Attachment 1 – Extract from Planning and Design Code (Phase 3) – Performance outcomes and deemed-to-satisfy solutions for residential and non-residential development

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
ALL DEVELOPMENT		
Design in urban areas		
Landscaping		
PO 3.1 Landscaped (including trees), permeable open spaces incorporated to: (a) minimise heat absorption and reflection; (b) maximise shade and shelter; (c) maximise stormwater infiltration; and (d) enhance the appearance of land and streetscapes.	DTS 3.1 None are applicable.	**Strongly supported** **Rationale/evidence** To achieve the objective of 20% increase in canopy cover projects on both private and public land, three things are needed: (i) sufficient space for the establishment of required root systems, (ii) uncompacted soil, and (iii) sufficient water to ensure health and vitality of the planting (leaf density). Factor (iii) above is supported by PO 3.1 (c) maximise stormwater infiltration Evidence is growing within Council monitoring programs (City of Mitcham and City of Burnside) of the effectiveness of verge infiltration systems in the re-establishment of leaf density in street trees. Refer to Attachment A for images from City of Burnside infiltration system and tree health case study for Lockwood Road, Erindale. **Recommendation 1:** **Generation 2 –** Explore potential for stormwater offsets including via solutions in the verge that contribute to the health of trees located on both private property and the verge, e.g. infiltration systems, raingardens.

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
Environmental performance		
PO 4.1 Buildings sited, oriented and designed to maximise natural sunlight access and ventilation to main activity areas, habitable rooms, common areas and open spaces.	**DTS 4.1** None are applicable.	**Strongly supported** **Recommendation 2:** Establish **guidelines** for new infill built form typologies, drawing upon the work of: (i) University of SA (Damien Madigen) to achieve density in established (heritage) suburbs, while retaining neighbourhood character (ii) Cooperative Research Centre for Water Sensitive Cities Draft (CRCWSC) *Infill typologies catalogue* that offers alternative designs for small-scale infill, including: Dual occupancies, one lot into three or four, row townhouses, apartments and stacked cluster developments. The designs demonstrate ways that the above-mentioned development types can deliver: Increased urban green cover; better usable outdoor spaces; better ventilation; and greater connection between habitable rooms and private or communal green spaces. The designs will also provide for higher quality integration with the streetscapes, and better management of stormwater runoff quality and quantity. (iii) The CRCWSC *Infill performance evaluation framework (draft)* offers a scale to assist the assessment of the relative contribution of private open space to householder quality of life/liveabilty Associated documents will be provided to DPTI separately. The CRCWSC *Infill typologies catalogue* could form the basis for a guideline to support development applicants to at least achieve

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
		the minimum standards offered by the deemed-to-satisfy solutions and also move towards a more desirable built form.
PO 4.2 Buildings sited and designed to maximise passive environmental performance and minimise energy consumption and reliance on mechanical systems, such as heating and cooling.	**DTS 4.2** None are applicable.	**Strongly supported** **Recommendation 3:** Establish **guidelines** for applicants for building siting and design that draw upon the following evidence: The CRCWSC research provides **evidence** of the cooling benefits and improved human thermal comfort derived from trees, irrigated turf, raingardens and water bodies: ▪ A study of a single isolated tree in Melbourne Cemetery showed that on very hot days in 2014, the air temperature below the tree canopy was 0.6 to 1.2 degrees cooler than immediately upwind of the tree. ▪ 10% increase in vegetation cover will decrease air temperature by approximately 0.2°C in a heatwave (Jacobs, Gallant and Tapper, 2017) ▪ 100% increase in vegetation cover will decrease air temperature by approximately 1.0°C in a heatwave (Jacobs, Gallant, Tapper, 2017) ▪ Increasing vegetation cover from 20% to 80% can reduce surface temperature by up to 6°C on a typical summer day (Nury, 2016) ▪ Air temperature will reduce by 1°C above and downwind of a wetland or waterway, by 1 x water body diameter width (Broadbent, Coutts, Tapper and Demuzere, 2017) ▪ Light irrigation of public open space/turf on a typical summer day can reduce air temperature by approximately 1°C and human thermal comfort by up to 10°C (Motazedian, 2016).

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
		▪ Low to moderate irrigation of public open space/turf during a suburban heatwave can reduce air temperature by approximately 0.5°C (Broadbent, Coutts, Tapper and Demuzere, 2017) ▪ Very heavy irrigation of public open space/turf during a suburban heatwave can reduce air temperature by approximately 2.5°C and surface temperature by up to 20°C (Broadbent, Coutts, Tapper and Demuzere, 2017) Refer to Figure 1 in Attachment A for a visual summary of CRCWSC research: Project B3.1 *Cities as water supply catchments: Green cities and microclimate* and B3.2 *The design of the public realm to enhance urban microclimates*. Human thermal comfort (HTC) is a term used to describe a person's satisfaction with the surrounding thermal conditions.
PO 4.3 Buildings incorporate climate responsive techniques and features such as building and window orientation, use of eaves, verandahs and shading structures, water harvesting, at ground landscaping, green walls, green roofs and photovoltaic cells.	**DTS 4.3** None are applicable.	**PO 4.3 is Strongly supported, with amendment as below** Add "and use" as below: *Buildings incorporate climate responsive techniques and features such as building and window orientation, use of eaves, verandahs and shading structures, water harvesting **and use**, at ground landscaping, green walls, green roofs and photovoltaic cells.* It is the use of the harvested rainwater at the lot scale that delivers the climate resilience, whether outdoors to supplement or substitute for mains water OR indoors to support water conservation.
ALL DEVELOPMENT		
Carparking appearance		
PO 6.4	**DTS / DPF 6.4**	**DTS supported in principle, with an amendment as below to strengthen**

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
Street level vehicle parking areas that are open to the sky are landscaped to provide shade and reduce solar heat absorption and reflection.	Vehicle parking areas that are open to the sky and comprise 10 or more car parking spaces include a shade tree with a mature canopy of 4m diameter spaced for each 10 car parking spaces provided and a landscaped strip on any road frontage of a minimum dimension of 1m.	**Recommendation 4:** **Amendment to DTS/DPF 6.4** *Vehicle parking areas that are open to the sky and comprise 10 or more car parking spaces include a shade tree with a mature canopy of 4 m diameter spaced for each* ***~~10~~ eight*** *car parking spaces provided and a landscaped strip on any road frontage of a minimum dimension of 1 m.* A typical car park is 2.4 m wide, if a tree with a mature canopy of 4 m diameter is planted at the centre of four parking bays, shading of all vehicles will be optimised. However, if the trees are to reach their canopy potential, they will need uncompacted soils and water. **Recommendation 5:** Establish **guidelines** for applicants to demonstrate how various techniques can be achieved, including but not limited to: • Ensure soil is uncompacted • How to establish a deep soil zone • Methods to passively irrigate trees and other vegetation, particularly when in conjunction with carparks, driveways and other hard paved surfaces (Note: Water Sensitive SA and CRCWSC have resources that can assist, in particular the CRCWSC national *Guidelines for passively irrigated landscapes (draft)* due for release in early 2020)

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
PO 6.5 Vehicle parking areas are landscaped along public frontages, allotment boundaries and between double rows of parking spaces.	**DTS / DPF 6.5** Vehicle parking areas comprising 10 or more car parking spaces contain a vegetated landscaped strip of a minimum dimension of: (a) 1m along all public road frontages and allotment boundaries; and (b) 0.6m between double rows of car parking spaces.	**Strongly supported** If this policy is integrated with WSUD objectives, multiple benefits can be derived, for example: **Recommendation 6:** Promote/adapt existing **guidelines** for applicants to demonstrate how various techniques can be achieved, including but not limited to: • Direct stormwater runoff to – landscaped areas and grassed buffers – infiltration systems – raingardens – swales. These techniques can: • Capture pollutants and reduce their mobilisation and transport to waterways and the coast via the drainage system • Reduce peak stormwater flows emanating from the site. **Existing guidelines and tools to underpin policy** Water Sensitive SA has developed the general guideline *WSUD 01 – A Guide to water sensitive urban design (WSUD), Stormwater management for small-scale development* that will assist applicants and the CRCWSC national *Guidelines for passively irrigated landscapes (draft)*. **Recommendation 7:** Generation 2 – Establish **DTS solutions** for the management of stormwater runoff via redirection to landscaped areas.
PO 6.6	**DTS 6.6**	**Strongly supported**

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
Vehicle parking areas and associated driveways are landscaped to shade and positively contribute to amenity.	None are applicable.	Refer to the evidence provided above for PO 4.2.
PO 6.7 Vehicle parking areas and accessways incorporate integrated stormwater management techniques such as permeable or porous surfaces, infiltration systems, drainage swales or rain gardens that integrate with landscaping requirements.	**DTS 6.7** None are applicable	**Strongly supported** Car parks are the easiest development types to integrate WSUD measures, as there are generally limited conflicts of WSUD measures with underground services or footings of structures, given the vast nature of the space. This is an easy win and should be taken at every opportunity. Carparks that fail to require such minimum standards represent "underperforming asphalt". Local parks and recreational areas must carry the load of every missed opportunity to better manage stormwater in carparks, through increased inundation to manage flood events. Carparks must manage their stormwater onsite so open spaces can better provide their primary functions to the community, offering amenity and recreation. **(as per PO 6.5 above) Recommendation 8:** Generation 2 – Establish **DTS solutions** for the direction of stormwater runoff to landscaped areas.
ALL DEVELOPMENT – 4 OR MORE BUILDING LEVELS		
Landscaping		
PO 10.1 Development facing a street provides a well landscaped area that contains a deep soil space to accommodate a tree of a species and size adequate to provide shade, contribute to tree canopy targets	**DTS / DPF 10.1** Buildings provide a 4m by 4m deep soil space in front of the building to accommodate a medium to large tree, except where no building setback from front property boundaries is desired.	**Strongly supported** Space for root systems + uncompacted soil + water = canopy cover.

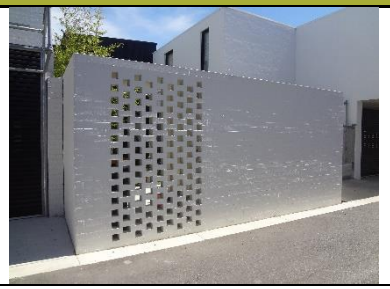
Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
and soften the appearance of buildings.		Provide all three and we have the best opportunity to reach the canopy cover targets in the *30 Year Plan for Greater Adelaide*. Deep soil zones can deliver space for roots and uncompacted soil. **Existing guidelines and tools to underpin policy** See commentary for PO6.5, for relevant guidelines **Evidence** Irrigation of trees, including passive infiltration with stormwater runoff, can increase canopy cover by up to 80% (Hitchmough, 1994)
ALL DEVELOPMENT		
PO 10.2 Deep soil zones provided to retain existing vegetation or provide areas that can accommodate new deep root vegetation, including tall trees with large canopies to provide shade and soften the appearance of multi storey buildings.	**DTS / DPF 10.2** Multi-storey development provides deep soil zones and incorporate trees at not less than the following rates, except in a location or zone	**Strongly supported** Trees also provide the added benefit of (i) intercepting rainfall, thereby reducing stormwater runoff; and (ii) enhancing infiltration of stormwater into the local soils as permeability of the soil is increased as major root systems develop and fine roots spread and die off in changing seasons, creating voids. **Regulated and significant trees** **Recommendation 9:** Significant trees be offered the same level of protection under the Code as currently exists under relevant Acts, Regulations and Development Plans. <u>Commentary</u> for the recommendation above: The draft Code presently contains a single Regulated Tree Overlay. This is to be contrasted with current Development Plan policy, which distinguishes between and provides separate policy for both regulated and significant trees.

<table>
<tr><th>Performance outcome</th><th>Deemed-to-satisfy solution</th><th>Water Sensitive SA – recommendation/comment</th></tr>
<tr><td></td><td>where full site coverage is desired:
<table>
<tr><th>Site area</th><th>Minimum deep soil area</th><th>Minimum dimension</th><th>Tree/ deep soil zones</th></tr>
<tr><td><300m²</td><td>10m²</td><td>1.5m</td><td>1 small tree / 10m² deep soil</td></tr>
<tr><td>300-1500m²</td><td>7% site area</td><td>3m</td><td>1 medium tree / 30m² deep soil</td></tr>
<tr><td>>1500m²</td><td>7% site area</td><td>6m</td><td>1 large or medium tree / 60m² deep soil</td></tr>
<tr><th colspan="4">Tree size and site area definitions</th></tr>
<tr><td>Small tree</td><td colspan="3">4-6m mature height and <4m canopy spread</td></tr>
<tr><td>Medium tree</td><td colspan="3">6-12m mature height and 4-8m canopy spread</td></tr>
<tr><td>Large tree</td><td colspan="3">12m mature height and >8m canopy spread</td></tr>
<tr><td>Site area</td><td colspan="3">The total area for development site, not average area per dwelling</td></tr>
</table></td><td>It is not clear whether significant trees under the current definition will have the same level of protection under the Code There is concern that regulated tree policy appears to have been consolidated within a single Regulated Tree Overlay with no higher order of policy relating to the proposed removal of a regulated tree that is a significant tree. It is unclear as to whether the omission of a separate Significant Tree Overlay is a deliberate policy decision or an inadvertent omission.

In any event, the proposed criteria for a tree damaging activity that is not to be undertaken with other development does not reference the current test that “all other reasonable remedial treatments and measures must first have been determined to be ineffective”. The omission of this requirement, at least in respect of significant trees, would result in a severe weakening of the current level of protection. This must be rectified to ensure that the Code affords the same level of protection to such trees as presently exists under the Development Plan.</td></tr>
<tr><td>PO 10.3
Deep soil zones provided with access to natural light to assist in maintaining vegetation health.</td><td>DTS 10.3
None are applicable.</td><td>Strongly supported</td></tr>
</table>

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
PO 10.4 Unless separated by a public road or reserve, development sites adjacent to any zone that has a primary purpose of accommodating low rise residential development incorporate a deep soil zone along the common boundary, to enable medium to large trees to be retained or established to assist in screening new buildings of 3 or more storeys in height	**DTS / DPF 10.4** Building elements of 3 or more storeys in height are set back at least 6m from a zone boundary in which a deep soil zone area is incorporated.	**Strongly supported**
Environmental		
PO 11.1 Development minimises detrimental micro-climatic impacts on adjacent land and buildings.	**DTS 11.1** None are applicable.	**Strongly supported** Refer to the evidence provided above for PO 4.2
ALL DEVELOPMENT		
PO 11.2 Development incorporates sustainable design techniques and features such as window orientation, eaves and shading structures, water harvesting, green walls, and roof designs that enable the provision of rainwater tanks (where they are not provided elsewhere on site), green roofs and photovoltaic cells.	**DTS 11.2** None are applicable.	**Strongly supported** Add “and use” as below: *Development incorporates sustainable design techniques and features such as window orientation, eaves and shading structures, water harvesting* ***and use****, green walls, and roof designs that enable the provision of rainwater tanks (where they are not provided elsewhere on site), green roofs and photovoltaic cells*. It is the use of the harvested rainwater at the lot scale that delivers the climate resilience whether outdoors to supplement or substitute for mains water OR indoors to support water conservation.

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
Private Open Space		
PO 20.1 Dwellings provided with suitable sized areas of usable private open space to meet the needs of occupants.	**DTS / DPF 20.1** Private open space provided in accordance with Design in Urban Areas Table 1 - Outdoor Open Space. (see end of this document)	**Strongly supported**
PO 20.2 Private open space positioned to provide convenient access from internal living areas.	**DTS / DPF 20.2** Private open space is directly accessible from a habitable room, other than a bedroom or study.	**Strongly supported** See also Recommendation 2 for PO 4.1 above:
PO 20.3 Private open space is positioned and designed to: (a) provide useable outdoor space that suits the needs of occupants; (b) take advantage of desirable orientation and vistas; (c) animate the street frontage by encouraging activity between buildings and public streets; (d) adequately define public and private space when located forward of the building; and (e) prolong activity along street frontages by protecting against inclement weather.	**DTS / DPF 20.3** A portion of the private open space specified in DTS 20.1 can be provided forward of the primary building line where: (a) the area is fenced to a maximum height of 1.8m; (b) the area incorporates a verandah with a minimum dimension of 1.5m (c) an area is provided behind the primary building line that has the minimum dimensions identified in DTS 20.1;	**Strongly supported** **DTS / DPF 20.3 is supported with the amendment below:** Add "that provides visual permeability" (a) the area is fenced to a maximum height of 1.8m **that provides visual permeability**; **Recommendation 10:** Built form guidelines include images of ways to achieve visual permeability of fences forward of the building line. Refer to examples below:

<table>
<tr><th>Performance outcome</th><th>Deemed-to-satisfy solution</th><th>Water Sensitive SA – recommendation/comment</th></tr>
<tr><td></td><td></td><td> 
Images: Knutsford, WA. Source: Water Sensitive SA
Original high-resolution images can be provided upon request</td></tr>
<tr><td>Landscaping</td><td></td><td></td></tr>
<tr><td>PO 21.1
Soft landscaping incorporated into development to:
(a) minimise heat absorption and reflection;
(b) contribute shade and shelter;
(c) provide for stormwater infiltration and biodiversity; and
(d) enhance the appearance of land and streetscapes.</td><td>DTS / DPF 21.1
Residential development incorporates areas for soft landscaping with a minimum dimension of 0.5 metres provided in accordance with the following:
<table><tr><th>Dwelling site area (or in the case of residential flat or group average site area) (square metres)</th><th>% of site</th></tr><tr><td><200</td><td>15%</td></tr><tr><td>201 – 450</td><td>20%</td></tr><tr><td>>450</td><td>25%</td></tr></table>and
(b) 25% of any land between the road boundary and the primary building line is provided for soft landscaping with a minimum dimension of 0.5 metres.</td><td>Supported, with amendments as below.

Comment – 0.5 m width landscape along a side boundary of a property is inadequate as the growing media will be less than 300 mm wide once edge kerbs are constructed, and is deemed to be extremely inadequate as a landscape provision forward of the primary building line (i.e. between building line and front boundary). Soft landscaping forward of the building line should be at least 4.0 m to be consistent with Table DTS 21.2 Tree Size for a small tree of mature canopy spread 2-4 metres

Recommendation 11:
(i) Amend DTS / DPF 21.1 as follows:
(a) Residential development incorporates areas for soft landscaping with a minimum dimension of ~~0.5~~ 0.7 m provided in accordance with the following:
<table><tr><th>Dwelling site area (or in the case of residential flat or group average site area) (square metres)</th><th>% of site</th></tr><tr><td><200</td><td>15%</td></tr><tr><td>201 – 450</td><td>20%</td></tr><tr><td>>450</td><td>25%</td></tr></table></td></tr>
</table>

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
		and (b) 25% of any land between the road boundary and the primary building line is provided for soft landscaping with a minimum dimension of ~~**0.5**~~ **0.7** m. **Recommendation 12:** Provide a figure that demonstrates what constitutes a minimum garden bed and how it is measured. There needs to be 300 mm width of clear plantable space at depth. If the garden bed includes a perimeter kerb and associated haunching, the plantable space of any garden bed cross section can be reduced by up to 400 mm. **(ii) Recommendation 13: Define "soft landscaping" in the Code** Suggest this provision should be increased to 1.5 m minimum. (iii) **Recommendation 14:** Put in place mechanisms and development compliance avenues to ensure that soft landscaped areas cannot be compromised in the future e.g. via hard paving that may not require development approval. The **evidence** of the importance of trees and landscaped areas in urban areas is compelling. Refer to **Attachment B for more details** and reference documents. **Physical health** ▪ Hospital patients heal faster and better ▪ Decline in diastolic blood pressure ▪ Trees make people feel younger and healthier ▪ Increase in physical activity, less likely to be overweight ▪ Children are less likely to be overweight ▪ Alzheimer patients are less violent and have fewer falls

<table>
<tr><th>Performance outcome</th><th>Deemed-to-satisfy solution</th><th>Water Sensitive SA – recommendation/comment</th></tr>
<tr><td></td><td></td><td>Mortality
Living near green spaces associated with reduced mortality
Living near green spaces results in lower mortality in women
Reduction in tree cover results in increased mortality
Mental health
Reduction in negative thoughts and activities in the brain associated with mental illness
Increase in attention, positive emotions and reflection
Increased memory in depressed people
Green spaces reduce stress in participants
Increased memory and attention
Ability to recover from stress more easily
Increased attention and focus
Reduced symptoms of ADD/ADHD in children
Better attention and recovery from stress
Increased discipline in young girls
Increased ability in paying attention
Increase in street trees results in a reduction in prescribed antidepressants
Tree images make people happier
Increased tree diversity, increased reflection
Increase in life satisfaction, decrease in mental distress</td></tr>
<tr><td>ALL DEVELOPMENT</td><td></td><td></td></tr>
<tr><td>PO 21.2
Tree planting provided to:
(a) contribute shade and shelter;
(b) improve outlook for occupants of buildings;
(c) reduce the apparent mass of buildings;
(d) contribute to biodiversity;
(e) mitigate urban heat; and</td><td>DTS / DPF 21.2
Tree planting is provided in accordance with the following tables:
(a)<table><tr><th>Allotment size¤</th><th>Tree size* and number required per dwelling¶ ¤</th></tr><tr><td><450m²¤</td><td>1 small tree per dwelling¤</td></tr><tr><td>450-800m²¤</td><td>1 medium tree¤</td></tr><tr><td>800m²+¤</td><td>1 large tree¤</td></tr></table>*refer Table DTS 21.2 Tree Size</td><td>Strongly supported, with amendments

Minimum tree planting is provided in accordance with the following tables:
(a)<table><tr><th>Allotment size¤</th><th>Tree size* and number required per dwelling¶ ¤</th></tr><tr><td><450m²¤</td><td>1 small tree per dwelling¤</td></tr><tr><td>450-800m²¤</td><td>1 medium tree¤</td></tr><tr><td>800m²+¤</td><td>1 large tree¤</td></tr></table></td></tr>
</table>

<table>
<tr><th>Performance outcome</th><th>Deemed-to-satisfy solution</th><th>Water Sensitive SA – recommendation/comment</th></tr>
<tr>
<td>(f) improve the amenity and character of streetscapes and contribute to attractive vistas.</td>
<td>
<table>
<tr><th colspan="4">Table DTS 21.2 Tree Size</th></tr>
<tr><th>Tree Size</th><th>Mature Height</th><th>Mature spread</th><th>Min soil area</th></tr>
<tr><td>Small</td><td>4-6m</td><td>2-4m</td><td>10m² and min dimension of 1.5m</td></tr>
<tr><td>Medium</td><td>6-12m</td><td>4-8m</td><td>30m² and min. dimension of 2m</td></tr>
<tr><td>Large</td><td>>12m</td><td>>8m</td><td>60m² and min dimension of 4m</td></tr>
</table>
Table DTS 21.2 Tree Size
(b) The following discounts apply where existing trees are retained on the subject land that are not a species identified in Regulation3F(4)(b):
<table>
<tr><th>Retained tree height</th><th>Retained tree spread</th><th>Retained soil area within development site</th><th>Discount applied</th></tr>
<tr><td>4-6m</td><td><4m</td><td>10m² and min dimension of 1.5m</td><td>2 small</td></tr>
<tr><td>6-12m</td><td>4-8m</td><td>30m² and min. dimension of 3m</td><td>2 medium</td></tr>
<tr><td>>12m</td><td>>8m</td><td>60m² and min dimension of 6m</td><td>2 large</td></tr>
</table>
(c) Trees can be replaced with smaller trees in accordance with the following rates:
<table>
<tr><th>Tree size*</th><th>Equivalent planting</th></tr>
<tr><td>Medium tree</td><td>2 small trees</td></tr>
<tr><td>Large tree</td><td>4 small trees or
2 medium trees</td></tr>
</table>
</td>
<td>
*refer Table DTS 21.2 Tree Size

Recommendation 15: Guidelines be developed to include details of minimum tree size and quality at time of installation.

Recommendation 16: All landscaping be established prior to occupancy.

Recommendation 17: The Botanic Gardens of SA Plant selector and local Council lists used to develop suitable plant species by zone, postcode.

Recommendation 18: Need a definition of “Mature spread”

Evidence
In relation to PO21.2 (e) mitigate urban heat, CRCWSC research has shown that:

A 10% increase in vegetation cover will provide about 0.2°C decrease in air temperature
A 100% increase in vegetation cover (effective doubling) will provide a 1.0°C decrease in air temperature (Jacobs, Gallant and Tapper 2017)

However, Broadbent (2016) found HTC is less influenced by land surface characteristics, and is mostly determined by contrasts in shading and airflow in the environment.

Drawing on the results of the recent western Adelaide heat mapping analysis[1], Seed Consulting Services et. al. (2017), key observations that can be deduced from heat mapping are:
</td>
</tr>
</table>

[1] Data were collected on 9 February 2017, which at 39.2°C was the fourth hottest day and second warmest night (25.2°C) of the 2016/2017 summer.

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
	*refer Table DTS 21.2 Tree Size	• land use and building and pavement material selection in western Adelaide can cause at least a 7°C difference in surface temperature • temperatures were, on average, 2.8°C lower over green infrastructure, with irrigation creating an additional cooling effect of 1.7°C compared with non-irrigated open space which was mostly non-irrigated grass • roadside WSUD features can provide localised cooling benefits • artificial turf is significantly warmer than average surface temperatures (5.5°C) and can be up to 14°C warmer than irrigated natural turf surfaces • tree lined streets are significantly cooler than streets without trees. **Evidence** of this is also available interstate, including: https://researchdirect.westernsydney.edu.au/islandora/object/uws%3A52453/datastream/PDF/view This research looked at air temperature about 2.5-3 metres above ground level. The following are excerpts from this research: • Between December 2018 and February 2019, a street with 30% tree canopy cover experienced only five days of air temperatures greater than 40°C. In a nearby street where canopy cover was just over 10%, air temperatures soared above 40°C on 13 days • Depending on location, the number of days where air temperature was above 35°C was much greater (47 days) compared to any available information based on official BoM weather station data (10-25 days). Evidence provided here reveals that local communities are exposed to extreme heat much more frequently than previously known.

<table>
<tr><th>Performance outcome</th><th>Deemed-to-satisfy solution</th><th>Water Sensitive SA – recommendation/comment</th></tr>
<tr><td>ALL DEVELOPMENT</td><td></td><td></td></tr>
<tr><td>Water Sensitive Design
PO 22.1
Residential development designed to capture and re-use stormwater to:
(a) maximise conservation of water resources;
(b) manage peak stormwater runoff flows and volume to ensure the carrying capacities of downstream systems are not overloaded; and
(c) manage stormwater runoff quality.</td><td>DTS / DPF 22.1
Residential development in the form of:
(a) detached, semi-detached or row dwellings include a retention rainwater tank storage:
i. connected to at least 80% of the roof area of the dwelling (row dwelling), or at least 60%of the
roof area of the dwelling (detached and semi-detached dwellings);
ii. connected to all toilets and either the laundry cold water outlets or hot water service;
iii. that has a minimum total capacity in accordance with Table 1, and
iv. the roof is at least 80% of the impervious area; or

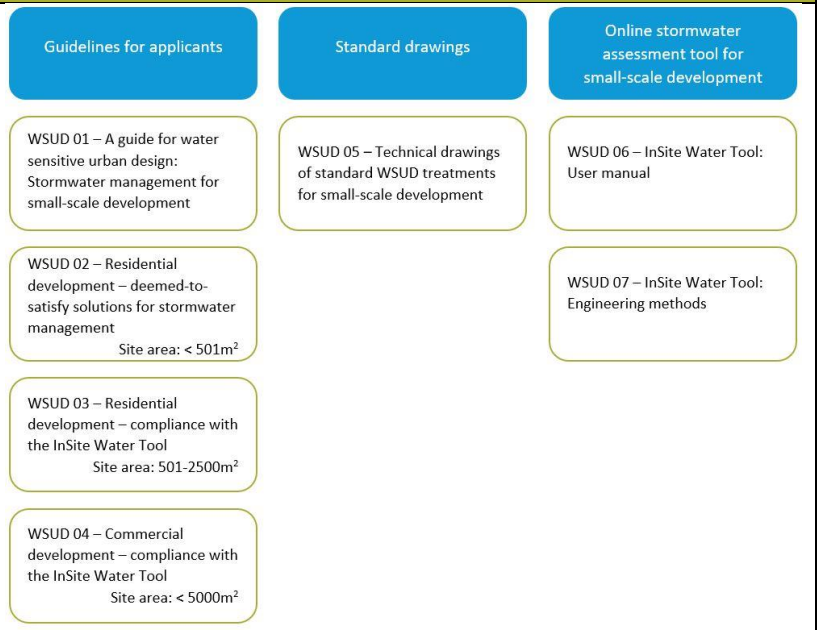
Table 1: Retention Rainwater Tank
<table><tr><th>Allotment size (m²)</th><th>Minimum site % perviousness</th><th>Minimum rainwater tank volume</th><th colspan="2">Additional site permeability discount opportunity</th></tr><tr><th></th><th></th><th></th><th>Site % perviousness</th><th>Minimum rainwater tank volume (L)</th></tr><tr><td><200</td><td>15%</td><td>2,000</td><td></td><td></td></tr><tr><td>201-400</td><td>20%</td><td>3,000</td><td>30%</td><td>2,000</td></tr><tr><td>400-500</td><td>25%</td><td>5,000</td><td>35%</td><td>3,000</td></tr></table>
(a) hammerhead dwellings have driveways and pathways constructed of a minimum of 50% permeable or porous material and include a retention rainwater tank storage:
i. connected to at least 60% of the roof area of the dwelling;
ii. connected to all toilets and either the laundry cold water outlets or hot water service; and</td><td>Strongly supported

Conventional stormwater management only targets stormwater runoff peak flow management, however a water sensitive urban design approach can meet all of the objectives of PO22.1
Stormwater harvesting and re-use at either the lot, streetscape or precinct scale, in particular, is one of the most effective techniques to meet all of the objectives in PO22.1

Table 1: Summary of benefits of retention versus detention
<table><tr><th rowspan="2">Rainwater tank function</th><th colspan="5">Contribution to management of the following objectives</th></tr><tr><th>Water conservation</th><th>Stormwater runoff quality</th><th>Stormwater runoff peak volumes</th><th>Stormwater runoff peak flows (rate)</th><th>Urban stream stability</th></tr><tr><td>Detention</td><td>×</td><td>×</td><td>×</td><td>✓</td><td>×</td></tr><tr><td>Retention (and re-use)</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr></table>
Preference for 80% of the roof area to be connected to maximise benefits.</td></tr>
</table>

<table>
<tr><th>Performance outcome</th><th>Deemed-to-satisfy solution</th><th>Water Sensitive SA – recommendation/comment</th></tr>
<tr><td></td><td>iii. that has a minimum total capacity in accordance with Table 2.
Table 2: Retention Rainwater Tank Option
<table><tr><th>Allotment size (m2)</th><th>Site % pervious-ness</th><th>Rainwater tank volume (L)</th></tr><tr><td>< 200</td><td>15%</td><td>2,000</td></tr><tr><td>201-400</td><td>20%</td><td>3,000</td></tr><tr><td>401-500</td><td>25%</td><td>5,000</td></tr></table></td><td></td></tr>
<tr><td>PO 22.2
Development creating 5-19 dwellings includes stormwater management systems that minimise the discharge of sediment, suspended solids, organic matter, nutrients, bacteria, litter and other contaminants
to the stormwater system, watercourses or other water bodies.</td><td>DTS 22.2
Development creating 5-19 dwellings is accompanied by an approved Stormwater Management Plan that achieves the following stormwater runoff outcomes:
(a) 80 per cent reduction in average annual total suspended solids;
(b) 60 per cent reduction in average annual total phosphorus; and
(c) 45 per cent reduction in average annual total nitrogen.</td><td>Strongly supported

Existing guidelines and tools to underpin policy
The Water Sensitive SA InSite Water Tool can also be used to demonstrate compliance with <u>stormwater runoff quality objectives</u> for residential development up to approximately 2,500 m^2 (provided no public road is created in conjunction with any land division) and commercial development with a gross area of the allotment to be subdivided of less than 5,000m^2.
Stormwater management solutions that can be assessed using the InSite Water Tool are:
– rainwater retention tanks
– rainwater detention tanks
– combined rainwater retention and detention tanks
– water efficient fixtures and appliances
– permeable or porous paving
– infiltrations pits and trenches
– raingardens
– grassed buffers and swales
– green roofs.
A suite of resources has been prepared to support development applicants to apply WSUD practices and the Insite Water Tool as follows:</td></tr>
</table>

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
		 *Figure 1: Water sensitive urban design resources for development applicants*
PO 22.3 Development creating 5-19 dwellings includes a stormwater management system designed to mitigate peak flows and manage the rate and duration of stormwater discharges from the site to ensure the carrying capacities of downstream systems are not overloaded.	**DTS 22.3** Development creating 5-19 dwellings (a) maintains: i. a pre-development peak flow rate from the site based upon a 0.35 runoff coefficient for the 5-year ARI (18.1% AEP) 30 minute storm; and ii. the stormwater runoff time to peak to match that of the pre-development condition; or (b) capture and retain the difference in pre-development runoff volume (based upon a 0.35 runoff coefficient) vs post development runoff	**Strongly supported** **Existing guidelines and tools to underpin policy** The Water Sensitive SA InSite Water Tool can also be used to demonstrate compliance with stormwater runoff **peak flow objectives** for residential development up to approximately 2,500 m^2 (provided no public road is created in conjunction . with any land division) and commercial development with a gross area of the allotment to be subdivided of less than 5,000 m^2. Stormwater management solutions that can be assessed using the InSite Water Tool are: – rainwater retention tanks

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
	volume from the site for a 5-year ARI (18.1% AEP) 30 minute storm; and (c) manage site generated stormwater runoff up to and including the 100 –year ARI flood event (1% AEP) to avoid flooding of buildings.	– rainwater detention tanks – combined rainwater retention and detention tanks – water efficient fixtures and appliances – permeable or porous paving – infiltrations pits and trenches – raingardens – grassed buffers and swales – green roofs. A suite of resources has been prepared to support development applicants to apply WSUD practices and the Insite Water Tool as described above for PO22.2

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
ALL DEVELOPMENT		
PO 23.3 Driveways and access points located and designed to facilitate safe access and egress while maximising land available for street tree planting, landscaped street frontages and on-street parking.	**DTS / DPF 23.3** Driveways and access points: (a) for sites with a frontage to a public road of 12m or less, have a maximum width of 3.2m measured at the property boundary and are the only access point provided on the site; or (b) for sites with a frontage to a public road greater than 12m: i. have a maximum width of 6m measured at the property and are the only access point provided on the site; or ii. have a maximum width of 3.2 metres measured at the property boundary and no more than two access points are provided on site.	**Strongly supported** Not only does PO 23.3 and DTS/DPF 23.3 provide space for existing trees or the establishment of new trees, it also maximises opportunities for Councils to integrate infiltration systems that redirect water from the kerb and gutter to stormwater wells in the verge.

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
PO 23.4 Vehicle access is safe, convenient, minimises interruption to the operation of public roads and does not interfere with street infrastructure or street trees.	**DTS / DPF 23.4** Vehicle access to designated car parking spaces: (a) is provided via a lawfully existing or authorised driveway or access point or an access point for which consent has been granted as part of an application for the division of land (b) where newly proposed, is setback: (a) 500mm or more from any street furniture, street pole, infrastructure services pit, or other stormwater or utility infrastructure unless consent is provided from the asset owner; (b) 2m or more from a street tree unless consent is provided from the tree owner; (c) 6m or more from the tangent point of an intersection of 2 or more roads or a pedestrian-actuated crossing.	**PO 23.4 Strongly supported** **DTS 23.4 b) <u>NOT</u> supported** **The policy, *Vehicle access to designated car parking spaces: (b) where newly proposed, is setback: (b) 2 m or more from a street tree unless consent is provided from the tree owner*** has significant risks associated with it**.** A blanket rule of this kind does not take into consideration that impacts to trees are dependent on species type, age, surrounding growing conditions, health and condition. The Australian Standard AS4970-2009 provides guidance to encroachment considerations however this Standard still needs input from a technically qualified person as it is not a simple one rule for all. **Recommendation 19: Alternative DTS** *Vehicle access to designated car parking spaces:* (d) that are within any part of the tree protection zone are designed in accordance with professional advice from a qualified arborist and Australian Standard AS4970-2009 and include measures to protect existing or proposed trees, including but not limited to: (i) be constructed of a permeable or porous material, and (ii) incorporate structural soils. **Recommendation 20:** Establish definitions for deep soil zones, structural soils and tree protection zones in the Code and other relevant planning documents

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
ALL NON-RESIDENTIAL DEVELOPMENT		
Water Sensitive Design **PO 41.1** Development likely to result in risk of export of sediment, suspended solids, organic matter, nutrients, oil and grease include stormwater management systems designed to minimise pollutants entering stormwater.	**DTS/DPF 41.1** Development includes stormwater management systems designed to achieve the following gross pollutant outcomes: (a) 80 per cent reduction in average annual total suspended solids; (b) 60 per cent reduction in average annual total phosphorus; (c) 45 per cent reduction in average annual total nitrogen; (d) 90 per cent reduction of litter/gross pollutants compared to untreated stormwater runoff; and (e) no visible oils/grease for flows up to the 1-in-3 month average return interval flood peak flow.	**Strongly supported** **Existing guidelines and tools to underpin policy** The InSite Water Tool can also be used to demonstrate compliance with **stormwater runoff quality objectives** for commercial development with a gross area of the allotment to be subdivided of less than 5,000 m^2. Stormwater management solutions that can be assessed using the InSite Water Tool are: – rainwater retention tanks – rainwater detention tanks – combined rainwater retention and detention tanks – water efficient fixtures and appliances – permeable or porous paving – infiltrations pits and trenches – raingardens – grassed buffers and swales – green roofs. A suite of resources has been prepared to support development applicants to apply WSUD practices and the Insite Water Tool as described above for PO22.2
PO 41.3 Development includes stormwater management systems to mitigate peak flows and manage the rate and duration of stormwater discharges from the site to ensure the carrying capacities of downstream systems are not overloaded.	**DTS / DPF 41.3** Development includes stormwater management systems that: (a) maintain a pre-development peak flow rate from the site, based upon a 0.35 runoff coefficient for the 20-year ARI (5% AEP) 30 minute storm, unless a lower performance measure is specified in an approved catchment based Stormwater Management Plan;	**Strongly supported** **Existing guidelines and tools to underpin policy** The InSite Water Tool can also be used to demonstrate compliance with **stormwater runoff peak flow and volume management objectives** for commercial development with a gross area of the allotment to be subdivided of less than 5,000 m^2. Stormwater management solutions that can be assessed using the InSite Water Tool are:

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
	(b) maintains the stormwater runoff time to peak to match that of the pre-development; and (c) manages up to and including the 100-year ARI flood event (1% AEP) to avoid flooding of buildings.	– rainwater retention tanks – rainwater detention tanks – combined rainwater retention and detention tanks – water efficient fixtures and appliances – permeable or porous paving – infiltrations pits and trenches – raingardens – grassed buffers and swales – green roofs. A suite of resources has been prepared to support development applicants to apply WSUD practices and the Insite Water Tool as described above for PO22.2
MAJOR LAND DIVISION (20+ ALLOTMENTS)		
PO 5.2 Land division creating 5-19 non-residential allotments includes a stormwater management system designed to mitigate peak flows and manage the rate and duration of stormwater discharges from the site to ensure the carrying capacities of downstream systems are not overloaded.	**DTS 5.2** Land division creating 5-19 non-residential allotments is accompanied by an approved Stormwater Management Plan and manages up to and including the 100 –year ARI flood event (1% AEP) to avoid flooding of buildings and: (a) maintain i. a pre-development peak flow rate from the site based upon a 0.35 runoff coefficient for the 5- ii. year ARI (18.1% AEP) 30 minute storm; and iii. the stormwater runoff time to peak to match that of the pre-development; or b) capture and retain the difference in pre-development runoff volume (based upon a 0.35 runoff coefficient) vs post development runoff volume from the site	**Strongly supported, with amendment below** Delete "*(c) manage site generated stormwater runoff up to and including the 100 –year ARI flood event (1% AEP) to avoid flooding of buildings"* as it is repetition. **Existing guidelines and tools to underpin policy** The Water Sensitive SA InSite Water Tool can also be used to demonstrate compliance with stormwater runoff **peak flow objectives** for residential development up to approximately 2,500 m^2 (provided no public road is created in conjunction with any land division) and commercial development with a gross area of the allotment to be subdivided of less than 5,000 m^2.

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
	for a 5-year ARI (18.1% AEP) 30 minute storm; and (c) manage site generated stormwater runoff up to and including the 100 –year ARI flood event (1% AEP) to avoid flooding of buildings	
PO 7.1 Land division creating 5-19 allotments includes stormwater management systems that minimise the discharge of sediment, suspended solids, organic matter, nutrients, bacteria, litter and other contaminants to the stormwater system, watercourses or other water bodies.	DTS 7.1 Land division creating 5-19 allotments is accompanied by an approved Stormwater Management Plan and achieves the following stormwater runoff outcomes: a) 80 per cent reduction in average annual total suspended solids; b) 60 per cent reduction in average annual total phosphorus; **c)** 45 per cent reduction in average annual total nitrogen.	**Strongly supported** **Existing guidelines and tools to underpin policy** The Water Sensitive SA InSite Water Tool can also be used to demonstrate compliance with **stormwater runoff quality objectives** for residential development up to approximately 2,500 m^2 (provided no public road is created in conjunction i=with any land division) and commercial development with a gross area of the allotment to be subdivided of less than 5,000 m^2.
PO 7.2 Land division creating 5-19 non-residential allotments includes a stormwater management system designed to mitigate peak flows and manage the rate and duration of stormwater discharges from the site to ensure the carrying capacities of downstream systems are not overloaded.	**DTS / DPF 7.2** Land division creating 5-19 non-residential allotments includes a storm water management system designed to: a) maintain a pre-development peak flow rate from the site based upon a 0.35 runoff coefficient for the 20-year ARI (5% AEP) 30 minute storm, unless a lower performance measure is specified in an approved catchment based Stormwater Management Plan; b) maintain the stormwater runoff time to peak to match that of the pre-development; and	Appears to be a duplication of PO 5.2 **Strongly supported** **Existing guidelines and tools to underpin policy** The Water Sensitive SA InSite Water Tool can also be used to demonstrate compliance with stormwater runoff **peak flow objectives** for residential development up to approximately 2,500 m^2 (provided no public road is created in conjunction with any land division) and commercial development with a gross area of the allotment to be subdivided of less than 5,000 m^2.

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
	c) manage site generated stormwater runoff up to and including the 100 – year ARI flood event (1% AEP).	
MAJOR LAND DIVISION (20+ ALLOTMENTS)		
PO 9.1 Land division creating 20 or more residential allotments includes a stormwater management system designed to mitigate peak flows and manage the rate and duration of stormwater discharges from the site to ensure the carrying capacities of downstream systems are not overloaded.	**DTS/DPF 9.1** Land division creating 20 or more residential allotments is accompanied by an approved Stormwater Management Plan and manages up to and including the 100 –year ARI flood event (1% AEP) to avoid flooding of buildings and: a. maintains pre-development peak 5-year ARI (18.1% AEP) flow rate from the site, and maintains the time to peak to match that of the pre-development; or b. captures and retains the difference in pre-development volume vs post development volume from the site for a 5-year ARI (18.1% AEP) 30 minute storm; or c. where there is no adequate local drainage scheme to connect to, captures and retains post development volume from the site for a 5 year ARI (18.1% AEP) 30 minute storm.	**Strongly supported**
PO 9.2 Land division creating 20 or more non- residential allotments includes a stormwater management system designed to mitigate peak flows and manage the rate and duration of stormwater discharges from the site to ensure the carrying	**DTS/DPF 9.2** Land division creating 20 or more non-residential allotments is accompanied by an approved Stormwater Management Plan and manages up to and including the 100 –year ARI flood event (1% AEP) to avoid flooding of buildings and:	**Strongly supported**

Performance outcome	Deemed-to-satisfy solution	Water Sensitive SA – recommendation/comment
capacities of downstream systems are not overloaded.	a. maintains pre-development peak 20-year ARI (5% AEP) flow rate from the site and, maintains the time to peak to match that of the pre-development; or captures and retains the difference in pre-development volume vs post development volume from the site for a 20-year ARI (5% AEP) 30 minute storm; where there is no adequate local drainage scheme to connect to, captures and retains post development volume from the site for a 20 year ARI (5% AEP) 30 minute storm.	
PO 9.3 Land division creating 20 or more allotments includes stormwater management systems that minimise the discharge of sediment, suspended solids, organic matter, nutrients, bacteria, litter and other contaminants to the stormwater system, watercourses or other water bodies	**DTS 9.3** Land division creating 20 or more allotments is accompanied by an approved Stormwater Management Plan and achieves the following stormwater runoff outcomes: a. 80 per cent reduction in average annual total suspended solids; b. 60 per cent reduction in average annual total phosphorus; c. 45 per cent reduction in average annual total nitrogen.	**Strongly supported** **Existing guidelines and tools to underpin policy** Water Sensitive SA is developing SA Guidelines for *Model for urban stormwater improvement conceptualisation* (MUSIC), which will assist developers of larger scale developments to undertake modelling to demonstrate compliance with this policy.

Table 1 - Outdoor Open Space

Dwelling Type	Dwelling / Site Configuration	Minimum Rate
Detached dwelling Semi-detached dwelling Row dwelling Group dwelling	Site area >1,000m^2	Total area: 20% of total site area Adjacent to habitable room: 10% total site area / minimum dimension 4m.
	Site area 500m^2 – 1,000m^2	Total area: 80m^2 Adjacent to habitable room: 24m^2 / minimum dimension 4m.
	Site area 300m^2 - 500m^2	Total area: 60m^2 Adjacent to habitable room: 16m^2 / minimum dimension 4m.
	Site area <300m^2	Total area: 24m^2 Adjacent to habitable room: 16m^2 / minimum dimension 3m
Cabin or caravan (permanently fixed to the ground) in a Residential Park Zone or Caravan and Tourist Park Zone		Total area: 16m^2, which may be uses as second car parking space, provided on each site intended for residential occupation.
Apartments	Dwellings at ground level:	
	- All types	15m^2 / minimum dimension 3m
	Dwellings located above ground level:	
	- Studio	4m^2 / minimum dimension 1.8m
	- One bedroom dwelling	8m^2 / minimum dimension 2.1m
	- Two bedroom dwelling	11m^2 / minimum dimension 2.4m
	- Three + bedroom dwelling	15 m^2 / minimum dimension 2.6m

Attachment A

City of Burnside infiltration system and tree health case study for Lockwood Road, Erindale

Site history

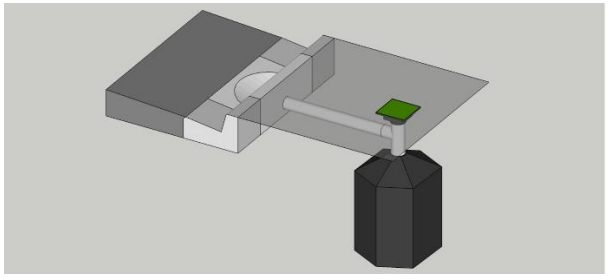
- Poor vigorlow leaf density (first reported 2014)

Stem injections

Manual water bollards

- TREENET Inlets installed Aug 2018
- Water trucks used to fill inlets from August to May
- TREENET Inlets looking good to help tree health
- Leaf density increased since installation in 2018
- Cost saving not installing tree bollard
- 2019 rainfall higher than preceding years however 2016 higher without improvements to tree health
- Impact when water truck removed?

TREENET Inlets excavation



TREENET Inlets design

TREENET Inlets post installation

Tree canopy density – August 2018 – pre installation of TREENET Inlet

Tree canopy density – October 2019 – 14 months post installation of TREENET Inlet

Attachment B

References

Broadbent AM (2016) *The effect of water sensitive urban design and outdoor water-use practices on urban microclimate*, Doctoral thesis, Monash University, Melbourne.

Broadbent AM, Coutts AM, Tapper NJ, Demuzere M, Beringer J (2017) *The microscale cooling effects of water sensitive urban design and irrigation in a suburban environment*. Theoretical and Applied Climatology, 1-23. https://doi.org/10.1007/s00704-017-2241-3

Hitchmough J (1994) *Roof gardens and other landscapes involving finite volumes of artificial soils*. Urban Landscape Management. Sydney, Inkata Press

Jacobs SJ, Gallant AJ, Tapper NJ, (2017) *The sensitivity of urban meteorology to soil moisture boundary conditions: a case study in Melbourne*, Australia. Journal of Applied Meteorology and Climatology, 56, pp. 2155–2172

Motazedian, (2016) FULL REFERENCE

Nury (2016) FULL REFERENCE

Seed Consulting Services, Airborne Research Australia and EnDev Geographic (2017) *Western Adelaide Urban Heat Mapping Project Report.* Adelaide: Prepared for the Cities of West Torrens, Charles Sturt and Port Adelaide Enfield, and the Adelaide Mount Lofty Ranges Natural Resources Management Board