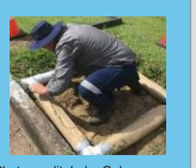
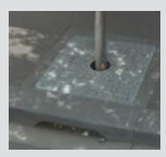
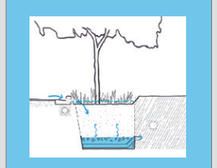
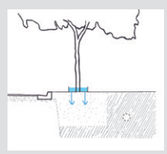
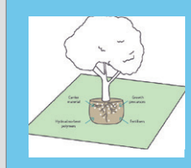
WATER EFFICIENT SOLUTIONS FOR TREES

In urban environments, the conditions are commonly harsh for trees with reduced available soil volumes due to compaction and underground services, less infiltration of water into soils due to impervious surfaces, and reflected heat from roads, buildings and pavements. Coupled with increasing climatic variability, this means all but the most drought tolerant and hardy native species will need some form of ongoing and/or supplementary irrigation to thrive and reach their full potential canopy cover.

There are a range of water efficient approaches available to support healthy and resilient tree growth. The adoption of these water efficient approaches can support the delivery of a green and cooler Greater Sydney. The following table provides a summary of a range of solutions to enable water efficient irrigation to urban trees in a range of contexts, settings and scales. The increasing scale of this application generally results in increasing benefit for tree health and vigour, and for broader benefits such as stormwater management, groundwater/deep soil moisture recharge and urban cooling. The costs are also likely to increase with this increasing scale of intervention, so the right solution will be very site dependent and will respond to the objectives of a project. More intensive solutions (for example linear irrigation and infiltration trenches) may be more suitable where constructed in conjunction with other significant infrastructure projects, such as pavement resurfacing or drainage works. Conversely, where limited disturbance is required, such as in instances where trees are established and disturbance to an existing road work is not desirable, less intensive interventions may be provided at a lower cost.

- Good
- Moderate
- Poor

Water efficient solution	Leaky pipe around tree	Below ground infiltration trench or well	Sunken tree pit or raingarden - open	Sunken tree pit - grated	Below ground storage	Permeable pavements	Structural soils and cells	Irrigation scheduling technology	Drip irrigation	Water wells and butts	Soil moisture retention improvements
Example image	 Photo credit: Luke Galea (Mackay Regional Council)	 Photo credit: Tim Johnson (City of Mitcham)	 Photo credit: E2Designlab	 Photo credit: E2Designlab		 Photo credit: E2Designlab	 Image credit: Citygreen - www.citygreen.com)				
Description	Kerb cut-outs and slotted pipes divert road stormwater into tree pit.	Kerb cut-outs direct road stormwater to a leaky infiltration trench or well	An open sunken tree pit captures road stormwater over a vegetated surface	A grated sunken tree pit receives stormwater from an inlet to the surface of a tree pit	A storage below the root zone of a sunken tree pit that makes water available to plants during dry periods.	Permeable pavements allow water to pass through them from the surface. Often used with structural soils and cells.	Structural soils and cells can support roads or pavement while storing water and allowing root growth. Often used with permeable pavement.	Soil moisture probes. Programming / weather station connections	Drip irrigation delivers water directly into the tree root zone.	Water wells and butts allow rapid filling from a water truck with slow leakage to a tree	Soil additives can improve properties such as aeration, wetting, soil water retention capacity and others.
Site suitability											
Park suitability	🟡	🟡	🟢	🔴	🟢	🟡	🔴	🟢	🟢	🟢	🟢
Plaza suitability	🟡	🟡	🟡	🟢	🟢	🟢	🟢	🟢	🔴	🔴	🟢
Streetscape suitability	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🟡	🟢	🟢
Likelihood of success due to the following considerations											
Design simplicity	🟢	🟢	🟢	🟢	🟡	🔴	🟡	🔴	🟢	🟢	🟢
Ease of retrofit	🟡	🟡	🔴	🔴	🔴	🟡	🟡	🟡	🟡	🟢	🟡
Poorly draining soils (water logging)*	🔴	🔴	🟢	🟢	🟢	🔴	🟡	🟢	🟡	🟢	🟢
Likelihood of delivering the following benefits											
Stormwater treatment	🔴	🔴	🟢	🟢	🟢	🟡	🟡	N/A	N/A	N/A	N/A
Extended soil moisture retention	🔴	🔴	🔴	🔴	🟢	🔴	🟡**	🟡	🟡	🟡	🟡
Connection to deep soils	🟢	🟢	🟡	🟡	🔴	🟡	🟡	🟡	🟡	🟡	🟡
Other considerations											
Typical water source	Stormwater from road / pavement	Stormwater from road / pavement	Stormwater from road / pavement	Stormwater from road / pavement	Stormwater from road/pavement.	Stormwater from road / pavement	Stormwater from road / pavement	Mains potable, recycled, harvested stormwater	Mains potable, recycled, harvested stormwater	Recycled water	Any
Ideal soil conditions	Freely draining soils	Freely draining soils	Any soil type with drainage, freely draining without	Any soil type with drainage, freely draining without	Any	Freely draining soils or structural soils and cells	Any	Any	Freely draining soils	Any	Response depends on soils
Typical cost range / tree***	$500 - $1,200	$500 - $1,500	$2,000 - $10,000	$3,000 - $15,000	additional $1,000 - $3,000	$1,500 - $2,000	$5,000 - $8,000 (soils) $5,000 - $25,000 (cells)	$5,000 to $20,000	varies	$50 - $400	varies
Applicability to Greater Sydney****	Suitability is not uniform across Greater Sydney depending on soil	Suitability is not uniform across Greater Sydney depending on soil	Applicable to all three cities	Applicable to all three cities	Everywhere – preferred configuration in Western Parkland City area of Sydney	Applicable to all three cities	Applicable to all three cities	Applicable to all three cities	Applicable to all three cities	Applicable to all three cities	Applicable to all three cities
Key benefits / drivers for use	• Low cost • Low complexity	• Low cost • Low complexity • Can be retrofitted • Scalable	• Useful for stormwater quality treatment • Underdrainage reduces risk of water logging in clay soils. • Open surface allows easy access for maintenance • Scalable • Suits a variety of contexts	• Useful for stormwater quality treatment • Underdrainage reduces risk of water logging in clay soils • Grate reduces risk of soil compaction, whilst increasing trafficable area	• Good water availability • Low chance of waterlogging • Lined systems so can be adapted for use on podiums or areas with poor soils (e.g. sodic soils)	• Soil moisture recharge over a wider area • Pre-treatment to prevent sedimentation of other systems • Improved stormwater management	• Provides adequate soil volume in otherwise highly constrained sites • Adequate soil volume reduces risk of root damage to other structures (e.g. pavement damage) • Uncompacted soils can be provided under pavements	• Easily retrofit to existing irrigation system • Highly reliable supply except during water restrictions when using mains water	• Where health risk prevents aerial application • Low loss of water through runoff, aerial drift and evaporation	• Low cost intervention that may improve efficiency of manual watering • Can be set up to facilitate effective watering during drought response • Generally low risk owing to low complexity solution	• Can increase soil condition to support plants including plant available water and water retention
Key management implications / risks	• Limited water volumes in pipes • Inlets and pipes can clog • No drainage so at risk of waterlogging	• Infiltration trenches not easily cleaned of sediment • No drainage so at risk of waterlogging	• Can dry out rapidly when sandy filter media used • Filter media with high organic matter can leach nutrients into stormwater • Drainage aggregate/gravel, when laid across the full base of the pit, will create a barrier to deep soil moisture access	• Can dry out rapidly when sandy filter media is used • Filter media with high organic matter can leach nutrients into stormwater • Maintenance required to ensure surface does not clog • Grate can inhibit maintenance	• Ensure the storage zone is sized for an infrequent average dry spell	• Excessive wear from very heavy traffic and turning • Clogging of the surface in the absence of effective regular maintenance	• Higher cost solution	• Maintenance of irrigation systems can be high • Calibration of soil moisture probes required • Moderate expertise levels needed to realise benefits	• Maintenance of irrigation systems can be high in streetscapes • Prone to clogging • Linear infrastructure may be broken by other construction activities • Poor moisture distribution away from irrigation lines	• Requires manual delivery of water to fill reservoirs • Water trucks are a high cost response	• Adds cost but may be more cost effective then importing topsoil particularly if the other soil qualities are good
Cost benefit summary	Good benefit cost ratio in areas with good drainage	Good benefit cost ratio in areas with good drainage	Good benefit cost ratio in areas with poorly draining soil and requirement for stormwater treatment	Good benefit cost ratio in areas with poorly draining soil, pavement, requirement for stormwater treatment	Good benefit cost ratio for trees which may be impacted by extended dry periods	Good benefit cost ratio in areas that require a hard surface but where infiltration is desired	Good benefit cost ratio in areas where there is a risk of compaction to roots from pavement and/ or where roots could damage pavement	Good benefit cost ratio where demand management is required	Good benefit cost ratio where demand management is required	Good benefit cost ratio as a temporary measure to improve watering efficiency	Good benefit cost ratio where insitu soil condition is poor

*The risk of water logging in poorly draining soils can be addressed in design (e.g. inclusion of drainage)
** Can be designed with underground storage to improve soil moisture
*** Assumes tree pits are approximately 10m^2. These costs are estimated ranges only and are based on best available data and experience gathered through built projects. These costs will vary depending on site conditions and scale.
**** Greater Sydney can be described as a metropolis of three cities: the Western Parkland City, the Central River City and the Eastern Harbour City.

E2DESIGNLAB