: A measurement of mental health using the HILDA Self-Completion Questionnaires which include a set of questions that make up the Medical Outcomes Study Short-Form General Health Survey (SF-36), one of the most widely used measures of subjective health. The SF-36 is a self-reported multidimensional measure of general health status or quality of life. It is a generic measure, as opposed to one that targets a specific age, disease or treatment group and was constructed to satisfy minimum psychometric standards necessary for group comparisons. The 36 survey items are used to produce an 8-scale profile of functional health and wellbeing scores as well as psychometrically-based physical and mental health summary measures and a preference based health utility index (Dockery, 2006).

Net present value: The monetary or dollar value of the overall impact generated by a project or proposal. It reflects the benefits delivered over timeless the costs in monetary terms or the 'return on investment'. It is calculated as the present value of the stream of benefits less the present value of costs (Infrastructure Victoria, 2016).

Odds ratio: Odds are the number of times an event happens divided by the number of times it does not within a group. Odds can also be expressed as the risk (or probability) of an event occurring over the risk of an event not occurring. The odds ratio is the odds of an event occurring in one group divided by the odds of the same event in another group (Scott, 2008).

Opportunity Cost: The cost of an alternative that is foregone when another option is chosen (Infrastructure Victoria, 2016).

Partworth: In conjoint analysis, the value of each level of an attribute of the alternatives available for choice by survey respondents (NSW Department of Environment and Conservation, 2005).

Present value: The future value expressed in present terms by means of discounting (Infrastructure Victoria, 2016).

Price premium in hedonic analysis: Using a hedonic property price approach, the amenity value associated with proximity to habitats, designated areas, domestic gardens, and other natural amenities are measured through the decomposition of positive price premiums (Gibbons et al., 2014).

Production Function approach: This approach relies on estimating the contribution of an environmental good in producing a market good (Meyer et al., 2014).

Rate of disease burden: The contributions of diseases, health conditions and risk factors to premature deaths (years of life lost or 'YLL') and years lived with disability (YLD) and also calculate a combined measure, disability-adjusted life years (DALYs). Together these provide an estimate of a society's total health loss and disease burden and provide an important basis for planning, policy development and priority setting (State of Victoria, 2015).

Replacement Cost method: The value of an ecosystem good or service is estimated based on the costs of replacing that good or service (Meyer et al., 2014).

Revealed preference: A method to estimate non-market values using observations from how much consumers spend on goods and services in similar or related markets (Infrastructure Victoria, 2016).

Stated preference (SP) techniques: Stated preference techniques use surveys to understand their preferences. Contingent Valuation and Choice Experiments are prominent examples of stated preference techniques (Holguín-Veras et al., 2016).

Travel Cost method: Recreational or environmental sites are valued by analysing observed travel time and expenditure of visitors (Meyer et al., 2014).

Value of Statistical Life Year: A measurement approximating how much a society is willing to pay to add on the value of an 'additional year of healthy life' (Infrastructure Victoria, 2016).

Value of Statistical Life: An estimate of the economic value society places on (society's willingness to pay for) reducing the average number of deaths by one (Infrastructure Victoria, 2016).

Willingness to accept (WTA): WTA is the amount that a decision maker is willing to accept to give up using a good or service, or to put up with a decrease in welfare (Holguín-Veras et al., 2016).

Willingness to pay (WTP): Willingness to pay is the amount of money that a decision maker is willing to part with to procure a good or service, or to achieve a higher level of welfare (Holguín-Veras et al., 2016).

Appendix B: List of selected benefit transfer studies

1. Baskaran, R., R. Cullen and S. Colombo (2010), Testing different types of benefit transfer in valuation of ecosystem services: New Zealand winegrowing case studies, Ecological Economics, 69(5), 1010–1022.

2. Bergstrom, J. C. and L. O. Taylor (2006), Using meta-analysis for benefits transfer: theory and practice, Ecological Economics, 60(2), 351–360.

3. Brent, D. A., L. Gangadharan, A. Lassiter, A. Leroux and P. A. Raschky (2017), Valuing environmental services provided by local stormwater management, Water Resources Research(53), 4907–4921.

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