2019

MONETISING THE BENEFITS OF WATER SENSITIVE URBAN DESIGN AND GREEN INFRASTRUCTURE FEATURES

RESILIENT EAST CASE STUDIES

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Executive Summary

Resilient East, a grouping of 8 council areas within Adelaide's eastern region, has undertaken an investigation to calculate notional monetisable benefits of implementing Water Sensitive Urban Design (WSUD) and Green Infrastructure (GI) features into the following local infrastructure projects:

- City of Adelaide – Gray Street Upgrade
- City of Burnside – Bell Yett Reserve carpark
- City of Norwood, Payneham & St Peters – Felixstow Wetlands
- City of Unley – Florence Street raingardens and Way Avenue tree inlets
- City of Tea Tree Gully – Smart Road Rain Gardens

The benefits were calculated using the Excel-based WSUD/GI Monetised Benefits Tool ('the tool'), developed by Martin Allen, Principal Policy Officer at the Water Sensitive Towns and Cities section of the Department for Environment and Water (DEW).

Following are the total calculated benefits (for an assumed 30-year asset life) and the benefit categories assessed for each project:

System	WSUD Monetised benefit	Benefit categories
Gray Street (7 trees + 2 rain gardens; City of Adelaide)	$98,283	Water Quality Runoff Attenuation Neighbourhood Character
Bell Yett Reserve car park and swale (City of Burnside)	$57,949	Water Quality Runoff Attenuation Neighbourhood Character
Felixstow Wetlands (City of Norwood, Payneham & St Peters; ERA Water) *(Covers wetland and biofilter civil works, extraction and transfer pump stations, WQ equipment and valving, biofilters, extraction station and vales, WQ and control, UV, injection pump station and bores)*	$5,269,736 *(excludes the greening and amenity benefits created in other areas from the irrigation capability)*	Water Quality Runoff Attenuation Health - Medical Costs Health - Physical Benefits Neighbourhood Character
Florence Street (3 Rain gardens + 3 bioretention filters; City of Unley)	$64,100	Water Quality Runoff Attenuation Neighbourhood Character
Way Avenue (water inlet wells for 31 trees; City of Unley)	$300,520	Water Quality Runoff Attenuation Neighbourhood Character
Smart Road – 3x rain gardens and bioretention swales	108,050	Water Quality Runoff Attenuation Health - Medical Costs Health - Physical Benefits

Overall, the most significant monetised benefit calculated by the tool relates to Neighbourhood Character, demonstrating the importance of further investigating the link between neighbourhood greening and property values.

In addition, the Water Sensitive Cities INFFEWS (Investment Framework for Economics of Water Sensitive Cities) Tool was used for further assessment the Smart Road project. The INFFEWS analyses indicate the Smart Road project has a Net Present Value of $737,259 and a Benefit-cost ratio (BCR) of 1.81. These results indicate that investing in the WSUD features on Smart Road has had a positive return on investment.

The Excel-based tool looked at five benefit parameters with no included costs, whereas the INFFEWS tool is a more holistic approach to monetising the benefits of WSUD feature implementation as it includes as many benefits as deemed necessary for the project as well as project costs. While both tools link some of the better-documented social, environmental and economic benefits of WSUD and GI features to easily-understandable monetary benefits, they should not be used as the sole means of determining the relative merits of any given infrastructure project. Rather, they should be used by state and local South Australian government bodies as a decision support aid through which the potential benefits of WSUD and GI features within any proposed, ongoing or completed infrastructure project can be modelled and then presented, all the while keeping the context of the project's broader costs and benefits in mind.

While every effort was made to obtain the best available data and use them in a rigorous and consistent manner, the tools' outputs are estimations. The findings of this and any similar exercise using this tool should be considered within the context of the broader costs and benefits of any proposed, ongoing or completed infrastructure project.

Contents

1. Introduction

Resilient East is a group of councils within Adelaide's eastern region consisting of the Cities of Adelaide, Burnside, Campbelltown, Norwood, Payneham & St Peters, Prospect, Tea Tree Gully, Unley and Walkerville (Figure 1).

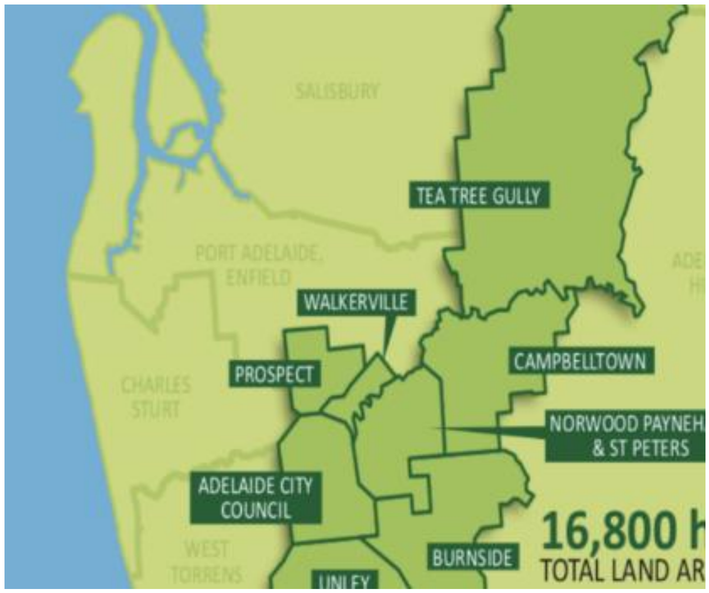

Figure 1: The Council areas that form the Resilient East region (source: Resilient East website).

Commencing in late 2018, the Resilient East project undertook an investigation to calculate notional monetisable benefits of implementing Water Sensitive Urban Design (WSUD) and Green Infrastructure (GI) features into five local infrastructure projects. The investigation used the Excel-based WSUD/GI Monetised Benefits Tool ('the tool') developed by Martin Allen, Principal Policy Officer, Urban Water Strategy at the Department for Environment and Water (DEW), targeting the following projects:

- City of Adelaide – Gray Street Upgrade
- City of Burnside – Bell Yett Reserve carpark
- City of Norwood, Payneham & St Peters – Felixstow Wetlands
- City of Unley – Florence Street raingardens
- City of Unley – Way Avenue tree inlets
- City of Tea Tree Gully – Smart Road Rain Gardens

The investigation aimed to determine the usefulness of the tool's application to current and future infrastructure projects within the Resilient East region, be they large or small.

2. The tool's benefit assessment areas

Based on extensive research, the tool enables the allocation of dollar values to some of the well documented social, environmental and economic benefits of WSUD and GI features. In doing so, it can assist state and local South Australian government bodies to assess those potential benefits and then present them to key interested parties within the context of the broader costs and benefits of any proposed, ongoing or completed infrastructure project. Key assumptions made in deriving the tool's default parameter values are outlined in Sections 2.1 – 2.5. The tool's strengths and some key factors to consider are provided in Appendix A, and more detailed explanations of the derivation of those values are provided in Appendix B, alongside the relevant literature references.

Note that some benefit categories were deemed irrelevant or negligible in value for some projects, most notably in cases where the addition of some greening to an already green area could not realistically be expected to result in significant additional health or property value benefits. Table 1 shows which benefit categories were utilised for each infrastructure project.

Table 1: A summary of benefit category relevance for each project.

	Water Quality	Runoff Attenuation	Health – Medical Costs	Health – Physical Benefits	Neighbourhood Character
City of Adelaide – Gray Street	✓	✓	✗	✗	✓
City of Burnside – Bell Yett Reserve carpar	✓	✓	✗	✗	✓
City of Norwood, Payneham & St Peters – Felixstow Wetlands	✓	✓	✓	✓	✓
City of Unley – Florence Street	✓	✓	✗	✗	✓
City of Unley – Way Avenue	✗	✗	✗	✗	✓
City of Tea Tree Gully – Smart Road	✓	✓	✓	✓	✗

2.1 Water Quality

The tool's water quality section addresses the health of near shore sea grasses and reefs by modelling the benefits of suspended solid and nitrogen reductions.

Regarding suspended solids, the modelled monetary benefit is calculated using the following key parameters and assumptions:

- An estimate of the reduction in average annual load exported from the project area (using as default values median concentrations provided by the Australian Runoff Quality guidelines).
- Improved near-shore marine health 'willingness to pay' values, obtained from a survey held in Adelaide in 2014.
- An assumed direct relationship between the coastal water quality outcomes the community is willing to pay for, and the total annual reduction in suspended solids entering metropolitan Adelaide coastal waters targeted by the Adelaide Coastal Water Quality Improvement Plan.

Regarding total nitrogen (TN), the modelled monetary benefit is calculated from the following parameters:

- An estimate of the reduction in average annual load exported from the project area, using as default values median concentrations provided by the Australian Runoff Quality guidelines.
- An inferred TN reduction value (per tonne per annum) of $1M.

As such water quality benefits were considered to be negligible in the Way Avenue tree inlets case, this benefit category was not used in this project.

2.2 Runoff Attenuation

In this section of the tool it is assumed that runoff being directed through a project's WSUD features would reduce average annual flood damage costs within the project's catchment.

The calculation is based on the estimated average annual flood damage cost across the catchment, and the proportion of that runoff which is generated within the project area.

As such flood mitigation benefits were considered to be negligible in the Way Avenue tree inlets case, this benefit category was not used in this project.

2.3 Health – Medical Costs

This component of the tool is based on research linking proximity to green infrastructure with rates of overweight and obesity within the adjacent resident population. The modelled monetary benefit is calculated using the following key parameters and assumptions:

- An average annual reduction in medical costs per obese and overweight adult residing within 200 metres of the project site (compared to the average medical cost of a healthy weight adult) due to potential increased physical activity.
- The proportion of that obese and overweight adult resident population which would actually increase its physical activity levels due to its proximity to the project's GI features (assumed to be 1%), resulting in that medical cost reduction.

Due to their surroundings already being quite green, and to their relatively small scale, the Gray Street (City of Adelaide), Bell Yett Reserve carpark (City of Burnside), Way Avenue tree inlets (City of Unley) and Florence Street upgrade (City of Unley) projects were deemed unlikely to generate any additional physical activity from within the surrounding area's resident population. This benefit category was therefore deemed irrelevant and this type of monetised benefit was not calculated for these four projects.

2.4 Health – Physical Benefits

This component of the tool is based on research linking proximity to green infrastructure with physical activity rates among adult residents. The modelled monetary benefit is calculated using the following key parameters and assumptions:

- Estimated residential adult population within 200 metres of the project's GI features.
- A proportion of that population which is already sufficiently active and is therefore assumed not to derive any additional benefit from proximity to the project's GI features.
- The proportion (assumed to be 1%) of the insufficiently active adult resident population which would increase its physical activity levels due to its proximity to the project's GI features.
- An assumed two additional life years per benefiting resident, resulting from their increased physical activity levels, and occurring on average 20 years after project completion.
- The value of a statistical life year, estimated at $187,000.

Due to their surroundings already being quite green, and to their relatively small scale, the Gray Street (City of Adelaide), Bell Yett Reserve carpark (City of Burnside), Way Avenue tree inlets (City of Unley) and Florence Street upgrade (City of Unley) projects were deemed unlikely to generate any additional physical activity from within the surrounding area's resident population. This benefit category was therefore deemed irrelevant and this type of monetised benefit was not calculated for these four projects.

However, Smart Road rain garden (City of Tea Tree Gully) underwent a considerable change in green infrastructure and hence produced the highest health benefit relative to the other projects. The health benefit parameter generated a value of $90,895 which accounted for 84% of the smart road monetised value. This is value was considered conservative as it did not consider individuals aged below 18.

2.5 Neighbourhood Character

The Neighbourhood Character component of the tool relates to a 'willingness to pay' for living in a greener neighbourhood, using residential property values as a surrogate measure. The values used in this component of the tool come from extensive evidence associating close proximity to green infrastructure with higher property values. The modelled monetary benefit is calculated using the following key parameters and assumptions:

- The current combined value of all detached and semi-detached residential properties within 20 metres linear distance of the project boundary.
- An estimated 4% increase in the value of those properties (which can be thought of as a 'local greening' benefit) per 10% increase in greening.
- An assumption that the value of the properties in question would increase each year linearly, reaching the full modelled benefit 10 years after project completion.

Note that as the Bell Yett Reserve carpark and the Way Avenue tree inlets projects are situated in already significantly green areas, it was deemed more realistic to set their associated Neighbourhood Character benefits at 0.2% for each 1% added local greening, being half the tool's default rate. This assumption regarding the benefit of further greening an already green area is broadly consistent with some international research suggesting there are limits to the extent that property values are likely to increase with increased local greening[1].

[1] For example a 2010 Minnesota-based study by Sander, Polasky and Haigh (https://www.fs.fed.us/research/highlights/highlights_display.php?in_high_id=499) found that less value appeared to be placed on additional greening beyond a local canopy cover of about 40%.

3. Data sources

Specific local data necessary for the monetised benefits assessment obtained with the assistance of each council's relevant contact person consisted of:

- total project area (in square metres)
- project equivalent impervious surface area (in square metres)
- local average annual rainfall (in millimetres per year)
- discount rate (in %)
- average annual cost (in AUD$) of stormwater related (flooding) damages in the catchment the project area discharges to
- average annual stormwater runoff (in mega litres) from the relevant catchment area, used to determine average annual stormwater related (flooding) damages
- average annual runoff volume generated within the project area (in mega litres)
- estimated residential adult population within 200 metres of the project's GI features
- current value of all detached and semi-detached residential properties within 20 metres linear distance from the project boundary (in AUD$)
- total area of residential properties with a boundary or part of their boundary within 20 metres of the project boundary (in square metres)
- total area of new large trees, rain gardens, constructed wetlands and watercourses (in square metres).

Where local data were not available, the tool's recommended default values were used.

4. Results

4.1 City of Adelaide – Gray Street Upgrade

This project undertook the monetisation of benefits of the following WSUD and GI features, implemented as part of an upgrade of a section of Gray Street, Adelaide:

- 7 trees
- 2 raingardens

140 m in length, the upgraded section of Gray Street (the 'study area') runs between Waymouth Street and Franklin Street and features residential properties, business properties, and road and footpath areas (Figure 2).

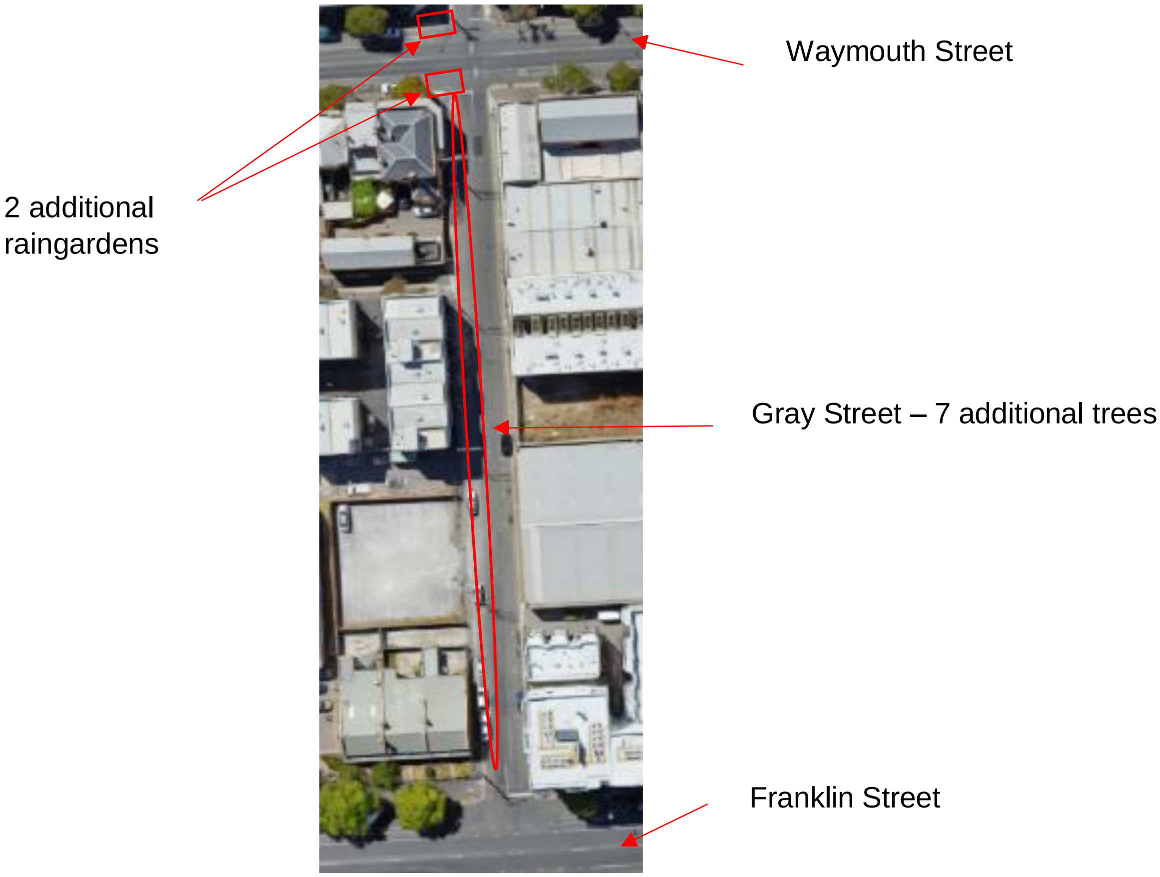

Figure 2: The study area and its surrounds, prior to implementation of WSUD and GI features.

Using the monetised benefits tool, the addition of trees and raingardens along the 140 m stretch of road resulted in an overall calculated benefit of $98,283, to be reached within the project's first 30 years, as shown in Table 2.

As explained in Chapter 2, the benefit categories of Health - Medical Costs and Health – Physical Benefits were not deemed relevant for this project, and their corresponding values in Table 2 are therefore represented as '$-'.

Table 2: Summary of WSUD and GI monetised benefits for the Gray Street Upgrade project.

	Value of quantified benefits	Proportion of total quantified benefit
Water Quality	$9,694	10%
Runoff Attenuation	$2,312	2%
Health - Medical Costs	$-	-
Health - Physical Benefits*	$-	-
Neighbourhood Character*	$86,280	88%
Sum of quantified benefits	**$98,283**	**100%**

*Although they have not been quantified during this analysis, these benefits may still be derived at this site (this benefit category was not able to be assessed as it did not meet the criteria of the tool).

The benefit category with the highest calculated value was Neighbourhood Character at $86,280, or 88% of total quantified benefits for this project. While this was by far the highest figure calculated by the tool for this project, it could still be seen as relatively conservative, as it only takes into account a benefit to properties situated within a 20 m distance of the project area.

The parameter with the lowest calculated benefit was runoff attenuation, at $2,312, or 2% of total quantified benefits for this project.

4.2 City of Burnside – Bell Yett Reserve carpark

This project undertook the monetisation of benefits of the following WSUD and GI features, implemented as part of the Bell Yett Reserve carpark upgrade:

- 1 bio-retention swale
- 17 new trees
- permeable pavements
- shrub plantings.

Totalling 2,300 m^2 in area, the Bell Yett Reserve carpark is located on Stonyfell Road, Wattle Park, across from St Peter's Girls' school. As shown in Figure 3, prior to the implementation of WSUD and GI features the carpark was an area of bare ground.

Figure 3: The study area and its surrounds with Stage 1 (consisting of half the planned carpark and the bioretention swale) completed, prior to implementation of the other planned features.

The addition of a bio-retention swale, new trees, shrubs and permeable paving at the Bell Yett Reserve carpark resulted in $57,949 of calculated benefits, to be reached within the project's first 30 years, as shown in Table 3.

As explained in Chapter 2, the benefit categories of Health - Medical Costs And Health – Physical Benefits were not deemed relevant for this projects, and their corresponding values in Table 3 are therefore represented as '$-'. As explained in Section 2.5 (and as was also the case with the Way Avenue project), the Neighbourhood Character benefit for this project was calculated using half the tool's default rate, due to the surrounding area already being green.

Table 3: Summary of WSUD and GI monetised benefits for the Bell Yett Reserve carpark.

	Value of quantified benefits	**Proportion of total quantified benefit**
Water Quality	$4,476	8%
Runoff Attenuation	$3,375	6%
Health - Medical Costs*	$-	-
Health - Physical Benefits*	$-	-
Neighbourhood Character	$50,098	86%
Sum of quantified benefits	**$57,949**	**100%**

*Although they have not been quantified during this analysis, these benefits may still be derived at this site (this benefit category was not able to be assessed as it did not meet the criteria of the tool).

The benefit category with the highest calculated value was Neighbourhood Character at $50,098, or 86% of total quantified benefits for this project.

The parameter with the lowest calculated benefit was runoff attenuation, at $3,375, or 6% of total quantified benefits.

4.3 City of Norwood, Payneham & St Peters – Felixstow Wetlands

This project undertook the monetisation of benefits of the following WSUD and GI features, implemented as part of the Felixstow Wetlands:

- wetlands
- irrigated turf
- irrigated garden beds
- non-irrigated open space.

62,000 m^2 in area, the Felixstow Wetlands are located between Riverside Drive, Langman Grove and Wicks Avenue and before the implementation of the wetlands, feature an area of open space (Figure 4).

Figure 4: The study area and its surrounds prior to implementation of all WSUD and GI features.

The addition of wetlands, irrigated turf, irrigated garden beds and non-irrigated open space within the Felixstow Wetlands resulted in $5,269,736 of calculated benefits, to be reached within the project's first 30 years, as shown in Table 4.

Table 4 Summary of WSUD and GI monetised benefits for the Felixstow Wetlands.

	Value of quantified benefits	**Proportion of total quantified benefit**
Water Quality	$17,207	0.3%
Runoff Attenuation	$443,143	8%
Health - Medical Costs	$34,432	0.7%
Health - Physical Benefits	$348,431	7%
Neighbourhood Character	$4,426,523	84%
Sum of quantified benefits	**$5,269,736**	**100%**

The parameter with the highest calculated benefit was Neighbourhood Character at $4,426,523, or 84% of total quantified benefits.

The following two highest calculated benefits were Runoff attenuation at $443,143, or 8% of total quantified benefits, and Health – Physical Benefits at $348,431, or 7% of total quantified benefits.

4.4 City of Unley – Florence Street raingardens

This project undertook the monetisation of benefits of the following WSUD and GI features implemented as part of an upgrade to Florence Street, Fullarton:

- 3 raingardens
- 3 bio-retention filters.

600 m in length, Florence Street runs between Fullarton Road and Glen Osmond Road and features residential properties, street trees, and road and footpath areas (Figure 5).

Figure 5: The study area and its surrounds, prior to implementation of WSUD and GI features.

The addition of bio-retention filters and raingardens in this project resulted in $64,100 of calculated benefits, to be reached within the project's first 30 years, as shown in Table 5.

As explained in Chapter 2, the benefit categories of Health – Medical Costs and Health – Physical Benefits were not deemed relevant for this project, and their corresponding values in Table 5 are therefore represented as '$-'.

Table 5 Summary of WSUD and GI monetised benefits for the Florence Street raingardens

	Value of quantified benefits	**Proportion of total quantified benefit**
Water Quality	$11,791	18%
Runoff Attenuation	$24,031	37%
Health - Medical Costs*	$-	-
Health - Physical Benefits*	$-	-
Neighbourhood Character	$28,277	44%
Sum of quantified benefits	**$64,100**	**100%**

*Although they have not been quantified during this analysis, these benefits may still be derived at this site (this benefit category was not able to be assessed as it did not meet the criteria of the tool).

The benefit category with the highest calculated value was Neighbourhood Character at $28,277, or 44% of total quantified benefits for this project, with the second highest calculated value being runoff attenuation at $24,031, or 37% of total monetised benefits.

4.5 City of Unley – Way Avenue tree inlets

This project undertook the monetisation of benefits of the following WSUD and GI features, implemented as part of an upgrade to Way Avenue, Myrtle Bank:

- tree inlets containing 31 new trees.

170 m in length, Way Avenue runs between Ridge Avenue and Riverdale Road and features residential properties, as well as road and footpath areas (Figure 6).

Figure 6: The study area and its surrounds, prior to implementation of WSUD and GI features.

Due to the project being situated in an already fairly green neighbourhood, the addition of new trees and tree inlets was not deemed likely to give rise to additional health benefits. For the same reason, the Neighbourhood Character benefit (the only one deemed relevant and significant enough to be quantified, as shown in Table 6) was calculated using half the tool's default rate (as further explained in Section 2.5 and as was also the case with the Bell Yett Reserve carpark project). As the potential benefits to reef health and to flood risk were also deemed negligible, no values were calculated for the Water Quality and Runoff Attenuation benefit categories

Table 6 Summary of WSUD and GI monetised benefits for the Way Avenue tree inlets.

	Value of quantified benefits	Proportion of total quantified benefit
Water Quality*	$-	-
Runoff Attenuation*	$-	-
Health - Medical Costs*	$-	-
Health - Physical Benefits*	$-	-
Neighbourhood Character	$300,520	100%
Sum of quantified benefits	**$300,520**	**100%**

*Although they have not been quantified during this analysis, these benefits may still be derived at this site (this benefit category was not able to be assessed as it did not meet the criteria of the tool).

4.6 City of Tea Tree Gully – Smart Road Rain Gardens

This project undertook the monetisation of benefits of the following WSUD and GI features, implemented as part of the Smart Road Upgrade:

- 3 rain gardens and bio retention swales
- Trees with tree water inlets: 156 mature and semi-mature trees and understory planting

The Smart Road project extended 700m in length adjacent the Tea Tree Plaza Shopping Centre from Ramsay Avenue to Reservoir Road roundabout, Modbury. The approximate area that was affected was 2,663m^2. Before the implementation of raingardens, bioretention swales and trees, the area was predominantly impervious surfaces (Figure 7). The road is situated within a commercial area with the only close proximity residential housing being a soon-to-be developed nursing home.

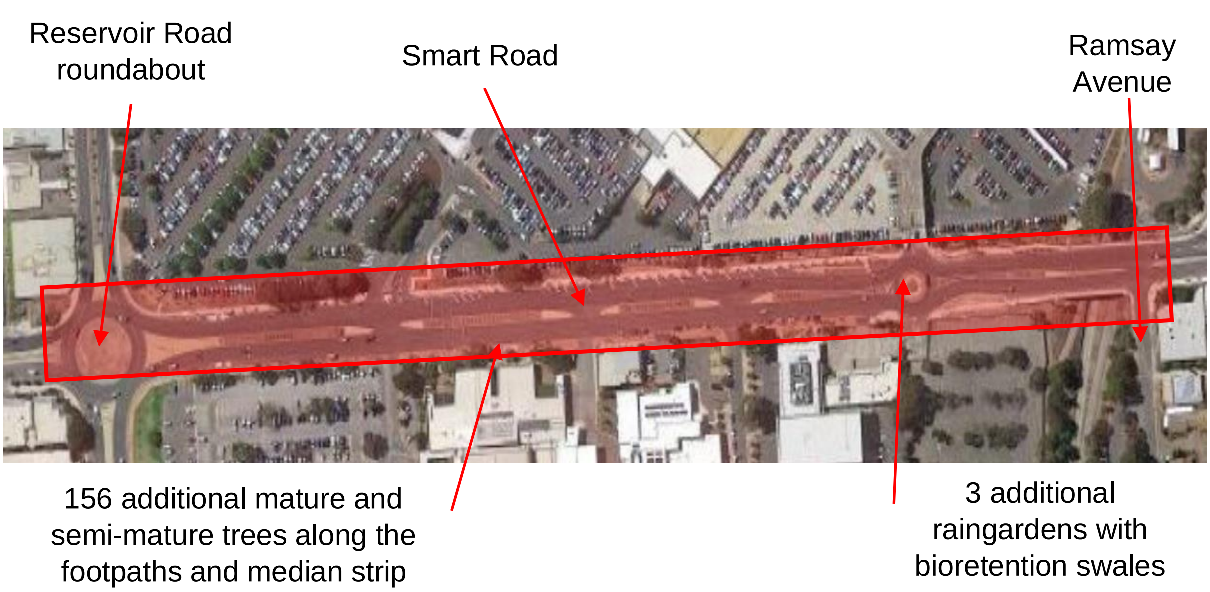

Figure 7 Smart Road Upgrade - highlighted is the area of works

The analyses at this site included two different benefit analysis tools:

- The Excel-based Monetised Benefits Tool developed by the Department for Environment and Water (DEW).
- CRC Water Sensitive Cities INFFEWS (Investment Framework for Economics of Water Sensitive Cities) cost-benefit analysis tool

The main difference between the two tools is that the INFFEWS tool analyses the costs as well as the project benefits, whereas the Excel-based tool monetises a select few benefits and does not allow the incorporation of project costs or further benefits.

It is important to note that using different tools means that the results will need to be interpreted differently. The INFFEWS tool results include a Net Present Value (NPV) and a Benefit-Cost Ratio (BCR). The Excel-based tool results in are based on a more limited range of potential benefits and with different underlying assumptions. . The Excel-based tool does not incorporate project costs and is solely a figure based on the benefits to the surrounding community.

Project costs

For the purpose of analysing the benefits of WSUD features, below are the total project costs as well as the total costs of WSUD features (the WSUD costs are included in the total project cost, they are not in addition to the project costs).

Total project cost: $1.5 M

Segregated WSUD component cost $210,000:

- Rain gardens and swales: $100,000
- Tree water inlets and tree plantings: $110,000

Another cost associated with the implementation of WSUD features is the additional maintenance/operations costs per year, which is $15,000 per annum.

Monetised Benefits Tool results

Using the Excel-based tool, the addition of WSUD features along the 700 m stretch of road resulted in $108,050 of expected benefits within the projects first 30 years, as shown in Table 7. The ‘neighbourhood character’ benefit category was not used in this project as a nursing home does not meet the criteria of the tool and is therefore not deemed eligible.

Table 7: Summary of WSUD and GI monetised benefits for the Smart Road Rain Gardens

	Value of quantified benefits	Proportion of total quantified benefit
Water quality	$7,340	7%
Runoff attenuation	$832	1%
Health - Medical Costs	$8,983	8%
Health - Physical Benefits	$90,895	84%
Neighbourhood Character*	$-	-
Sum of quantified benefits	**$108,050**	**100%**

*Although they have not been quantified during this analysis, these benefits may still be derived at this site (this benefit category was not able to be assessed as it did not meet the criteria of the tool).

The parameter with the highest expected benefit was Health – Physical Benefits at $90,895, or 84% of total quantified benefits. While this was by far the highest figure calculated by the tool, it could still be seen as relatively conservative, as it only takes into account the adult population (individuals aged 18 years and over).

The parameter with the lowest expected benefit was runoff attenuation, at $832, or 1% of total quantified benefits.

As this tool does not have the ability to incorporate project costs, it is difficult to comment on the sum of quantified benefits vs project costs relativity. However, it is interesting to note that analysing only four benefits resulted in a sum of quantified benefits of just over half of the projects WSUD components costs.

INFFEWS tool results

The Water Sensitive Cities INFFEWS (Investment Framework for Economics of Water Sensitive Cities) Tool was used for further assessment the Smart Road project. Using the INFFEWS tool, the WSUD features installed along the 700 m stretch of road resulted in:

- **Net Present Value (NPV): $737,259**
- **Benefit-cost ratio (BCR): 1.81**

These results indicate that investing in WSUD features has a positive return on investment. These results are indicative of the benefits received from implementing WSUD features over the projects first 30 years. The benefits used in the analysis were:

- Reduced recurring costs (e.g. energy for cooling)
- Increased work productivity (e.g. from less extreme heat)
- Improved aesthetics
- Improved opportunities for recreation

- Reduced mortality (e.g. from reduced extreme heat)
- Reduced morbidity, improved health (e.g. from reduced extreme heat)
- Reduced greenhouse gas emissions, increased CO_2 sequestration
- Groundwater recharge (e.g. for potable extraction or wetland enhancement
- Enhancing water quality in a water body
- Reduced flood risk
- Improved security of water supply – Reduced irrigation demand for plants in raingardens as they are supplemented by stormwater runoff.

Comparing the two tools

- Using the Excel-based tool, the addition of WSUD features resulted in $108,050 of expected benefits within the projects first 30 years.
- Using the INFFEWS tool, the addition of WSUD features resulted in a NPV of $737,259 and a BCR of 1.81.

There is such a vast difference in the results of each tool because they analyse different things and in somewhat different ways.

The Excel-based tool looked at 5 benefit parameters with no included costs (in this analysis, only 4 benefit parameters met the requirements of the tool), whereas the INFFEWS tool is a more holistic approach to monetising the benefits of WSUD feature implementation as it includes as many benefits as deemed necessary for the project as well as considering project costs.

It could be argued that because the entire streetscape upgrade cost $1.5 M, the benefits of the implemented WSUD features do not outweigh the costs. However, they outweigh the costs of the WSUD feature components. The total WSUD component costs were $210,000 and the INFFEWS tool states that it is a positive return on investment.

Furthermore, even though the Excel-based tool only resulted in a monetised benefit of $108,050 (approximately half of the WSUD component cost), it is important to note that this is only based on the 4 benefits of water quality, runoff attenuation, health – medical costs and health – physical benefits.

While both tools link some of the better-documented social, environmental and economic benefits of WSUD and GI features to easily understandable monetary benefits, they should not be used as the sole means of determining the relative merits of any given infrastructure project. Rather, they should be considered by state and local South Australian government bodies as a decision support aid through which the potential benefits of WSUD and GI features within any proposed, ongoing or completed infrastructure project can be modelled and then presented, all the while keeping the context of the project’s broader costs and benefits in mind.

Excel-based tool findings and limitations

- The DEW Excel-based tool is more suited to smaller projects as the tool requires easily accessible data and can support business cases. The use of this tool could be justified for smaller projects, where the time and expense of the more complex INFFEWS Tool could not be justified.
- The DEW Excel-based tool is extremely user-friendly as it only requires easily accessible data and is a relatively quick process, in comparison to the INFFEWS tool.
- The DEW Excel-based tool incorporates up to (only) 5 WSUD feature benefits and does not take into account project costs. It is simply a valuation of benefits, mostly to understand the potential direct benefits for the neighbouring community.
- If a benefit parameter does not meet the tool requirements, it cannot be used in the tool. The limitation of this is that it does not mean that the implementation of WSUD features do not have those benefits, it simply cannot be measured using this tool.

INFFEWS tool findings and limitations

- The INFFEWS Tool is a more complex, time consuming tool that requires training, access to all project costs (including ongoing maintenance) and an understanding of environmental benefits and economics.
- The INFFEWS Tool gives a more holistic view of a project as it takes into account a broader array of WSUD feature implementation benefits, and accommodates costs being included (documented) directly in the tool.
- The INFFEWS tool is user-friendly, once the user has been sufficiently trained.
- The INFFEWS tool has 20 benefits to choose from as well the ability to incorporate further benefits if they are not already an option in the tool.

5. Conclusion

While the Monetised Benefits tool links some of the better-documented social, environmental and economic benefits of WSUD and GI features to easily understandable dollar values, it should not be used as the sole means of determining the relative merits of any given infrastructure project. Rather, it should be considered by state and local South Australian government bodies as a useful decision support aid through which the potential benefits of WSUD and GI features within any proposed, ongoing or completed infrastructure project can be modelled and then presented, all the while keeping the context of the project's broader costs and benefits in mind.

Following are the total quantified benefits calculated by using the tool for each project:

- Gray Street upgrage: $98,283
- Bell Yett Reserve carpark: $57,949
- Felixstow Wetlands: $5,269,736
- Florence Street raingardens: $64,100
- Way Avenue tree inlets: $300,520.
- Smart Road rain gardens: $108,050

Overall, the most valuable benefit category across the projects investigated in this study was the Neighbourhood Character category, suggesting that the link between neighbourhood greening and property values within the Resilient East region merits further investigation.

The use of the Water Sensitive Cities INFFEWS (Investment Framework for Economics of Water Sensitive Cities) Tool indicated the Smart Road project has a Net Present Value of $737,259 and a Benefit-cost ratio (BCR) of 1.81. These results indicate that investing in the WSUD features on Smart Road has had a positive return on investment. These results also demonstrate that the Monetised Benefits tool does not capture all potential value of WSUD projects.

Appendix A: The tool’s strengths and factors to consider

Table 8 lists the tool’s key strengths, as well as key factors to be aware of while interpreting the results in each of the benefit areas. A key strength of the tool overall is that all default values and assumptions used are clearly documented and explained (Appendix B). Additionally, all default values can be modified by the tool’s users, thus facilitating sensitivity analyses.

It should also be recognised that:

- some potential benefit areas, such as urban cooling, increased social cohesion and improved mental health outcomes, are not represented in the tool, as research findings in these areas were deemed insufficiently robust to warrant monetisation
- the tool is intended to be used as a decision support aid, and never as the sole means of determining the relative merits of any given infrastructure project proposal.

Table 8 Key strengths and factors to consider for each of the tool's benefit areas.

Water quality	
Strengths	• Default values for pollutant concentrations are based on median values from the widely used Australian runoff quality guidelines.
Factors to consider	• The default dollar value for one tonne of total suspended solids (TSS) removal is based on a single research project. It also assumes there is a direct link between community willingness to pay for coastal water quality improvement and TSS removal rates sought by the Adelaide Coastal Waters Quality Improvement Plan. • The default dollar value for a tonne of total nitrogen (TN) removed (used in the absence of relevant local evidence), may be perceived as subjective. That value is much lower than the equivalent value used in Melbourne.
Runoff attenuation	
Factors to consider	• The methodology is quite simplistic, since: – it assumes WSUD elements within a project may aim to manage up to the 1 in 100 year flow (consistent with the South Australian Government's WSUD policy's aim), although in many instances these elements may be implemented to manage higher frequency flows, such as 1 year Average Recurrence Interval – it does not have regard for the location of the project within a catchment, a factor which may impact on the likely magnitude of the runoff attenuation benefit – in situations where, in the absence of WSUD features, new drainage infrastructure would be required downstream to cater for increased runoff flows, it may significantly underestimate the features' cost savings potential. • Due to the above factors, while this component of the tool might be useful for early project planning, the methodology and assumptions would preferably be refined during the detailed planning and design stages.
Health – medical costs	
Factors to consider	• Some default values may be perceived as conservative. For example, the methodology provides for an assessment of medical cost savings only for the resident adult population, excluding young people under 18 years of age. • Although considerable evidence exists which links the presence of GI features to rates of obesity/overweight, it is not possible to pinpoint the relative contribution of those features from the contributions of other potential influencers, such as other aesthetic features, street connectivity, presence of walking destinations and the presence of safety features.
Health – physical benefits	
Strengths	• The monetary value of a life year used is that suggested by the Australian Government's Office of Best Practice Regulation.
Factors to consider	• The methodology and default values may be perceived as conservative. For example, the methodology only provides for an assessment of the adult population. • The factors to consider when interpreting the results for the Health – medical costs area are equally relevant for this area.
Neighbourhood character	
Strengths	• The research evidence generally shows a high level of consistency in relation to the influence of GI features on property pricing, which the tool uses as a surrogate for valuing neighbourhood character benefits.
Factors to consider	• The default value for the distance over which WSUD and GI features influence property values may be conservative.

Appendix B: Basis of default parameters used in the WSUD/GI monetised benefits tool

The parameters discussed below refer to those specified in the relevant spreadsheet/s in the MS Excel WSUD/GI Monetised Benefits Tool.

WATER QUALITY

This component is largely restricted to consideration of reduced discharges of TSS and TN on the health of near shore assets (such as sea grasses and reefs).

TSS_{road} TSS_{roof} and TSS_{cp} (respectively: 250, 35 and 180 mg/L)

These concentration default values are based on mean values in runoff for 'urban roads', 'all roofs', and 'other urban' surfaces in Figure 3.2, Chapter 3 of *Australian Runoff Quality A guide to Water Sensitive Urban Design* (Engineers Australia 2003). The values in Figure 3.2 are based on monitoring/research of TSS concentrations in various types of runoff.

TN_{road} TN_{roof} and TN_{cp} (2.5 mg/L in each case)

These concentration default values are based on mean values in runoff for 'all urban' Figure 3.4, Chapter 3 of *Australian Runoff Quality A guide to Water Sensitive Urban Design* (Engineers Australia 2003). The values in Figure 3.4 are based on various monitoring/research of TN concentrations in various types of runoff and indicate TM mean values for various urban surfaces (e.g. residential, roads, industrial, commercial) are comparatively similar.

V_{TSS} ($25,000 in $2016)

a) These $ valuation are partly based on a choice experiment survey undertaken in late Dec 2014 to late Jan 2015 (source: MacDonald D.H., Ardeshiri, A., Rose, J. M., Russell, B. D., Connell, S. D., "*Valuing coastal water quality: Adelaide, South Australia metropolitan area"*, Marine Policy 52 (2015), p.120).

b) The choice experiment was undertaken by 505 people (excluding some involved in a pilot survey before the full choice experiment).

c) The research inferred that a willingness to pay by Adelaide households of $67.1M comprised of:

- Improved water clarity (reducing turbid days from 50 to 25) valued at $12.4 million
- Improvement in seagrass (10% increase) valued at $18.9 million
- Restored five additional reefs to good health valued at $35.8 million

d) The Adelaide Coastal Water Quality Improvement Plan (ACWQIP) sets a target to reduce suspended solids from 6,180 tonnes/year (2008 levels) to 3,430 tonnes/year, a reduction of 2,750 tonnes/year

e) Assuming the suspended solids target reduction in the ACWQIP will achieve the environmental outcomes MacDonald et al estimated, it is possible to calculate the benefits of implementing WSUD measures that will reduce the level of suspended solids in run-off resulting from infrastructure and development project (i.e. the sum of the above $ values divided by the required reduction of TSS)

f) Sum of above benefits is ~$24,400 per tonne TSS reduction ($67.1M/2750 tonnes)

g) Assume willingness to pay in $2016 would be marginally greater at $25,000 (noting that an assumption of an increase in willingness to pay based on the CPI would yield a marginally higher value that this in $2016).

V_{TN} ($1,000,000 in $2016)

a) Adelaide Coastal Water Quality Improvement Plan (ACWQIP) indicates a target 50 tonnes per year of nitrogen discharge to Adelaide's coastal waters by 2028 from stormwater inputs (ACQWIP, Table 12). ACWQIP indicates nitrogen discharged in stormwater in 2003 was 375 tonnes.

b) There is currently no market or other basis to value nitrogen load reductions in Adelaide or elsewhere in SA. However there is clearly an implicit value in reducing nitrogen as evidenced by environmental improvement projects, largely focussing on reducing nitrogen, in respect of wastewater treatment plants owned by SA Water.

c) It is noted that a stormwater water quality offset scheme for nitrogen was introduced in Melbourne more than 10 years ago, with the current value being $6,645 per kg of annual nitrogen load ($6.645 million per tonne). (In Melbourne, new residential subdivisions are required to meet on-site nitrogen reduction through on-site water quality measures or, in lieu of on-site measures, to pay the offset based on deemed load of nitrogen discharge from the property). Melbourne Water is required to justify the basis of the charge to its economic regulator, with the economic regulator making a ruling decision.

d) In the absence of a specific value having been determined in Adelaide or elsewhere in South Australia, it is assumed that a value of $1 million per tonne reduction is reasonable for Adelaide's coastal waters, given the ACWQIP's expectation for a significant reduction in nitrogen discharged from stormwater. This is conservative compared with the offset value adopted in Melbourne which is based on costs for TN mitigation measures.

RUNOFF ATTENUATION

It is assumed that a potential runoff management benefit is derivable as a result of runoff being directed through WSUD features that can help to mitigate average annual flood damage cost within the catchment in which the project is located[2]. The calculation is based on the estimated average annual flood damage cost (AAD) across the catchment multiplied by proportion of runoff generated by the project compared to the runoff generated across the catchment area that was used to determine AAD.

Although the methodology has some limitations, it should be quite simple to apply and reflects the WSUD policy, and requirements for many developments, for managing stormwater within certain bounds (e.g. no increase in flood risk for 100 year ARI event).

AF (in the absence of any site-determined value: 0.8 for road work projects and 0.6 for other built projects)

These default values are based on runoff coefficients that are typical of these types of surfaces. For example, Melbourne Water suggest values be used that are in the range 0.5 to 0.9 for major road reserves, and 0.7 to 0.9 for commercial/industrial areas (i.e. sites with a high proportion of coverage by roofs and other paved surfaces). Generally, roads, roofs and carparks with connected drainage in built up urban areas are likely to have a high proportion of rainfall-runoff discharge.

S_c (default average annual runoff values for Adelaide catchments)

The default values are those determined by Wilkinson, J. (2005). "*Reconstruction of historical stormwater flows in the Adelaide metropolitan area*." ACWS Technical Report No. 10 prepared for the Adelaide Coastal Waters Study Steering Committee, September 2005. Department of Environmental Health, Flinders University of SA. (The values are taken from Table 1 of that report.)

[2] This assumption is based in part on the fact that the State-wide WSUD policy includes principles and targets for managing runoff flows for flood management purposes. The targets provide that the capacity of the existing drainage system should not be exceeded, and that there is no increase in the 5 year ARI peak flow and no increase in flood risk for the 100 year ARI peak flow compared to existing conditions.

HEALTH – MEDICAL COSTS

Evidence of association between physical activity and obesity with green infrastructure

Numerous investigations have found associations between proximity to accessible green space with the likelihood of residents undertaking some physical exercise such as walking, with some (but not all) also identifying a linkage between obesity levels and green space.

For example, Ellaway A., Macintyre S., Bonnefoy X. (2005) "*Graffiti, greenery, and obesity in adults: secondary analysis of European cross sectional survey*" (British Medical Journal Vol. 331, 17 Sep 2005, p661-662) determined from a survey of 6,919 people that in residential areas with high levels of greenery the likelihood of residents being more physically active was more than three times higher and the chance of being overweight and obese was 37% lower than for similar areas with low greenery. The study used a measure of greenspace that included the level of vegetation and greenery visible on houses and the streets immediately surrounding it.

In Australia, Pereira G., Christian H., Foster S., Boruff B., Bull F., Knuiman M., and Giles-Corti B. (2013) "*The association between neighbourhood greenness and weight status: an observational study in Perth Western Australia*" in Environmental Health 2013, 12:49 discuss a cross-sectional study of 10,208 Perth residents of various ages between 16 and 64+ who completed the Western Australian Health and Wellbeing Survey between 2004 and 2009. The paper concludes: "Greater levels of neighbourhood greenness and variability in neighbourhood greenness are associated with lower odds of obesity among adults." The study found that the odds were 22% lower of being obese and 16% lower of being overweight-or-obese, among people in high vs low greenness neighbourhoods. The research found the associations held across all the studied age groups. The authors state, "The lower prevalence of obesity among adults in greener areas might be attributable to higher levels of physical activity, such as neighbourhood walking, with studies indicating that adults with access to a large high-quality park within walking distance (also 1600 m) from home are more likely to walk, and tend to do so at recommended levels. Parks and tree-lined streets are typically representative of green vegetation that might promote physical activity in the neighbourhood, as neighbourhood attractiveness is consistently associated with increased recreational walking… Overall, there was a 25% lower odds of obesity (and overweight-or-obesity) for those in neighbourhoods with high variability in greenness... A high degree of variability in neighbourhood greenness suggests mixed land use, that might, for example, be indicative of neighbourhoods that have both a large presence of built destinations and well connected tree-lined routes to these destinations."

Astell-Burt T., Feng X., and Kolt G.S. (2014), Br J Sports Med. 2014 Mar;48(5):404-6, also found, based on findings for more than 200,000 Australians in the 45 and Up Study, that (45 years of age and older) residents of greener areas were significantly more likely to walk and participate in moderate to vigorous physical activity (MVPA) at least once a week compared with residents in less green areas.

In the South Australian context, Sugiyama T., Giles-Corti B., Summers J., Du Toit L., Leslie, E., and Owen N. (2013) "*Initiating and maintaining recreational walking: A longitudinal study on the influence of neighbourhood green space*" in Preventive Medicine, 57, 178-182 found the presence of and proximity to neighbourhood green spaces helps maintain recreational walking over time. It also found aesthetics involving the presence of trees and attractive/interesting views and objects to be associated with the likelihood of walking (44% greater likelihood of occasional walking vs non-walking, and 13% greater likelihood of frequent walking vs non-walking, for areas with 'better' aesthetics and nearby public open space[3]).

[3] Public open space "*within 10–15 minute walk, within 5 minute drive, or on a frequently travelled route*"

The authors also reported, "positive perceptions of the presence of and proximity to green spaces and the total and largest areas of green spaces were significantly associated with a higher likelihood of walking maintenance over four years."[4]

A literature review of existent research investigating the influencers of neighbourhood walkability was undertaken by Talen E. and Koschinsky K. (2013). "*The Walkable Neighbourhood: A Literature Review*" Int. Journal of Sustainable Land Use and Urban Planning. Vol. 1. No. 1 pp. 42-63. The paper references more than 160 published articles. Their conclusion states, "The testing of assumptions has mostly supported the claims made by walkable neighbourhood proponents. Walkable neighbourhoods have been shown to increase walking, physical activity and health, increase property value and the value of place more generally, and there seems to be some association with social goals like interaction… " It also states: "Conventional wisdom has now coalesced around the notion that neighbourhood context effects exercise, even independent of an individual's background... In a typical example, one study found that "household heads of single-family dwellings" in a new urbanist neighbourhood had lower BMI (body mass index) due, in part, to "utilitarian trips made by walking or bicycling". Another study compared a walkable neighbourhood with a conventional suburb to find higher physical activity in the former."

More recently, Richardson E. (2016) "*Greenness/green spaces & health effects: The state of the art (i.e., what do we know?)*" and the World Health Organisation (2016) "*Urban green spaces and health - a review of evidence*" (WHO Regional Office Europe) reviewed current evidence. Richardson (powerpoint presentation) concludes that the evidence indicates a greater likelihood of a person meeting the recommended level of physical activity in greener versus less green areas. Richardson states, "greener places are often healthier places", with a caveat that the relationship varies by individual characteristics and context. WHO also cites studies in various countries, including Australia, that found recreational walking, increased physical activity and reduced sedentary time to be associated with access to, and use of, green spaces in working age adults, children and senior citizens. WHO concludes, "The evidence shows that urban green space has health benefits, particularly for economically deprived communities, children, pregnant women and senior citizens".

The WHO report cites studies in various countries that have demonstrated that recreational walking, increased physical activity and reduced sedentary time to be associated with access to, and use of, green spaces in working age adults, children and senior citizens, which include the following (full references provided in the WHO document): Wendel-Vos et al., 2004; Epstein et al., 2006; Kaczynski & Henderson, 2007; Kaczynski et al., 2008; Sugiyama & Ward Thompson, 2008; Sugiyama et al., 2009; Cochrane et al., 2009; Astell-Burt et al., 2013; Schipperijn et al., 2013; Sugiyama et al., 2014; Gardsjord et al., 2014; James et al., 2015; Lachowycz and Jones, 2014). The latter of these, Lachowycz K. and Jones A.P. (2014) "*Greenspace and obesity: a systematic review of the evidence*" Obesity Reviews, International Association for the Study of Obesity 12 e183-e189, reported that, "Overall, the majority of studies [those reviewed by the authors] found some evidence of a relationship with BMI[5], or report mixed results across subgroups and according to the greenspace measure used."

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[4] Interestingly, the authors also state, "*… in areas with pedestrian-friendly streets or trails, access to POS [public open space] may not matter. It was originally considered that POS and local pedestrian environments have "additive" or "cumulative" effects. But, in the case of walking infrastructure and walking trails, the relationship may be complementary. A study in Colombia reported similar findings, where participants with less parks in their local area tend to use Ciclovia [a local cycle and pedestrian path] more often than participants with greater park availability*".

[5] Body mass index

A very recent report which summarises findings from various research investigating the potential association between quality open space and health, is work by Davern, M., Farrar, A., Kendal, D., and Billie Giles-Corti, B. (2017) "*Quality Green Space Supporting Health, Wellbeing and Biodiversity: A Literature Review*" produced as a joint initiative of the National Heart Foundation of Australia (SA Division), South Australian Government (Department for Health and Ageing, Department of Environment, Water and Natural Resources, and Office for Recreation and Sport), and South Australian Local Government Association. Among the report's findings is that, "Provision of POS[6] has health benefits including obesity reduction, lowered blood pressure, extended life span and provides important places to engage in physical activity while evidence is inconclusive if proximity to POS initiates or maintains physical activity.

While not all research has found evidence linking physical activity and obesity rates to green space, and it is also somewhat uncertain if there may exist causal links (e.g. people more inclined to be active decide to live in greener areas[7]), it can be inferred that attractive green space is more conducive to supporting physical activity, through providing an environment that facilitates commencement or additional physical activity and/or facilitating those already physically active to remain active. An alternative expression of this inference would be that lack of green space, of an appropriate quality, is likely to be a discouragement to some people becoming physically active or maintaining physical activity – resulting in a dis-benefit.

HEALTH - PHYSICAL BENEFITS

Stringhini S. et al (2017) "*Socioeconomic status and the 25 × 25 risk factors as determinants of premature mortality: a multicohort study and meta-analysis of 1·7 million men and women*" The Lancet Vol 389, Issue 10075, 25-31 March 2017, pp1229-1237 undertook a multi-cohort study and meta analysis utilising data from 48 cohort studies from seven high-income World Health Organisation countries (including Australia). Their analysis indicated a 2.4 year reduction in life expectancy for 40-85 year olds due to physical inactivity, and 0.7 years for obesity. (The study also reported reduced life expectancy for 40-85 year olds for some other factors including: diabetes (3.9 years), low socio-economic status (2.1 years) diabetes (3.9 years) and hypertension (1.6 years)).

Moore, S.C., Patel A.V., Matthews C.E., de Gonzalez A.B., Par, Y., Katki H.A., Linet, M.S., Weiderpass, E., Visvanathan, K., Helzlsouer, K.J., Thun, M., Gapstur, S.M., Hartge, P., Lee, I. (2012) *"Leisure Time Physical Activity of Moderate to Vigorous Intensity and Mortality: A Large Pooled Cohort Analysis"* PLOS Medicine, Vol. 9, Issue 11, e1001335 (Nov 2012) examined the association of leisure time physical activity with mortality during follow-up in pooled data from six prospective cohort studies in the (US) National Cancer Institute Cohort Consortium, comprising 654,827 individuals between 21–90 years of age. The authors determined that, relative to no leisure time activity, a physical activity level equivalent to brisk walking for up to 75 minutes per week was associated with a gain of 1.8 (95% CI: 1.6–2.0) years in life expectancy, and a physical activity equivalent to 7.5 hours or more of brisk walking per week was associated with 4.5 (95% CI: 4.3–4.7) years gain in life expectancy. Also, being both active (7.5 or more hours per week)

[6] Public open space

[7] Albeit one research found an opposite effect, that is, evidence that residential selection bias under states the relationship between neighbourhood walkability features and body mass index. Zick, D. Hanson, H. Fan, J. X, Smith, K. R., Kowaleski-Jones, L., Brown, B. and Yamada, I. (2013) *"Re-visiting the relationship between neighbourhood environment and BMI: an instrumental variables approach to correcting for residential selection bias"* Int. Journal of Behavioral Nutrition and Physical Activity 2013, 10:27

and normal weight (body mass index 18.5–24.9) was associated with a gain of 7.2 (95% CI: 6.5–7.9) years of life compared to being inactive and obese (body mass index 35 or higher).

Evidence linking lower rates of greening with premature death

Some research directly links green space and mortality, which may include (but not limited to) the consequence of physical activity opportunities provided by green space in lowering mortality risk.

These include Lachowycz and Jones (previously cited) who refer to three studies that identified lower prevalence of heart disease, diabetes and premature mortality from circulatory diseases in greener areas.

Gascon, M., Triguero-Mas, M., Martinez, D., Dadvand, P., Rojas-Rueda, D., Plasencia, A. andNieuwenhuijsen, M.J. (2016) *"Residential green spaces and mortality: a systematic review"* Environment International, 86, 60-67 in a systematic review of evidence for a possible association between green space presence and mortality rates, reviewed evidence from twelve studies conducted in North America, Europe and Oceania with study populations that ranged between 1645 to 43 million individuals. These particular studies were considered by the authors to be heterogeneous in respect of key factors including design, green space assessment and covariate data. The authors concluded from their meta-analysis that the evidence supports the hypothesis that living in areas with higher amounts of green spaces reduces mortality, mainly cardiovascular disease.

James P., Hart, J.E., Banay, R. F. and Laden, F. (2016). *"Exposure to Greenness and Mortality in a Nationwide Prospective Cohort Study of Women"* Environmental Health Perspectives volume 124 number 9, September 2016 examined the prospective association between residential greenness and mortality. Based on a U.S.-based Nurses' Health Study prospective cohort of 108,630 women and observed 8,604 deaths between 2000 and 2008, they concluded after accounting for age, race/ethnicity, smoking, individual and area-level socioeconomic status, that women living in the highest quintile of cumulative average greenness (Normalized Difference Vegetation Index, NDVI, of 0.62) in a 250 metre area around their home had a 12% lower rate of all-cause nonaccidental mortality than those living in the lowest quintile (NDVI of 0.29). Their findings suggest that the association between greenness and mortality may be at least partly mediated by physical activity opportunity (as well as to other factors such as particulate matter < 2.5 μm, social engagement, and depression).

Default values for health

$\mathbf{P}_{200}$ (residential population aged 18 y.o. within 200 metres of green infrastructure)

Various literature suggests that a measure of a convenient walking distance to a destination as about 5 minutes. Assuming an average walking speed of about 4.8 km per hour (typically stated as 3 miles per hour) suggests people may be prepared to walk 400 metres. Some studies suggest that walking preparedness will depend on the purpose of a trip and attributes of the destination, and that convenient walking distance may be up 1,600 metres (1 mile) assuming a preparedness to walk for about 20 minutes each way to/from a destination.

The popular Walk Score methodology, which relates a neighbourhood's walking score out of one hundred based on distance to local amenities, assigns maximum points to amenities that are within 5 minutes walk (400 metres) of a location, and assigns a decay function to amenities located further away, with no pints for destinations beyond 30 minutes walking time.

For the purpose of designating a distance where a potential health benefit may arise, it is assumed that the main effect of greenness infrastructure would be experienced close to the locality of the green infrastructure. Given that there may be other green infrastructure within the vicinity of a public work project (for example, local streets with green infrastructure and local parks) it is assumed that there will be a limited additional potential for new green infrastructure, that associated with the public work, leading to an increased level of physical exercise or any associated reduction in obesity or overweight. For the purpose of this tool it is assumed that only adults within 2½ minutes walking distance (equating to 200 metres) of new green infrastructure established by a public work project will experience potential capacity to benefit.

This may be conservative for some public works projects such as those which incorporate significant amounts of and/or high quality green infrastructure, particularly if they are designed to provide a high local aesthetic outcome or act as local hubs (such as public transport facility).

PA_o (% reduction in the rate of obesity and overweight residential adult population anticipated as an outcome of implementing WSUD-related green infrastructure)

As per above, there is an existing body of literature indicating a likely association between proximity to greenness and obesity. Although research typically finds relationships hold across both the adult and child population, in relation to monetising reduced medical costs, documented Australian evidence has been identified for the adult population only. Consequently, PA_o only considers the adult population rather than the entire population.

Shay E, Spoon S, Khattak A, "*Walkable Environments and Walking Activity*" Carolina Transportation Program, University of North Carolina at Chapel Hill (2003), reviewed the then existent literature on neighbourhood walkability and concluded walkability (n.b. not obesity per se) to be related to a number of variables that included aesthetic factors including street trees and local parks, but also other factors such as density, presence or absence of pedestrian facilities, other aesthetic variables such as attractive architecture, and access to transit. Although it is not possible to access the likely contribution of each of these and other variables on the likelihood of walking activity, the report deemed that the evidence was that aesthetics including street trees and presence of parks and open space act as encouragement factors for walking.

In the absence of strong data, it is assumed that proximity to additional green infrastructure (within the distance defined by P_{200}) may facilitate a 1 per cent reduction in the likelihood of obese and overweight adult residents within that proximity who are already overweight or obese[8].

P_{ob} and **P_{ow}** (respectively, the per cent of residential adult population within the area used to derive the value of P_{200} which is obese (body mass index, BMI of 30.00 or more) or overweight (BMI of 25.00 to less than 30.00)).

In the absence of local evidence, or a value from a more recent relevant survey if available, a default value of 30.0 may be used for obese, and 35.6 for overweight (these are the values indicated in the *National Health Survey: First Results 2014-15 – South Australia*[9]).

HC_{ob} and **HC_{ow}** (respectively, the estimated cost savings relating to being of normal weight compared to being either obese or overweight).

Colagiuri S., Lee C, Colagiuri R., Magliano D., Shaw J., Zimmet P., and Caterson I. "*The cost of overweight and obesity in Australia*" in The Medical Journal of Australia (2010; 192 (5): 260-264) analysed 5-year follow up data from the Australian Diabetes, Obesity and Lifestyle study, collected in 2004–2005. Data were available for 6,140 participants aged at least 25 years at

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[8] This should not be taken to imply that the presence of additional green infrastructure is necessarily solely responsible for facilitating a 1% reduction in overweight and obesity, but that it could also act in conjunction with other change initiatives for promoting and maintaining a healthy weight.

[9] See Table 8.3, within Table 23 of: http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/4364.0.55.0012014-15?OpenDocument Obese is taken to indicate a Body Mass Index of 30.00 or higher

baseline. The authors measured: direct health care costs (included: ambulatory services, hospitalisation, prescription medication and, some medically related consumables); direct non-health care costs (included transport to hospitals, supported accommodation, home service and day centres, and purchase of special food); and, government subsidies (included payments for the aged pension, disability pension, veteran pension, mobility allowance, sickness allowance and unemployment benefit) associated with normal, overweight and obesity, defined by both body mass index (BMI) and waist circumference. $ values were determined from 2004-05 cost data.

The authors found that the annual total direct cost per person was $1,710 (95% CI $1,464-$1,956) per person of normal weight, $2,110 (95% CI $1,877-$2,334) for overweight and $2,540 (95% CI $2,275-$2,805) for obese – i.e. direct cost increases per person of $400 for overweight and $830 for obese.

In addition, annual Government subsidies were determined as $2,948 (95% CI $2,696–$3,199) for people of normal weight to $3,737 (95% CI $3,496–$3,978) for overweight and $4,153 (95% CI $3,840–$4,466) for obese. This suggests annual government subsidies in the range $789 for overweight and $1,205 for obese, compared to normal weight (or, by conservative consideration of the 95% CI, a very high likelihood of Government subsidies being at least $297 more for overweight and at least $641 more for overweight, than for persons of normal weight[10].

Conservatively, excluding any potential benefit to Governments that may arise from reduced Government subsidies, the additional annual cost per person may be considered, from the above, as $400 for overweight and $830 for obese in 2004-2005 (assume $ June 2005).

Health related costs have increased at a disproportionately higher rate over a number of years compared to weighted CPI increases. Assuming that the Adelaide Health CPI is more representative of cost increases (rather than the weighted CPI) the relevant values may be costs for overweight and obese may be calculated from *ABS data 6401.0 - Consumer Price Index, Australia*[11]*.* The June 2005 Adelaide Health CPI value is 76.7. If a greening project is undertaken in 2015-16, use of the June 2016 Adelaide Health CPI value of 126.5 infers an annual cost of $1,370 for obese and $660 for overweight, above the annual cost for being normal weight. For projects undertaken in other financial years, these values should be adjusted according to the appropriate Health CPI. (For areas outside of Adelaide, unless known locally the Adelaide Health CPI may be assumed as an approximation.)

Although the analysis is reliant on limited cost data, it should be noted that the calculation does not reflect all potential costs associated with obesity or overweight. In addition to the absence of allowance for higher Government subsidies for obese and overweight, it does not reflect associated cost impacts, such as productivity losses, which various research suggests may be a significant cost factor. There is also research suggesting that the various additional costs associated with obesity might be significantly greater than the direct health-related cost[12]. Also, as discussed above, the calculation is limited to consideration of adult-related costs and does not reflect health costs associated with children. Consequently, the described approach may

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[10] $297 calculated as the 95% CI *lower limit* of $3,496 for overweight less the 95% *upper limit* of $3,199 for normal weight; $641 calculated as the 95% CI *lower limit* of $3,840 for obese less the 95% *upper limit* of $3,199 for normal weight.

[11] Data may be downloaded from the ABS. Table 9 - CPI: Group, Sub-group and Expenditure Class, Index Numbers by Capital City, includes Health CPI data for Adelaide (under: series ID A2231086L)

[12] For example, Medibank research (2010) "Obesity in Australia: financial impacts and cost benefits of intervention" reports that KPMG Econtech toolling provided an estimate of the potential cost of obesity to Australia as $37.7 billion for 2008-09 of which it estimated the direct cost as $1.3 billion, against indirect costs (absenteeism and lower productivity) of $6.4 billion, and burden of disease costs of $30 billion.

represent a relatively conservative assessment of potential health-associated benefits that might be encouraged or facilitated by local greening.

$\mathbf{NPV_o}$ (calculated net present value of reduced obesity and overweight)

The NPV calculation should be undertaken using an appropriate discount rate[13]. The methodology provides for consideration of a timeframe for realising the full effect of the benefit. For example, green infrastructure anticipated to give rise to the benefit may take a number of years to mature to a state where the benefit (capacity to facilitate a potential reduction in rate of obesity and overweight) is fully realised. No research has been identified that provides information on the likely timeframe, the methodology default assumes (general default position) that the benefit will be zero at the time of project completion (i.e. negligible impact from new 'green infrastructure') and will increase linearly each year thereafter until full realisation of the benefit ten years after the expected project completion (relatively mature 'green infrastructure').

For projects with long time frames that may be several decades or more, consideration should be given to the anticipated staging to estimate the NPV_o from each stage.

$\mathbf{PA_{pa}}$ (per cent increase in physical activity facilitation anticipated as an outcome of implementing WSUD-related green infrastructure)

As discussed above, research literature generally supports the premise of a relationship between physical activity and local green infrastructure. Although it is not possible to isolate the contribution of green infrastructure (acting alone) from other variables that may influence walking activity, information discussed previously suggests that aesthetics (which include but are not limited to the presence of street trees, parks and other green infrastructure) acts as an encouragement factor for physical exercise.

In the absence of data specific to green infrastructure acting in isolation of other factors, it is assumed that proximity to additional green infrastructure (within the distance defined by P_{200}) may encourage physical activity equivalent to that of 1 per cent of adult residents who are not currently physically active or who are insufficiently physically active becoming sufficiently physically active. It is not necessary that green infrastructure itself is solely responsible but may work with other initiatives that aim to encourage the community to become more physically active (e.g. health promotion/education, other urban improvement, etc).

While various research associates higher levels of physical activity to greater levels of green space (e.g. comparing physical activity rates in areas with the lowest vs highest quintile of green cover), research is not definitive about what amount of green infrastructure is required to encourage increased physical activity. In the absence of appropriate evidence it is premised that in order to facilitate the 1 per cent increase in physical activity, at least 5 per cent green infrastructure cover that is must accessible by the public, must be planned/provided for in the project site. The per cent of green infrastructure should presume fully mature cover (e.g. for trees, canopy cover when fully mature).

$\mathbf{P_{ac}}$ (per cent of the residential adult population (persons aged 18 years and over) within the area used to derive the value of P_{200} which is already sufficiently physically active.)

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[13] For SA state projects, guidance on discount rate determination is provided in the Department of Treasury and Finance publication *"Guidelines for the evaluation of public sector initiatives Part B: Investment Evaluation Process."* pp. 20-22. (Based on the methodology recommended in the guidelines the nominal discount rate is calculated to be 4.38% and the real discount rate is calculated to be 1.83% on 28/4/17. The guidelines recommend valuing benefits using the real discount rate).

In the absence of local data, a default value of 42.2 may be used based on the *National Health Survey: First Results 2014-15 – South Australia* (per cent of South Australian adults who are sufficiently active[14]), or a value from a more recent relevant survey.

VLSY (value of a statistical life year)

In the absence of other information, a default value of $187,000 ($2016) may be used. This is based on the *Best Practice Regulation Guidance Note: Value of statistical life* (Department of the Prime Minister and Cabinet, Office for Best Practice Regulation, Dec 2014) recommended value of $182,000 ($2014).

NPV_{pa} (calculated net present value of increased physical activity potential)

The NPV calculation should be undertaken using an appropriate discount rate[15]. Account must also be taken of the likely timeframe for realising the full effect of the benefit. In the absence of local data, the default position is to assume a life year saved benefit is accrued in each of years 21 and 22 following the completion of the project (i.e. 2 years increased life expectancy benefit accrues after 20 years of establishment of the green infrastructure).

However, for projects with long time frames that may be several decades or more (such as large staged projects) consideration should be given to the anticipated staging to estimate the NPV_{pa} from each stage.

NEIGHBOURHOOD CHARACTER

There is a considerable amount of research evidence that associates proximity to green infrastructure/WSUD with property values, including various hedonic research that isolates out other possible causes of differential property values between more/less green areas. Although property value is useful for estimating the benefit in $ value, it is the not the benefit *per se* but reflects a 'willingness to pay' to live in green neighbourhoods.

Many hedonic research studies have determined an association between proximity of green infrastructure / water sensitive design features and property values[16]. The following table summarises findings from a number of investigations using hedonic methodology.

	Identified benefit equivalent ($)	**Notes**
Trees		
Donovan, G. H. and D. Butry (2010). "*Trees in the city: Valuing street trees in Portland, Oregon.*" Landscape and Urban Planning 94: 77-83	US$7,130 average for each household fronted by the street tree. US$8,870 average for each household (including both fronting street trees and effect of nearby street trees up to 30.5 metres from the centre of the property boundary - equating to 3% for homes within a distance of 100 feet (30.5 metres)).	Portland, USA; sample size 2,608 homes. Average 0.558 street trees per home, with the average canopy being 29 m^2. In most cases street trees were between the road and footpath however the study also included trees in road centre medians.

[14] See Table 13.3, within Table 23 of: http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/4364.0.55.0012014-15?OpenDocument. Sufficiently active is considered 150 minutes of physical activity per week from five or more sessions including walking for fitness/transport, moderate and/or vigorous physical activity.

[15] See previous note for NPV_o

[16] Hedonic price toolling (econometric analysis of property price determinants) is generally recognised as useful for quantifying externality benefits.

	US$19,958 benefit per additional one tree being the combined effect (home fronting the street tree plus effect on other homes within 30.5 metres of the tree).	30.5 metres was the distance used by researchers to observe an effect, but does not indicate that benefit may extend beyond that distance (although no observation/analysis was undertaken).
Donovan, G. H., & Butry, D.T. (2011). *"The effect of urban trees on the rental price of single-family homes in Portland, Oregon".* Urban Forestry and Urban Greening, 10(3), 163–168.	US$5.62 per week for renters of single family homes for an additional on-lot tree, and US$21.00 per week for renters of single family homes for an additional street tree fronting the house.	Portland, USA; sample size 985 homes. If it is assumed that the duration of benefit is 52 weeks per year (i.e. fully rented) the annual benefit of an additional street tree fronting a property is US$1092; assuming a 30 year evaluation period this equates to an NPV of US$10,300 (10% discount rate), US$13,550 (7% discount rate) and US$21,400 (3% discount rate).
Pandit, R, Polyakov, M. Tapsuwan, S., & Moran, T. (2013). "*The effect of street trees on property value in Perth, Western Australia*." Landscape and Urban Planning 110: 134–142	AUS$16,889 average for a median-valued household per adjacent broad-leafed street tree, equating to 4.27% marginal implicit price for a broad-leafed street tree.	Perth; sample size 2,149 homes. Average 0.558 street trees per home, with the average canopy being 29 m^2. In most cases street trees were between the road and footpath however the study also included trees in road centre medians.
Sander, H. Polasky, S. & Haight, R.G. (2010). "*The value of urban tree cover: A hedonic property price tool in Ramsey and Dakota Counties, Minnesota, USA.*" Ecological Economics 69 (2010) 1646–1656	US$1,371 average (0.477% of mean-valued home price) for a 10 percent increase in tree cover (from 14.55% to 24.55%) within 100 metres of a residential property. US$836 average (0.291% of mean home price) for a 10 percent increase in tree cover (from 14.55% to 25.44%) within 250 metres of a residential property. Tree cover beyond 250 metres did not contribute significantly. Toolling suggested benefit applies for tree covers of up to 40-60%, beyond which increased tree cover resulted in a negative benefit.	Minnesota; base sample size 9,992 single-family residential homes. Authors conclude that, "In sum, home owners value trees in their local neighbourhoods, at distances that roughly correspond to the length of a city block. This value may reflect a preference for tree-lined streets and the shading and aesthetic environment they offer. Home owners appear to place less value on tree cover beyond their immediate local neighbourhood and on tree cover over 40% in their immediate local neighbourhood."
Plant, L (2016). "*Making the case for planning and investment in green infrastructure - a case study of street trees and property value*	5.05% higher median sale price for houses with greater than 50% tree cover on the footpath within 100 metres (median house price $530,000) AU$17,490 (3.3 per cent) above median house sale price, for houses	Brisbane: base sample 2,299 houses sold in 52 residential Brisbane suburbs between 2008 and 2010.

impacts in Brisbane, Australia". PhD thesis, University of Queensland, School of Geography, Planning and Environmental Management	with nearby mature-aged street trees compared to houses near trees of other age groups.	
Raingardens		
Polyakov, M., Iftekhar, S., Zhang, F. and Fogarty, J. (2015). *"The amenity value of water sensitive urban infrastructures: A case study on rain gardens."* 59th Annual Conference of the Australian Agricultural & Resource Economics Society, Rotorua, NZ, 10-13 February 2015	Raingardens at street intersections: • 6% increase in median-value within 50 metres of a raingarden ($54,000) • 4% increase in median-value within 100 metres of a raingarden ($36,000) • aggregate for all single family homes within 100 metres of a raingarden of $1.5 million The authors indicate that compared to Pandit, R., Polyakov, M. Tapsuwan, S., T. Moran (2013) (see above) effect of a raingarden within 50 metres of a house was comparable to the benefit of an additional 1.5 trees on the street verge adjacent to the house; and a raingarden within 50 to 100 metres from a house was comparable to the effect of an additional one tree adjacent to the house.	Sydney; 4,437 single family homes within proximity of raingardens at street intersections (41 raingardens in Sydney constructed between 2008 and 2013). Hedonic tool utilising spatial and temporal fixed effects to control spatial heterogeneity, spatial autocorrelation, and general house price trend.
Large-scale urban green space		
Hatton MacDonald, Crossman, Mahmoudi, Taylor, Summers, & Boxall (2010). *"The value of public and private green spaces under water restrictions."* Landscape and Urban Planning 95 (2010) 192–200	Property price effect increase by $24 and $18 per metre closer to watercourse and golf course respectively "demonstrating their amenity value". Property price effect increase of $11 per metre more distant from a large reserve (in 'natural state' i.e. dry and brown in summer).	Adelaide ('leafy' eastern suburbs). Increased value of on-property greenness was identified up to 42% green cover, where after increased on-property greenness had a negative effect on property value. Concludes, "The present study provides a further argument for planners to incorporate small parks and playgrounds into urban developments. Households value these areas and they are willing to pay more to live in loser proximity… Open spaces such as large natural reserves in this dry Mediterranean climate are not necessarily considered to be substitutes for private green space.

Tapsuwan, Ingram, Burton, & Brennan, (2009). *"Capitalized amenity value of urban wetlands: a hedonic property price approach to urban wetlands in Perth, Western Australia"*. The Australian Journal of Agricultural and Resource Economics, 53, pp. 527–545	For a property 943 metres from nearest wetland (the average distance to the wetland in the study), reducing the wetland distance by 1 metre increases property price by AU$42.40. Existence of an additional wetland within 1.5 km of the property increases sale price by AU$6,976. (Mean property sale price $794,922, implying an av. property price increase for an additional wetland within 1.5 km of the property of 0.877% of property value for homes cited within that distance.)	Perth. Sample size 1,741 free-standing homes. Mix of wetland types from relatively natural to extensively modified or man-made. No significant relationship was found between wetland size and property price.
Drake-McLaughlin, N. & Netusil, N.R. (2011) "*Valuing Walkability and Vegetation in Portland, Oregon" Reed College, Department of Economics*."	Toolled that the influence of increased walkability [17] (additional services/facilities within proximal distance) is about $US10,000 more [18] in areas with 75 percentile green vegetation (tall and low trees, shrubs and grass) compared to areas with 50 percentile green vegetation. This equates to approximately 3.4% increased property price. Increasing tree coverage in the 400 metre buffer surrounding properties was predicted to always increase a property's sale price, while effects of trees at further distance (400 to 800 metres) showed a diminishing benefit effect.	Portland, USA. Based on 21,869 properties. Includes trees and other vegetation.
Rosalind H. Bark, Daniel E. Osgood, Bonnie G. Colby, and Eve B. Halper (2011). "*How Do Homebuyers Value Different Types of Green Space*?" Journal of Agricultural and Resource Economics 36(2):395–415	US$17,860 av. per property with highest (52%) green cover compared to av. (20%) green cover. (Equates to 8.35% on a median property price of $213,892). US$12,446 av. (5.81% on the median property price per property) adjacent ephemeral riparian corridors with highest greenness (26%) compared to av. (21%) greenness.	Tuscon. 6,676 single family homes.
Mahmoudi, P., MacDonald, D., Crossman, N. D., Summers D.M. and van der Hoek, J. (2013) "*Space matters: the importance of amenity*	Private benefit of proximity to golf courses, green space, sporting facilities, or coast, to be in the order $0.54, $1.58, and $4.99 per metre closer (when evaluated at the median respectively).	Adelaide.

[17] One standard deviation increase in Walk Score (refer paper). Table 6 of the paper suggests a predicted effect of a 75 percentile green cover vs 50 percentile (average) green cover is about a US$10,000 increase.
[18] Refer Table 6 of cited reference

in planning metropolitan growth" Aust. Journal of Agricultural and Resource Economics, 57, 38–59	Adelaide Parklands add $1.55 to a property's value for each additional metre closer.	
Polyakov, M., Fogarty, J., Zhang, F., Pandit, R., and Pannell, D. J. (2016) *"The value of restoring urban drains to living streams"* Water Resources and Economics, Vol.17, Jan 2017, 42–55	Increase in average property price of 4.7% for homes within 200 metres of urban drain restoration.	Perth. Findings are for restoration of a 320 metre section of Bannister Creek within the Swan River catchment, replacing an urbanised creek/drain by a more natural creek design incorporating meanders, riffles, gentle sloping banks, fringing sedges, and dense bank vegetation. Benefits may extend beyond 200 metres however that distance was chosen to define the boundary for evaluation in the study.

AECOM's report, "*Green infrastructure: a vital step to brilliant Australian cities*" (2017) also suggests, based on AECOM's analysis of the impact of tree canopies on property prices in the Sydney suburbs of Annandale, Blacktown, and Willoughby, that street trees have significantly increased property prices in some Sydney suburbs: "… we conservatively estimate that a 10 percent increase in the leaf canopy of street trees could increase the value of properties by an average of $50,000." The findings for the individual suburbs analysed were Annandale ($60,761), Blacktown ($55,000) and Willoughby ($33,152).

Various research (see above table) infers a potential benefit to home owners that could equate to a several percent increase of property prices in close proximity to green infrastructure/WSUD assets[19], where such infrastructure is within the following distances of presidential properties:

Type of green infrastructure/WSUD	Minimum distances from urban residential properties where a benefit was reported (based on above research)
Individual trees	metres to tens of metres
Street raingardens	within about 100 metres
'Re-naturalised' urban waterway	within about 200 metres
Increased neighbourhood-scale tree cover	within about 250 metres (diminishing effect reported in one study up to about 400-800 metres)

[19] e.g. Trees: 3% Donnovan & Butry (2010); 4.27% Pandit et al (2013); 0.291%-0.477% (for a 10% increase in tree cover) Sander et al (2010); WSUD technologies: 4% to 6% for raingardens located at street intersections Polyakov et al (2015); large-scale green space/green infrastructure: 0.877% for an additional wetland within 1.5 kilometres; 8.35% for property with 52% green cover compared to 20% green cover Rosalind et al (2011) (equates to about 2.6% for a 10% increase in green cover).

GB (measure of potential amenity benefit (assessed as an expected differential in residential property value for projects with compared to those without WSUD-green infrastructure elements) for each percentage point increase in WSUD-related green infrastructure provided by the project).

In the absence of a detailed economic assessment for the project by an economist or other appropriate person/s, assuming plan/s are available (e.g. concept plan/s, or more detailed concept or design plan/s or drawings) which indicate how green infrastructure/WSUD could, potentially, be integrated into the project, an assumed default is to estimate a potential benefit (capitalised value) to local residents as 0.4% of the net residential property value (within 20 metres of the project boundary[20]) per each 1% increase in the net area of green infrastructure/WSUD (large trees[21], raingardens, wetlands or more naturalised watercourses) that will be publicly accessible. Given some research (above table) indicates that there may be a limit on the quantum of green infrastructure that generates a benefit, it is assumed that no additional marginal benefit will result if the amount of green infrastructure within combined area of the project and the area of residential properties within 20 metres of the project boundary exceeds 50% (for urban areas).

It should be noted that there is some likelihood of the default assumptions being conservative in relation to both distance effects and % benefit. A conservative approach reflects that there is relatively limited overall hedonic research particularly in relation to some specific WSUD techniques (e.g. raingardens) and that research has utilised diverse range of measures of greening, for example: different buffer distances from green infrastructure for statistical analyses; assessing different types of green infrastructure; measuring greenness via different measures such as NDVI or others.

$\mathbf{V}_{20}$ (capital value of all residential detached and semi-detached homes within 20 metres of the project boundary)

See above discussion for GB. The approach is conservative in that it does not account for potential benefits that may be experienced by others within the neighbourhood or beyond who may use or derive some intangible benefit from the presence of WSUD/green infrastructure established in the project.

[20] Value of properties with one or more boundary that is wholly or partly within 20 metres of the project.

[21] Trees with a potential canopy cover of at least 25 square metres at maturity.