Moreland City Council
Passively Irrigated Street Trees
Best practice guidelines / tech notes

Moreland City Council

1 Introduction

Passive irrigation of street trees using stormwater provides two key benefits in the urban environment:

1. Increased tree growth which in turn leads to increased ecosystem services such as helping to mitigate the Urban Heat Island Effect
2. Reduced volume and frequency of stormwater runoff which in turn helps to mitigate the Urban Stream Syndrome

Given these benefits, Moreland City Council is looking at extending the implementation of passive street tree irrigation across Council.

This technical note has been developed to outline best practice design guidelines for passive street tree irrigation, the basis of which is from the findings of two recent trials – 1) The Barrow Street trial – a partnership between Moreland City Council and The University of Melbourne (Grey et al., 2018a, Grey et al., 2018b) and 2) The Monash City Council trial – a partnership between Monash Council and The University of Melbourne (Szota et al., 2019).

In addition to the first-hand experience gained from these trials, we have included designs using 'structural soil' which was developed in the USA in the 1990's. Structural soil was designed for use under pavements to increase the available soil volume for vegetation, particularly trees, surrounded by impervious surfaces in urban areas (Grabosky & Bassuk, 1995, 1996). The large volume of structural soil required to support trees has naturally led researchers to investigate their potential as a stormwater control measure (Bartens et al., 2008, Bartens et al., 2009, Day & Dickinson, 2008). Structural soil has very high rates of infiltration and saturated hydraulic conductivity and drainage (Grabosky et al., 2009), therefore their potential as a stormwater control measure has been investigated with a detention/retention reservoir built into the design (Bartens et al., 2009); equipped with a raised overflow/outflow for flood prevention. Structural soil reservoirs work on the principle that stormwater will rapidly infiltrate and fill the reservoir, then slowly drain into the (compacted) subsoil and/or be transpired by street trees (Bartens et al., 2009). While there are examples of structural soil installations in Melbourne, specifically in the City of Melbourne, none to our knowledge have been instrumented and further, these installations typically do not have a reservoir of stormwater. The designs presented here involving structural soil reservoirs have not been tested (as of April 2019), therefore there is an element of risk involved in their implementation at this stage. That risk centres on tree health, i.e., the risk of waterlogging or adversely affecting the tree, as opposed to risks associated with stability of the pavement.

This technical note is intended to guide Council and its contractors in implementing passive street irrigation with opportunities expecting to arise from the following scenarios:

- Retrofit situations i.e. replacement of stressed trees or planting of new trees within established streets
- Capital works i.e. opportunities arising from road or footpath reconstruction
- Civic projects i.e. opportunities arising from high profile civic spaces or urban design projects

Typologies where passive irrigation are likely to be implemented within Council are shown in the table below.

1. Residential streets with no nature strip

2. Residential streets with nature strip

3. Kerb outstands

4. Road median strips

2 Best practice design guidelines

The following design guidelines (Table 1) have been developed from the findings of the two trials, experience and literature. Appendix B describes the findings from the two trials.

These guidelines have been applied to the implementation scenarios and street typologies in Moreland Council, described in the sections below. However, it should be noted that these guidelines are general in nature to allow for broad application across many different urban typologies, climates and soils.

Table 1. Best practice design guidelines.

Design principles	Design techniques

Keep inlet simple	• Use simple kerb-cut to avoid inlet blockages.
	• Note this will also transfer sediment and large debris into the passive irrigation system therefore requiring simple access to the top of the tree pit for maintenance.
	• Where kerb-cut is not preferred, use an inlet system that:
	  ◦ Avoids blockages (i.e. through having a large opening)
	  ◦ Easy to maintain e.g. by street sweeping operation and less frequently by suction/flushing/emptying operations
	  ◦ Simple and cheap (given that inlets is one of the most expensive item).

Maximise tree pit footprint	• Maximise the surface area available for the tree pit, the greater the tree pit volume, the greater the tree and stormwater benefit. • Where site constraints limit tree pit size, extend tree pits using “structural soil”. • Where stormwater runoff retention is a priority, ensure tree pits sized as at least 4 % of the catchment area (for soils with 10 mm hr^{-1} exfiltration rate, exact sizing to be determined from site exfiltration rate measurement; see Appendix A) and catch all hard surfaces.

Avoid water logging	• Assess the native soil type.
	• If clay soil, or there is the potentially for low exfiltration rates from the pit, undertake an exfiltration rate test.
	• If low exfiltration rates (exfiltration rates in top 100 mm of soil less than 20 mm hr^{-1}), then:
	  ◦ Plant tree so that the top 200 mm of root ball is above/outside of the extended detention zone, or
	  ◦ Install an underdrain.

Underdrains	• Underdrains may be required where soil exfiltration rates are low and therefore may affect tree growth. • A raised outlet should be installed on the underdrain, with the raised outlet level at ~ 300 mm below the surface level to create a water storage within the tree pit whilst avoiding waterlogging of the tree root ball. • An alternative to installing an underdrain is to plant the tree adjacent to (next to but outside of) the water receiving pit.
Improve growing media	• The use of native soil is encouraged in most circumstances. • Structural soils are recommended where the pit area may be limited, when compacted soils are encountered or when vehicular traffic is expected. • When tree pits have an underdrain and are a small size (< 2% of their catchment) the native soil should be replaced with a “biofiltration media” to reduce leaching of nutrients to waterways.
Meet stormwater objectives	• If achieving stormwater treatment / runoff reductions are a priority, tree pit area to catchment area ratios should be sized accordingly. • Appendix A contains a list of ratios to be used as a guide. If further accuracy is required modelling should be undertaken using local soil and climate data.
Avoid impact on other services	• As far as practically possible, elements of a passive irrigation system should remain away from services. Trenches around services will also carry water away.
Design to avoid future damage	• Construction markers to denote where systems are. • Increase community knowledge of these systems.

Passive irrigation – tree in footpath (retrofit)

DESIGN STATEMENT

For: passively irrigated trees planted in the footpath, implemented as a retrofit.

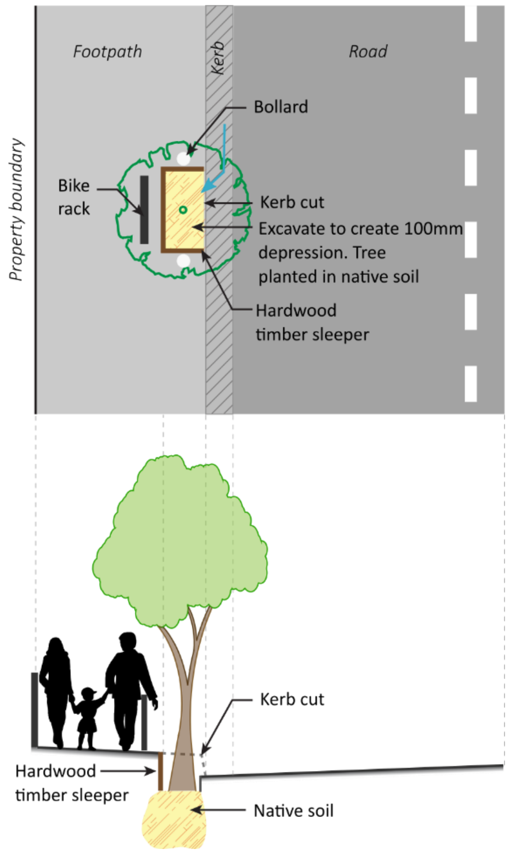
Recommended design: create a water receiving pit with the tree planted directly within the native soil (Design A).

DESIGN GUIDELINES

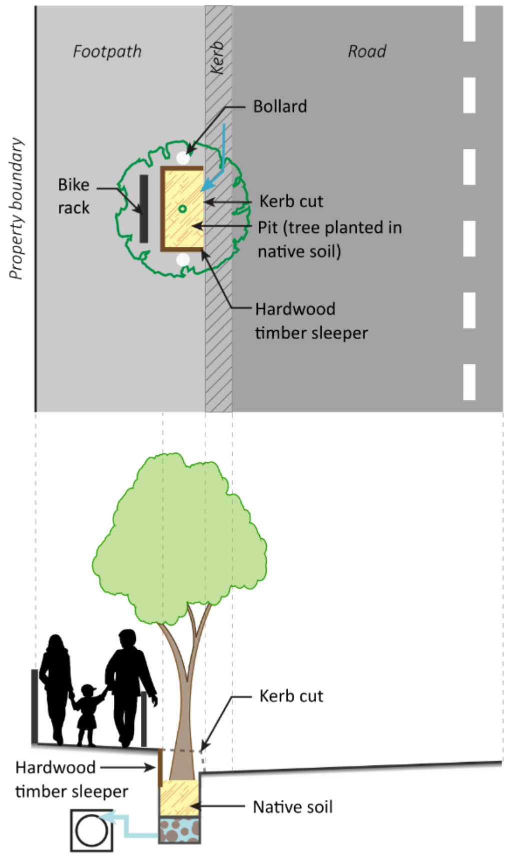
- **Excavation:** Cut and remove footpath, excavate to remove native soil to 100 mm below the channel to create an Extended Detention Depth (EDD) zone, create permanent edging at sides of footpath to prevent water undermining footpath.
- **Inlet:** Redirection of street runoff from kerb and channel via kerb cuts into the shallow depression cut into footpath. Minimum width of kerb cut 1.2 m.
- **Safety:** Ponding depth (target 100 mm) and bollards and bike rack selected to reduce tripping hazard associated with 100 mm EDD.
- **Site with normal drainage:** if native soil has normal drainage rates (exfiltration rates in top 100 mm of soil 20 mm hr^{-1} or greater), then plant tree directly in the water receiving pit.
- **Site with poor drainage:** To avoid water logging, if native soil has low exfiltration rates (exfiltration rates in top 100 mm of soil less than 20 mm hr^{-1}), then:
    - **EITHER** plant tree above the extended detention zone e.g. 200 mm of root ball is above the extended detention zone.
    - **OR** install an underdrain within the pit, with the outlet raised to create a water storage within the tree pit whilst avoiding waterlogging of the tree root ball (Design B). The outlet riser is to be located within the outlet pit to allow for adjustment of the water level within the pit as required. Council arborist to inform final level at which outlet should be set.
    - **ALTERNATELY** plant the tree adjacent to (but outside of) the water receiving pit (Design C).
- **Growing media:** The use of native soil is encouraged. If tree pit has an underdrain and is small relative to catchment (< 2% of their catchment) the native soil should be replaced with a low nutrient planting media (e.g. biofiltration media) to reduce leaching of nutrients to waterways (Design D).
- **Lining**: Trench should only be lined on the road side for the top 300 mm to protect the road pavement.
- **Stormwater retention**: All passively irrigated street trees may be sized to achieve meaningful stormwater retention. Refer to “Design of tree pits for stormwater retention” for design guidelines.

Tree in footpath (retrofit)

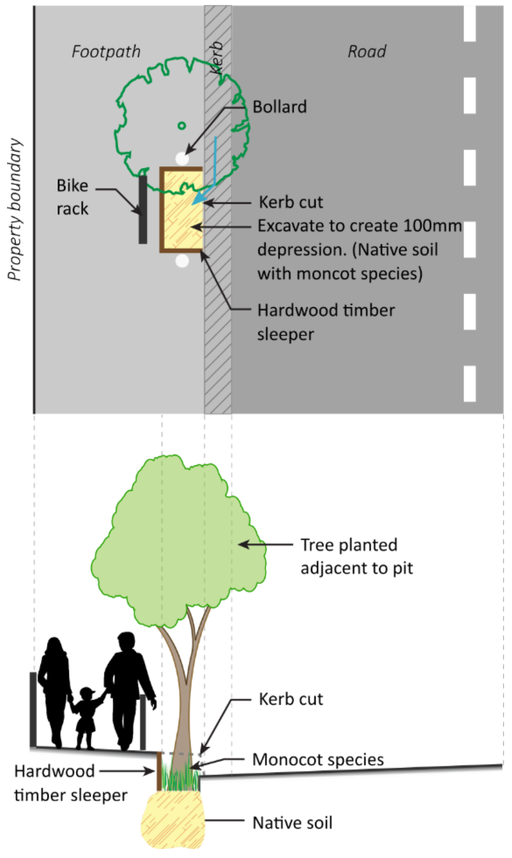
Design A



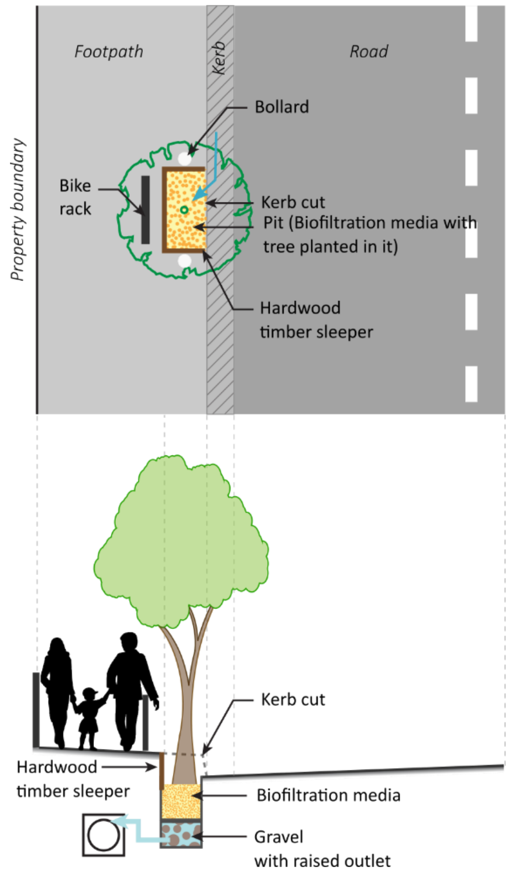
Design B



Design C



Design D



Passive irrigation – tree in footpath (road or footpath reconstruction)

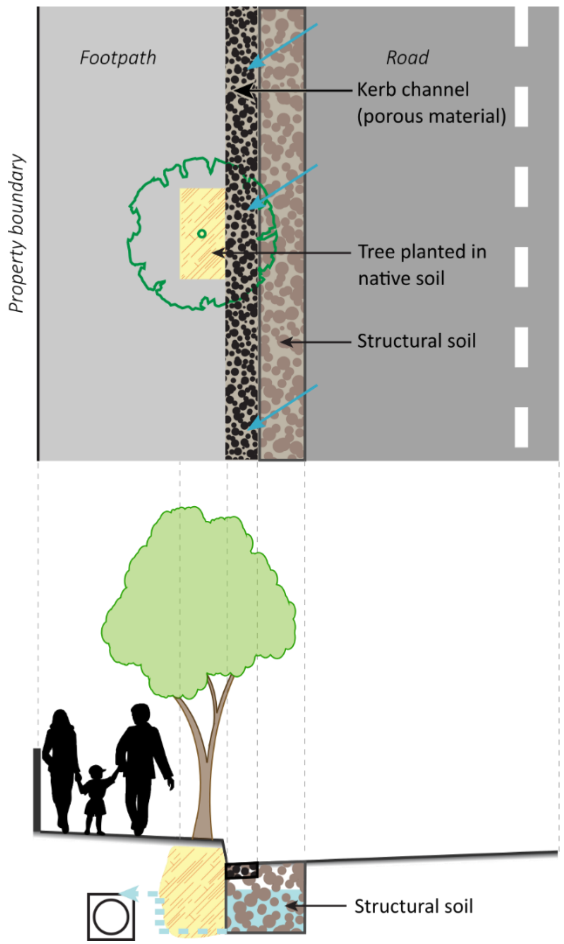
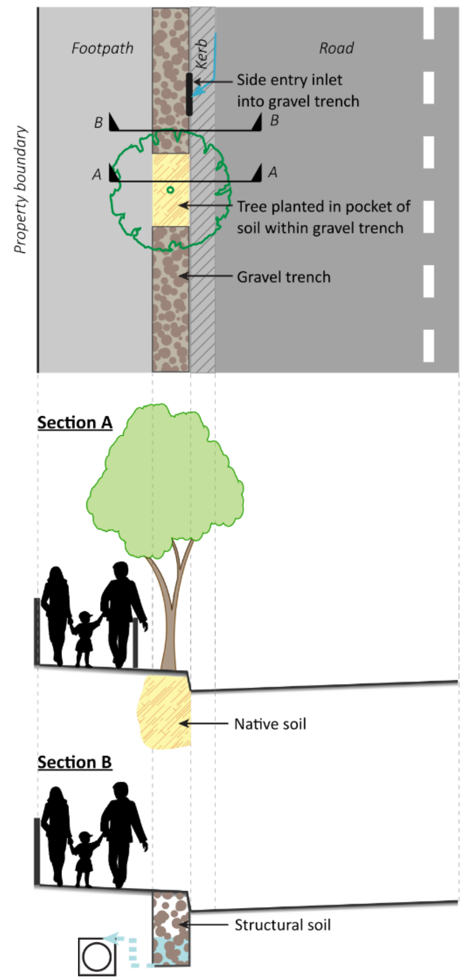
DESIGN STATEMENT

For: passively irrigated trees planted in the footpath, implemented during a road or footpath reconstruction. Recommended design: excavate a trench the length of the street (or area of works), backfilling the length of the trench with a structural soil. This is to ensure the system provide both a source of water for the trees and achieve stormwater retention.

DESIGN GUIDELINES

- **Inlet:** Design A: Structural soil trench to extend underneath the kerb and channel, with the channel replaced with "permeable pavement" that allows runoff to flow directly into the structural soil trench below. Trench may also extend underneath footpath. Trees planted within pockets of soil within trench or adjacent to the trench. Design B: Redirection of street runoff from kerb and channel via side entry pit inlets into the structural soil trench. Trees planted within native soil adjacent to trench.
- **Safety:** Design avoids tripping hazards associated with kerb cut.
- **Drainage**: An underdrain should be installed along the base of the structural soil trench, with the outlet raised to create a water storage within the trench whilst avoiding waterlogging of the tree root ball. The outlet riser is to be located within the outlet pit to allow for adjustment of the water level within the pit as required.
  If native soil has exfiltration rates greater than 20 mm hr^{-1} then the underdrain may be omitted.
- **Lining**: Trench should be lined on the road side only for the top 300 mm.
- **Stormwater retention:** Refer to "Design of tree pits for stormwater retention" for design guidelines. In practice trenches should be at least 900 mm deep and as wide as practically possible accounting for other site constraints.

Tree in footpath (road or footpath reconstruction)

Design A	Design B
	

Passive irrigation – tree in roadway (retrofit)

DESIGN STATEMENT

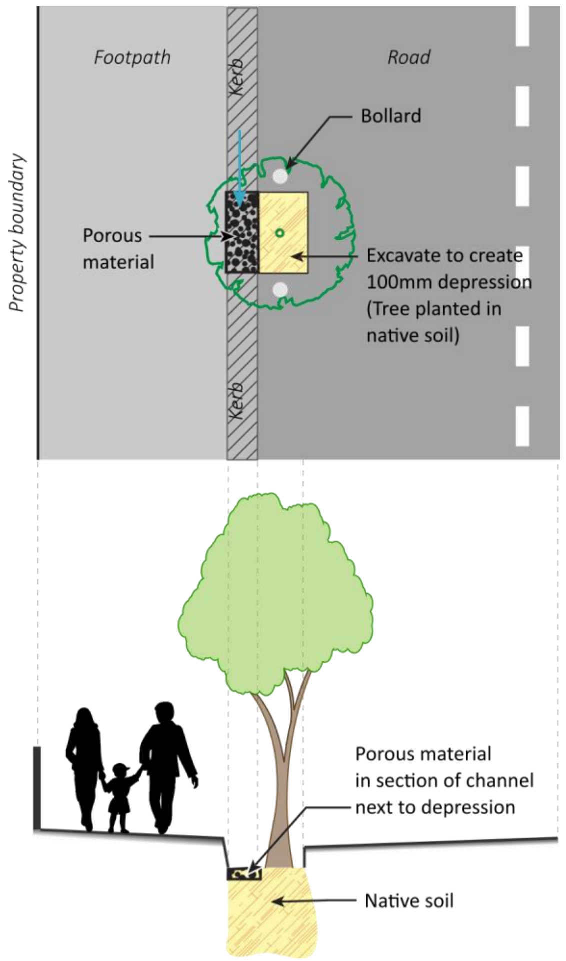
For: passively irrigated trees planted in the roadway, implemented as a retrofit.
Recommended design: create a water receiving pit within the roadway with the tree planted directly within the native soil (Design A).

DESIGN GUIDELINES

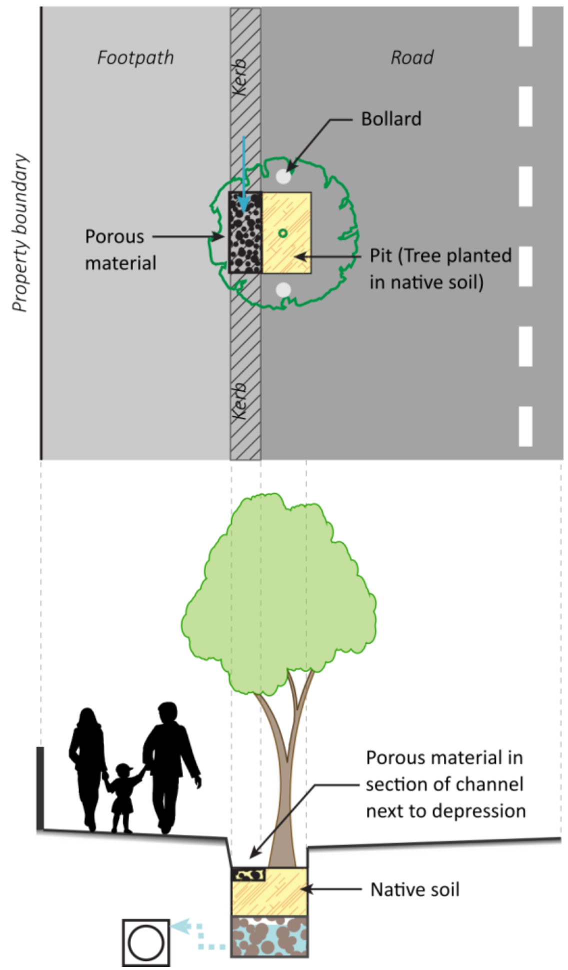
- **Excavation:** Cut and remove road pavement and channel, excavate to remove native soil to 100 mm below the channel to create an Extended Detention Depth (EDD) zone, create permanent edging at sides of road to prevent water undermining of road pavement.
- **Inlet:** Redirection of street runoff from kerb and channel into the shallow depression cut into roadway. The section of the kerb and channel next to the depression to be permeable paving material to avoid scouring.
- **Safety:** Ponding depth (target 100 mm) and bollards selected to reduce tripping hazard associated with 100 mm EDD.
- **Site with normal drainage:** if native soil has normal drainage rates (exfiltration rates in top 100 mm of soil 20 mm hr^{-1} or greater), then plant tree directly in water receiving pit.
- **Site with poor drainage:** To avoid water logging, if native soil has low exfiltration rates (exfiltration rates in top 100 mm of soil less than 20 mm hr^{-1}), then:
  - **EITHER** plant tree so that the top 200 mm of root ball is above/outside of the extended detention zone.
  - **OR** install an underdrain along the base of the pit, with the outlet the outlet raised to create a water storage within the tree pit whilst avoiding waterlogging of the tree root ball (Design B). The outlet riser is to be located within the outlet pit to allow for adjustment of the water level within the pit as required. Council arborist to inform final level at which outlet should be set.
- **Growing media:** The use of native soil is encouraged. If tree pit has an underdrain and is small relative to catchment (< 2% of their catchment) the native soil should be replaced with a “biofiltration media” to reduce leaching of nutrients to waterway (see Design C).
- **Lining**: Trench should be lined on the road side only for the top 300 mm.
- **Stormwater retention:** All passively irrigated street trees may be sized to achieve meaningful stormwater retention. Refer to “Design of tree pits for stormwater retention” for design guidelines.

Tree in roadway (retrofit)

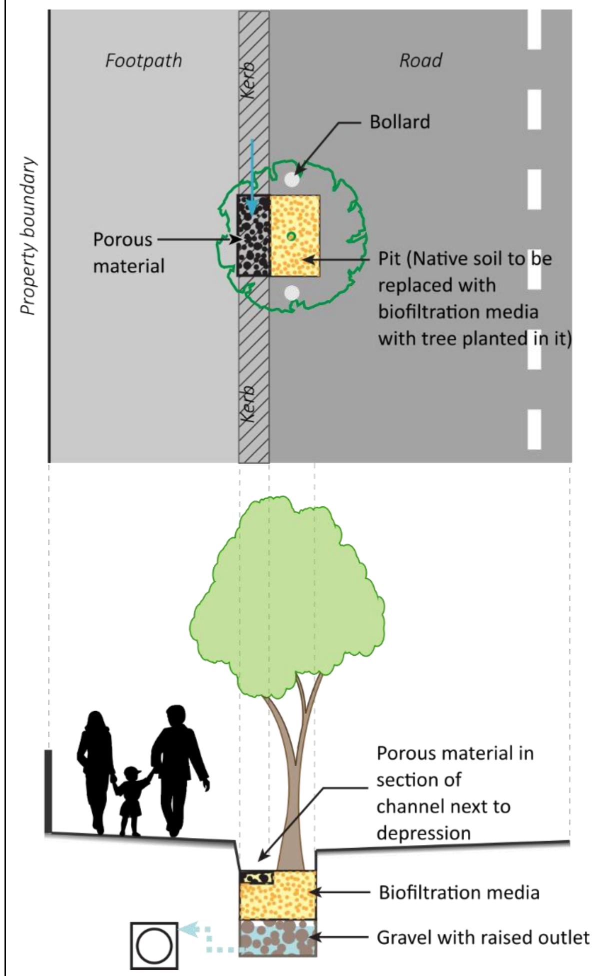
Design A



Design B



Design C



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Passive irrigation – tree in roadway (road reconstruction)

DESIGN STATEMENT

For: passively irrigated trees planted in the roadway, implemented during a road reconstruction.
Recommended design: excavate a trench the length of the street (or area of works), backfilling the length of the trench with a structural soil, and planting the trees within the structural soil trench (Design A).

DESIGN GUIDELINES

- **Inlet:** Design A: Structural soil trench to extend underneath the kerb and channel, with the channel and road above trench replaced with "permeable pavement" that allows runoff to flow directly into the structural soil trench below.
  OR Design B: Redirection of street runoff from kerb and channel into a shallow depression cut into roadway. The section of the kerb and channel next to the depression to be constructed of permeable material designed to avoid scouring while allowing infiltration.
- **Safety:** Design A avoids tripping hazards associated with kerb cut. In Design B, ponding depth (target 100 mm) and bollards are included to reduce tripping hazard associated with associated with 100 mm EDD.
- **Drainage**: An underdrain should be installed along the base of the structural soil trench, with the outlet into a drainage pit raised to be 300 mm below the channel level. The outlet riser is to be located within the outlet pit to allow for adjustment of the water level within the pit as required.
  If native soil has exfiltration rates greater than 20 mm hr^{-1} then the underdrain may be omitted.
- **Lining**: Trench should be lined on the road side only for the top 300 mm.
- **Stormwater retention:** All passively irrigated street trees may be sized to achieve meaningful stormwater retention. Refer to "Design of tree pits for stormwater retention" for design guidelines.

<table>
<tr><th colspan="2">Tree in roadway (road reconstruction)</th></tr>
<tr><th>Design A</th><th>Design B</th></tr>
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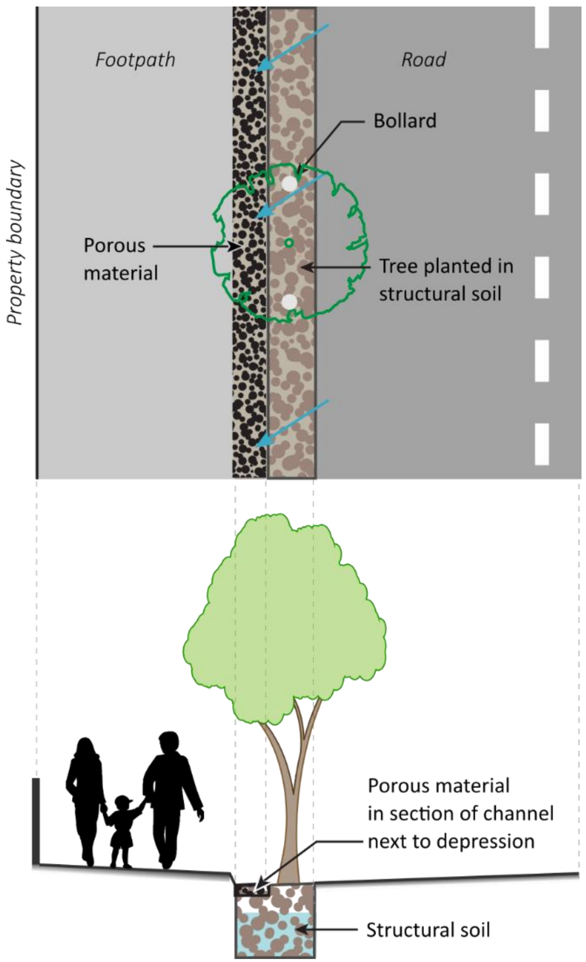

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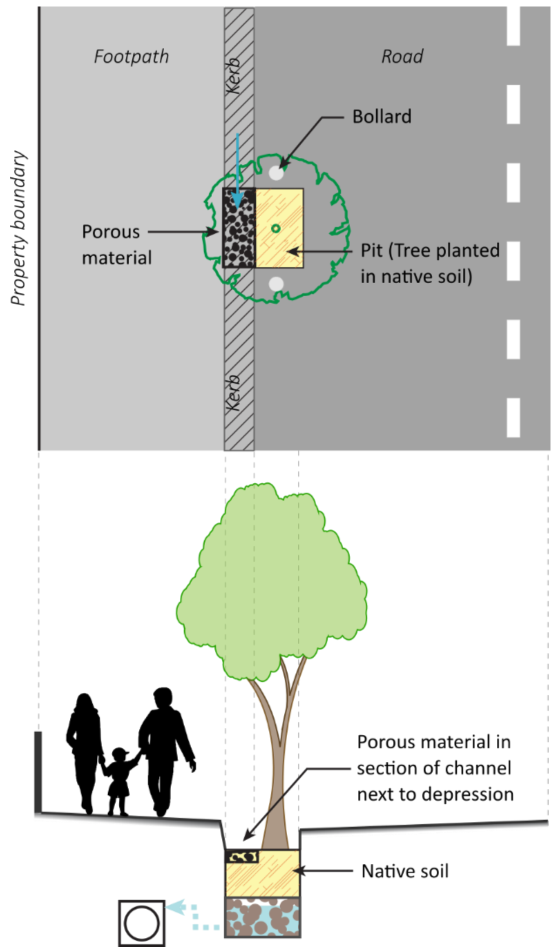

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Passive irrigation – tree in nature strip or road median strip (retrofit)

DESIGN STATEMENT

For: passively irrigated trees planted in the nature strip or road median strip, implemented as a retrofit.

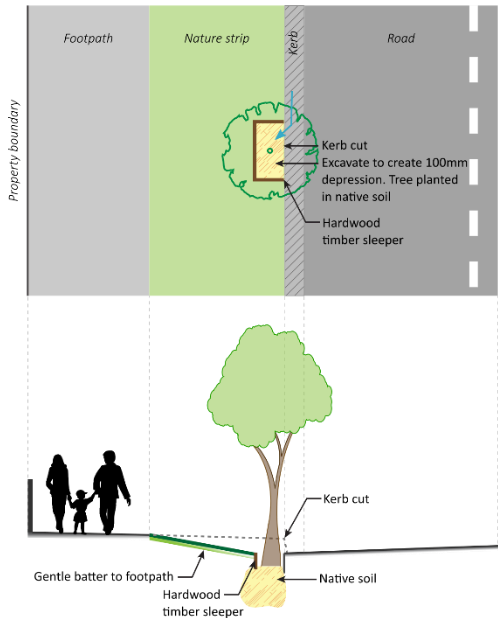
Recommended design: create a water receiving pit for each individual tree with the tree planted directly within the native soil (Design A).

DESIGN GUIDELINES

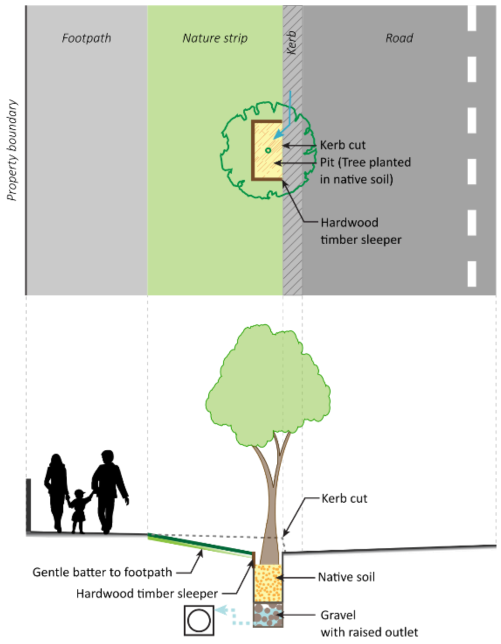
- **Excavation:** Excavate nature strip to remove native soil to 100 mm below the channel, create permanent edging at sides of footpath to prevent water undermining footpath.
- **Inlet:** Redirection of street runoff from kerb and channel into the shallow depression cut into the nature strip.
- **Safety**: Nature strip to be graded to create gentle slopes (no steeper than 1:3) and avoid drop offs into Extended Detention zone.
- **Site with normal drainage:** If native soil has normal drainage rates (exfiltration rates in top 100 mm of soil 20 mm hr^{-1} or greater), then plant tree directly in water receiving pit.
- **Site with poor drainage:** To avoid water logging, if native soil has low exfiltration rates (exfiltration rates in top 100 mm of soil less than 20 mm hr^{-1}), then:
    - **EITHER** plant tree so that the top 200 mm of root ball is above/outside of the extended detention zone
    - **OR** install an underdrain along the base of the pit, with the outlet the outlet raised to create a water. storage within the tree pit whilst avoiding waterlogging of the tree root ball (Design B). The outlet riser is to be located within the outlet pit to allow for adjustment of the water level within the pit as required. Council arborist to inform final level at which outlet should be set.
    - **ALTERNATIVELY,** plant the tree adjacent to (but outside of) the water receiving pit (Design C).
- **Growing media:** The use of native soil is encouraged. If tree pit has an underdrain and is small relative to catchment (< 2% of their catchment) the native soil should be replaced with a “biofiltration media” to reduce leaching of nutrients to waterways (Design D).
- **Lining**: Trench should only be lined on the road side for the top 300 mm.
- **Stormwater retention:** All passively irrigated street trees may be sized to achieve meaningful stormwater retention. Refer to “Design of tree pits for stormwater retention” for design guidelines.

Tree in nature strip or road median strip (retrofit)

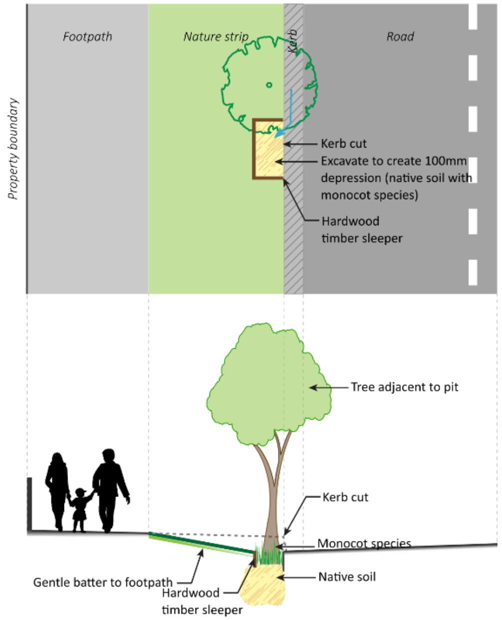
Design A



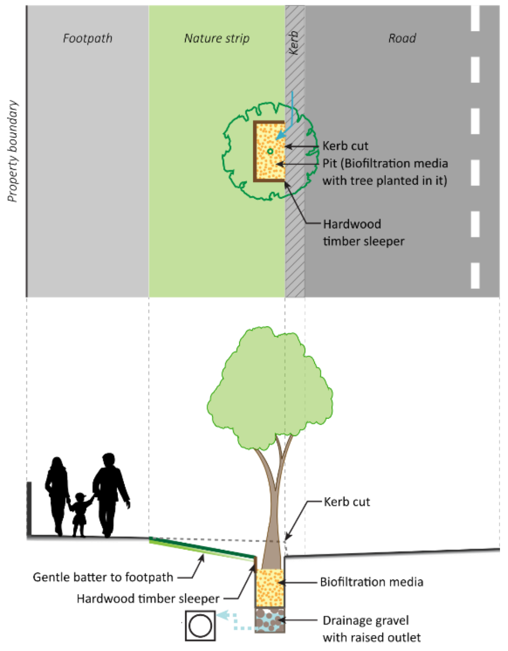
Design B



Design C



Design D



Passive irrigation – tree in nature strip or road median strip (road reconstruction)

DESIGN STATEMENT

For: passively irrigated trees planted in the nature strip or road median strip, implemented during a road reconstruction.

Recommended design: excavate a swale within the nature strip or road median strip with an optional underlying gravel trench (Design A).

DESIGN GUIDELINES

Inlet: Design A: Street runoff to flow directly into a swale constructed within the nature strip (broken or no kerb) with an optional underlying gravel trench

Design B: Structural soil trench to extend underneath the kerb and channel, with the channel replaced with “permeable pavement” that allows runoff to flow directly into the structural soil trench below. Trees planted within native soil adjacent to trench.

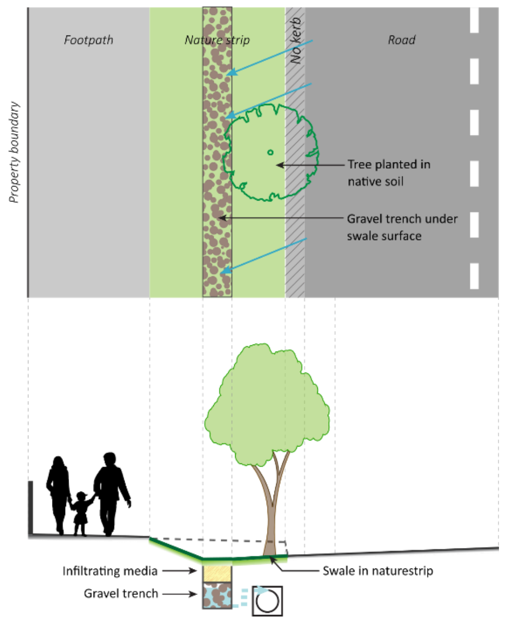
Design C: Redirection of street runoff from kerb and channel via side entry pit inlets into the structural soil trench. Trees planted within pockets of soil within trench.

Design D: Multiple kerb cuts along the length of a gravel trench allowing water to flow into a several shallow depressions on top of the trench. Trench to be covered with grass to allow runoff to flow directly into the structural soil trench below. Trees planted within pockets of soil within trench.

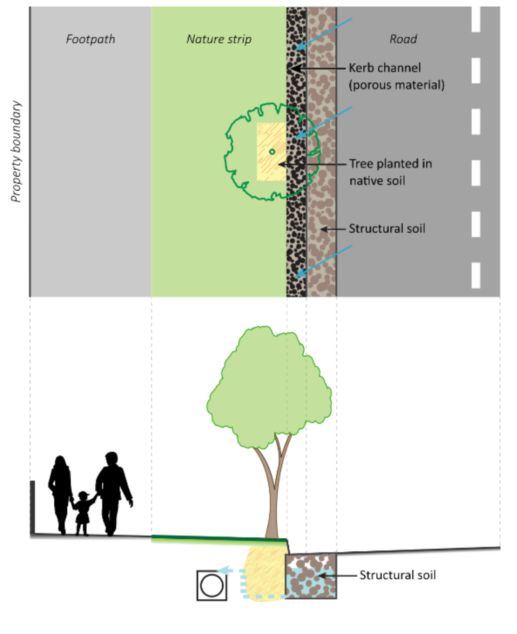
- **Safety:** Ponding depth and bollards selected to reduce tripping hazard
- **Drainage:** An underdrain should be installed along the base of structural soils or gravel trench, with the outlet raised to create a water storage. The outlet riser is to be located within the outlet pit to allow for adjustment of the water level within the pit as required. Council arborist to inform final level at which outlet should be set. If native soil has exfiltration rates greater than 20 mm hr^{-1} then the underdrain may be omitted.
- **Lining**: Trench should be lined on the road side only for the top 300 mm.
- **Stormwater retention:** All passively irrigated street trees may be sized to achieve meaningful stormwater retention. Refer to “Design of tree pits for stormwater retention” for design guidelines.

Tree in nature strip or road median strip (road reconstruction)

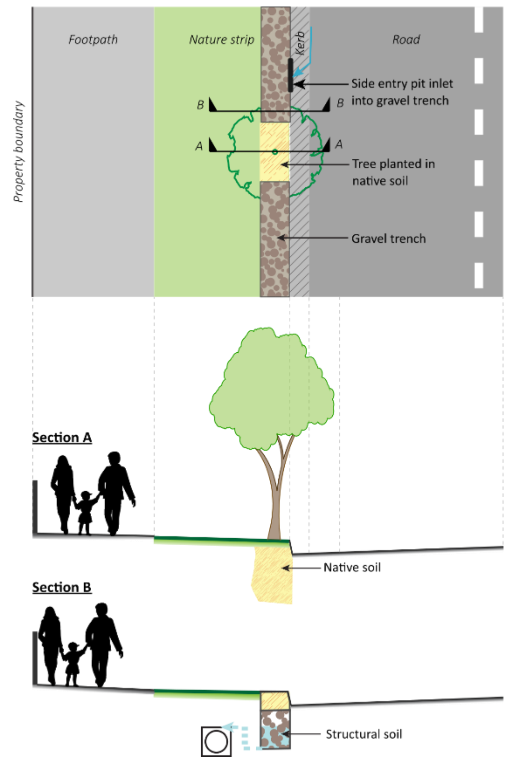
Design A



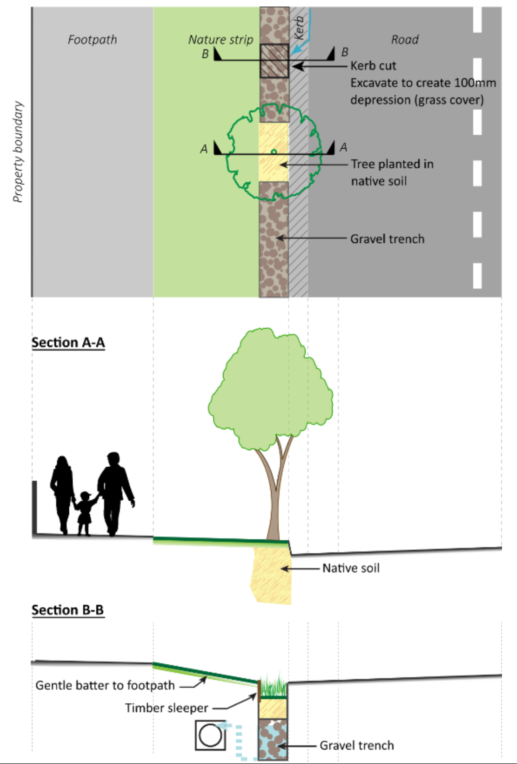
Design B



Design C



Design D



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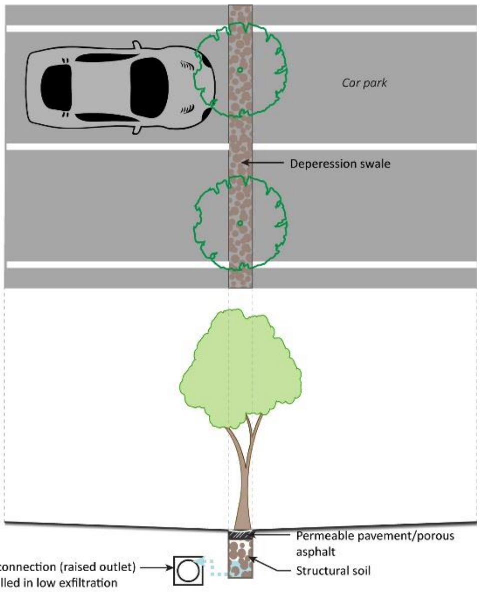
Passive irrigation – tree in car park (retrofit or car park reconstruction)



DESIGN STATEMENT

For: passively irrigated trees planted in a car park, implemented as a retrofit or during a carpark reconstruction.

Recommended design: create a linear depression swale consisting of structural soil with the tree planted in the structural soil.

DESIGN GUIDELINES

- **Inlet:** Reprofiling of car park surface to direct runoff towards linear depression/swale. Surface above trench of permeable paving / porous asphalt to infiltrate runoff into the underlying structural soil trench.
- **Drainage:** An underdrain should be installed along the base of structural soils or gravel trench, with the outlet raised to create a water storage. The outlet riser is to be located within the outlet pit to allow for adjustment of the water level within the pit as required. Council arborist to inform final level at which outlet should be set.
  If native soil has exfiltration rates greater than 20 mm hr^{-1} then the underdrain may be omitted.
- **Growing media:** Structural soil is recommended to allow vehicle traffic, yet a suitable growing media compared to compacted soils.
- **Stormwater retention:** All passively irrigated street trees may be sized to achieve meaningful stormwater retention. Refer to “Design of tree pits for stormwater retention” for design guidelines.

GENERAL

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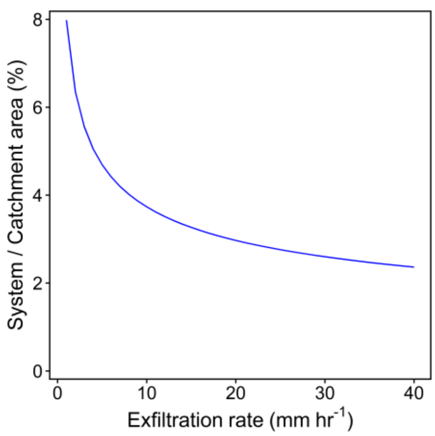
Design of tree pits for stormwater retention

Exfiltration rate	Tree pit area / catchment area
1 mm hr^{-1}	8.0 %
6 mm hr^{-1}	4.4 %
10 mm hr^{-1}	3.8 %
20 mm hr^{-1}	3.0 %
34 mm hr^{-1}	2.5 %



DESIGN STATEMENT

All passively irrigated street tree installations can be designed to provide a stormwater retention or stormwater treatment benefit. To achieve meaningful runoff reductions, the area of the tree pits need to be appropriately sized according to the tree pit exfiltration rate.

DESIGN GUIDELINES

- **Sizing**: To achieve meaningful stormwater treatment or runoff reduction, the tree pit area needs to be sized according to the exfiltration rate of the native soil. The table contains a list of ratios to be used as a guide based upon the Moreland climate and a range of commonly encountered native soil exfiltration rates within Moreland. For example, for a soil exfiltration rate of 10 mm hr^{-1} the tree pit should be sized to be at least 4 % of the catchment area. If further accuracy is required modelling should be undertaken using local soil and climate data.
- **Determining exfiltration rate**: Exfiltration rate for a site can be determined through:
  - Undertake a soil textural analysis
  - If soil type determined as “clay”, then undertake “in-situ” saturated hydraulic tests for at least three pits spread across the project site (http://www.monash.edu.au/fawb/products/fawb-practice-note1-in-situ-measurement-of-hydraulic-conductivity.pdf)
  - Note: Exfiltration rates may be highly variable across a site. Therefore, for high profile sites it’s recommended to undertake an exfiltration rate test for each pit or install an underdrain

Appendix A: Lessons learnt

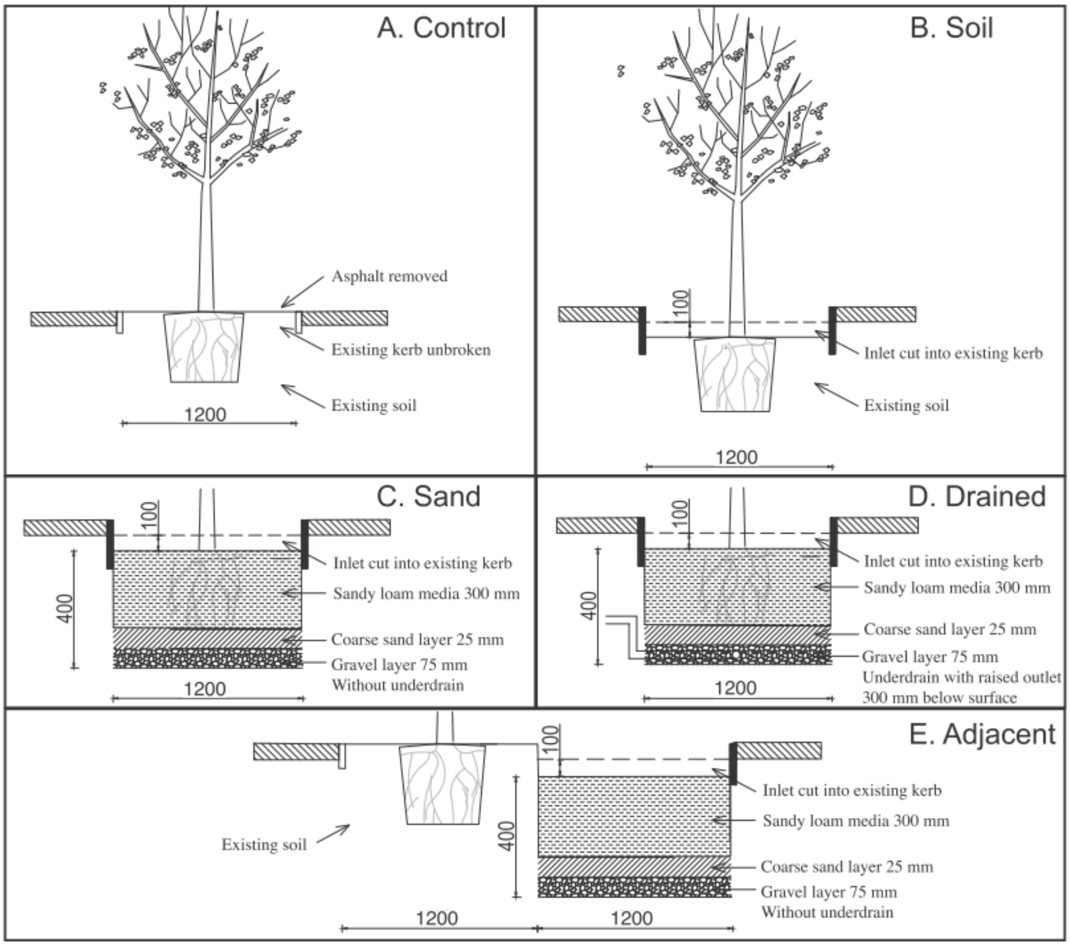
The findings from the Barrow Street trial and the Monash trial are outlined below in the tables below.

Table 2. Moreland City Council Passive Street Tree Irrigation Trial

Moreland City Council Passive Street Tree Irrigation Trial	
Project objectives	Trial to test various design configuration to: • Improve street tree growth. • Reduce urban stormwater runoff.
Passive irrigation design elements	Tree pit designs were tested with each watered by street runoff via kerb-cuts. The five designs tested were: A. Control tree (standard street tree planning). B. Trees planted in native soil. C. Trees planted in a filter media profile (sandy loam + gravel layer) without an underdrain. D. Trees planted in a filter media profile (sandy loam + gravel layer) with an underdrain (no saturated zone). E. Trees planted adjacent to a filter media profile (sandy loam + gravel layer) without an underdrain.
Outcomes achieved	• The trial has demonstrated street tree growth is approximately doubled when grown in a filter media profile with an underdrain and fed by street runoff compared to standard tree planting in existing native soil. • Tree growth in pits without an underdrain was strongly correlated with the soil exfiltration rate. Low rates (<20 mm hr^{-1}) resulted in poor growth or death, whereas pits with higher exfiltration rates showed equal or increased growth compared with the standard street tree planting. • These systems can achieve stormwater reduction benefit if they are sized appropriately relative to the catchment area.
Lessons Learnt	• Soil exfiltration rates are site specific and can vary largely within a street. For example, perched water table existed at one end and not the other. • Kerb-cut inlets are simple and reduce risk of blockages, but they transfer sediment and debris into the pits. • If systems are sized sufficiently large relative to catchment (e.g. at least 4 %), high stormwater retention can be achieved.

Figure 1. *System C*

Figure 2. *System D*



A. Control
Asphalt removed
Existing kerb unbroken
Existing soil
1200
B. Soil
100
Inlet cut into existing kerb
Existing soil
1200
C. Sand
100
400
Inlet cut into existing kerb
Sandy loam media 300 mm
Coarse sand layer 25 mm
Gravel layer 75 mm
Without underdrain
1200
D. Drained
100
400
Inlet cut into existing kerb
Sandy loam media 300 mm
Coarse sand layer 25 mm
Gravel layer 75 mm
Underdrain with raised outlet
300 mm below surface
1200
E. Adjacent
100
400
Existing soil
Inlet cut into existing kerb
Sandy loam media 300 mm
Coarse sand layer 25 mm
Gravel layer 75 mm
Without underdrain
1200
1200

Table 3. City of Monash Passive Street Tree Irrigation Trial

City of Monash Passive Street Tree Irrigation Trial	
Project objectives	A trial to test passive irrigation system (gravel infiltration trench) alongside established trees to: • Increase water available to street trees. • Reduce stormwater runoff volumes. • Two inlet types were also tested (i.e. 'lintel' and 'soaker pit') to compare stormwater capture efficiency and maintenance requirements.
Passive irrigation design elements	Infiltration gravel trench adjacent to trees are fed by street runoff via "lintel" or "soaker pits". No underdrainage is included. Trench fills up with water and overflows into existing kerb and channel.
Outcomes achieved	• Based on monitoring data, significant volume of stormwater runoff is retained and used by the established trees. • However, the volume of stormwater retention was less than expected which was driven by inlet blockages. • Trees used up to 70 L of water per day during spring/summer. • During the monitoring period, the additional water associated with the trench has had no measurable impact on tree growth or water stress when compared to control trees. The conclusion is that these trees are already well established and have adequate access to soil moisture with or without the infiltration trench (e.g. rainfall, leaky pipes, services trenches filled with water, irrigated front yards).
Lessons Learnt	• Both inlet types are prone to blockages from sediment and debris. Inlets designed to prevent transmission of sediment and debris are likely to block quickly and limit the volume of stormwater than can be captured. • Permeable pavers in the inlet pits quickly clog and require flushing. Pavers were replaced with simple mesh during the trial to facilitate maintenance. • Lintel pits can be cleared by regular street sweeping operations. However car parking and drivers not knowing exactly where the lintels are located can hinder this operation. • Despite inlet blockages, sufficient water was captured by the infiltration trench to sustain tree water use. • Gutter flow velocity can affect inlet capture efficiency, most likely by mobilising sediment and debris. • Existing drain at back of kerb can take water away from the gravel trench. This can be minimised by using a liner, sealing connections and extending the liner beyond the trench length, and allowing a buffer to the drain. • Soaker pit costs around $2,000 per unit and is significantly more expensive that the lintel at $ 400 per unit. • Three of the 24 systems have been compromised i.e. where houses have been demolished and the nature strip excavated to disconnect/reconnect services. • There has been no observed impact on road pavement.

Figure 4. *Lintel inlet*

Figure 5. *Soaker pit inlet*

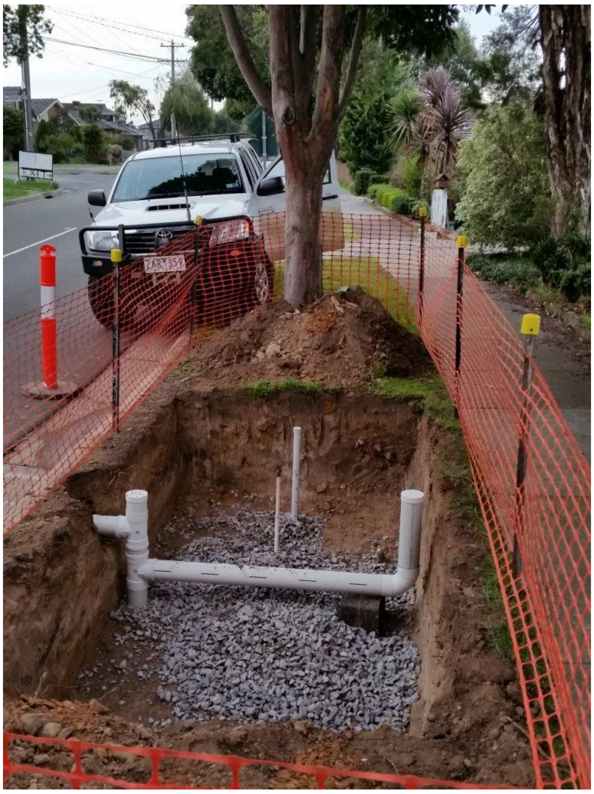


Figure 6. *Gravel trench within nature strip*

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