Three Designs for Passively Watered Street Trees

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Highlights

- Designs have been developed to allow street trees to be passively watered by road runoff
- A novel sediment filter was developed to prevent clogging and facilitate maintenance
- The contribution of street trees to stormwater pollutant removal and flow reduction was estimated

Introduction

Water Smart Street Trees (WSSTs) are street trees that are watered by stormwater runoff from the road pavements. Such street trees can be implemented for the dual purposes of filtering polluted stormwater to protect the receiving environment, and for providing the trees with additional water to improve the health and longevity of street trees.

In recent years, several Australian cities have been trialling the benefits of WSSTs. However, there is limited design guidance available for WSSTs, so standard designs and construction drawings were developed. This paper summarizes the work carried out during the study. It describes the drivers of each of the WSST designs, design opportunities and limitations, and presents estimates of pollutant removal performance and relative cost.

Methodology

Scenarios relevant to urban development and existing urban areas in the dry tropics of Queensland were explored based on locally observed opportunities for the implementation of water smart street trees (refer Table 1 and Figure 1).

Table 1. Design scenarios developed for Water Smart Street Trees, including urban setting, landscape design objectives and relative cost

Scenario/Design Name	Urban Typology	Landscape Objective	Cost
Greenfield	Greenfield Development	New Tree	Low
Minor Retrofit	Established Suburban	Retain Existing Tree	Low
Major Retrofit	Established Dense Urban	Replace Failed Tree	High


Figure 1. (Left) Greenfield development suited to the Greenfield WSST scenario, or the Minor Retrofit scenario. These trees would probably grow more quickly and would be in better health if more soil moisture was available. (Right) Failed trees in a highly urbanised setting where soil moisture severely limits the potential of street trees. – the Major Retrofit scenario would be appropriate here.

Since the problem of clogging with sediments is ever-present in WSST design, the designs included a novel stormwater prefilter that prevents the clogging of the flow distribution pipes. Additionally, the pollutant removal efficiencies of each design were calculated using industry standard software (MUSIC).

Results and discussion

The designs relied on kerb cuts connected to sub-soil perforated pipe ('ag-pipe') to allow the tree root zone to be watered with road runoff. Here, sediment protection is an important issue as design experience in Australia to date has found that once sediment accumulates in the inlet of a street tree, a large proportion of runoff bypasses the inlet (*pers comm*. Tim Davies Brisbane City Council 2019). Hence the tree is not watered, and the runoff is not treated. To overcome this issue, a sediment filter was designed in association with this project. The design was a collaboration between Salvador Prado (AECOM) and Jared Johnston (TCC) (refer Error! Reference source not found.).

Nylon mesh filter socks filters are widely available for the purposes of filtering water, for example in the aquarium industry or for cleaning pools. A filter sock was adapted to fit the ag pipe that would be used to water street trees from the kerb cut. The following components were used:

- Nylon sock filter (200 Micron 15" Length 4" Ring Nylon Filter Sock Aquarium Marine Set ES)
- Grate (Kinetic 100mm Chrome Plated Round Floor Grate). This prevents large debris from occluding the filter
- AG pipe adaptor (Vinidex 100mm Draincoil Coupling).

Maintenance of the filter simply requires the removal the nylon bag from the interior of the filter and rinsing with water. The maintenance can be carried out during the annual pruning of trees. The prototype cost about $40 AUD per unit. However, it is expected that the price will be less if bought in bulk.

Figure 2. Nylon mesh filter sock prototype showing cleanout of trapped sediments

The Greenfield WSST scenario (Figure 3) is based on minimal intervention. Kerb cuts and ag-pipe could be provided with street trees in new urban developments for very little additional cost. It is assumed that ample soil volumes are available to each tree and no imported planting soil would be required.
The Minor Retrofit WSST scenario (Figure 4) also relies on minimal interventions. A sand-filled trench could be connected to the kerb cut. The trench would act as a temporary water storage that allows road runoff to soak into the soil surrounding the street trees.
The Major Retrofit WSST scenario (Figure 5) aims to provide a reservoir of water for trees in highly constrained environments with limited soil volumes. It uses a sub-soil sand layer as a 'wicking bed'.

Modelling stormwater runoff with MUSIC software indicated that the developed designs were capable of infiltrating about 20 % of the runoff from their respective catchments. Predicted pollutant removal was approximately: Total Suspended Solids – 50 % reduction, Total Phosphorus – 30 % reduction, Total Nitrogen 15 % reduction. Incorporating infiltration would result in even higher pollutant reductions.

Conclusions and future work

Water Smart Street Trees offer the potential for substantial pollutant removal and reductions in urban runoff excess by using existing assets that are present in most urban settings. Paired trials should be undertaken to compare the soil moisture and tree growth/health of WSSTs in comparison to street trees not watered by road runoff.

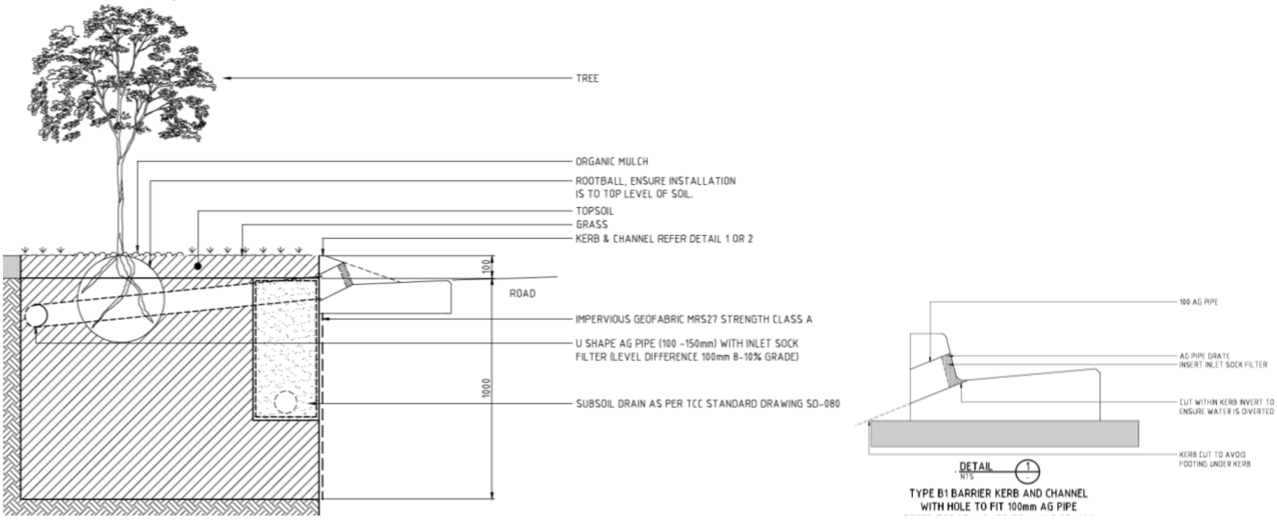

Figure 3. (Left) Greenfield WSST scenario illustrating kerb cut and ag pipe for water distribution around tree root ball. (Right) Kerb cut with ag pipe insertion. The pavement subsoil drain immediately adjacent to the kerb prevents soil waterlogging and protects the pavement from damage associated with soil saturation.

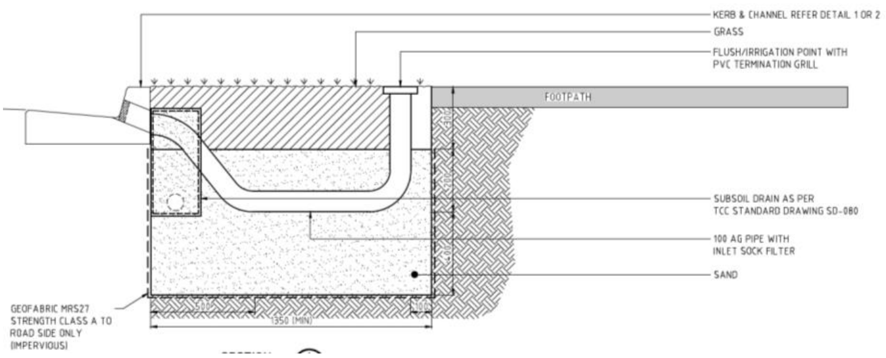

Figure 4. Minor Retrofit WSST scenario illustrating kerb cut and ag pipe for water distribution. An impervious liner protects the pavement infrastructure.

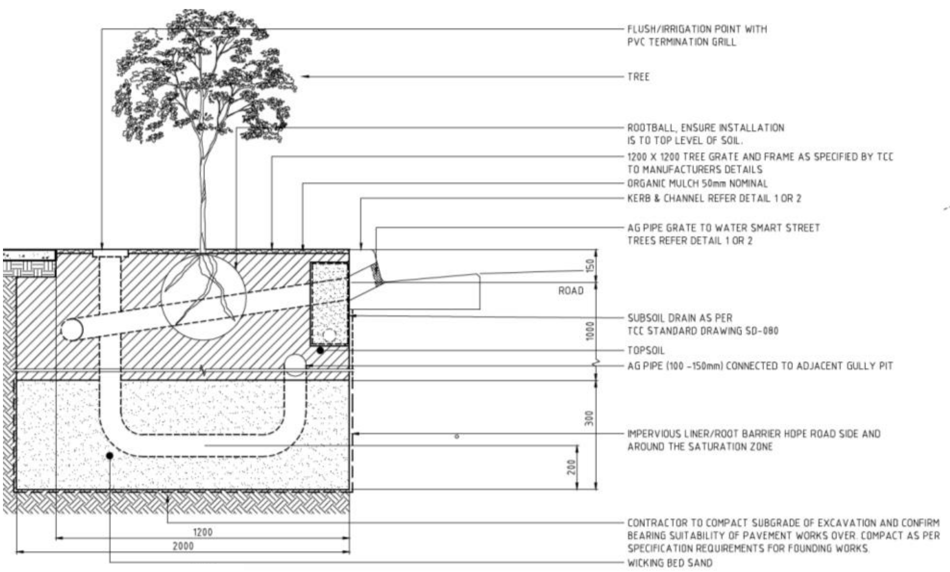

Figure 5. Major Retrofit WSST scenario illustrating kerb cut and ag pipe for water distribution above 'wicking bed' water storage

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