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Title: WATERING OF STREET TREES: THEORY AND PRACTICE

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ABSTRACT

One consequence of the drought has been the reduced availability of water to maintain urban trees in cities around Australia.

The street tree is generally recognized as the largest and most important greening element in the urban landscape. There have been and continue to be many efforts to deliver water to stressed street trees in an attempt to prevent loss of amenity and increased maintenance requirements through decline in tree health. Maintaining trees in a healthy condition is a high priority for many public open space managers.

The size of the plant, extensiveness of the root system and the physical environment in which it grows presents significant challenges to those responsible for the watering of the trees.

There have been a variety of techniques and technologies employed in street tree watering in Australia. These include both temporary (drought management) and permanent type watering installations. An overview of these various approaches is presented.

The Melbourne City Council is responsible for over 55,000 trees with 19,000 of these located in streetscapes and boulevards. These trees have a very high value to the people of Melbourne.

A project has been conducted during 2007, by the City of Melbourne, to evaluate a range of tree watering technologies. These technologies include drip systems, watering wells and watering trenches.

An outline of the evaluation trial and the performances of the various technologies is presented and discussed. A key part of the evaluation is the establishment of criteria used to assess particular technologies. The impact of the technology on the tree root

system, water distribution within the soil profile and the installation requirements are some of the criteria used.

STREET TREES IN THE CITY OF MELBOURNE

Value of Street Trees

The City of Melbourne is internationally recognised for its tree-lined boulevards, parks and gardens. Trees beautify, define and soften landscapes and give scale to buildings in addition to providing shade and wildlife habitat. Trees are the most life enriching of all the types of vegetation used in the urban environment. They also contribute significantly to the maintenance of a healthy urban environment by trapping airborne pollutants and absorbing carbon dioxide.

Melbourne's community is protective of its trees and interested in their health and maintenance. Consequently, any issues relating to Melbourne's trees generally have a high profile and generate considerable public debate and passion.

It is important that Council protect its trees, demonstrates to the community that it is doing so and is able to provide a rationale for the decisions it makes.

The City of Melbourne manages approximately 55,000 trees including approximately 18,000 street trees. Using the City's 'tree amenity valuation formula' the total value of Melbourne's trees is estimated to be over $550 million. This asset is irreplaceable in the short term and the tree population requires close monitoring and management to ensure its continued good health. Street trees also increase values of adjoining properties.

Melbourne has some of the most significant stands of mature elm trees remaining in the world following the destruction of many of the elm populations in the Northern Hemisphere by Dutch Elm Disease. The elms lining the major boulevards of Victoria Parade and Royal Parade, along with the avenues of trees in the Fitzroy Gardens are registered as significant by the National Trust.

Trees like all living things grow, age and eventually die. The overall age distribution of the City's tree stock is skewed to older-aged trees, leading to potential loss of large number of trees over the next 10-15 years. Loss of such large numbers of trees could have a devastating effect on the amenity of parks and streetscapes. Most of the boulevard and avenue trees were planted between the late 1800s and early 1900s and are also nearing the end of their lives. As trees age they become more vulnerable to pest and disease and other environmental pressures such as drought, compaction, pollution and traffic, all of which cause tree decline and contribute to early death.

Irrigation and Impact of Drought

Irrigation systems in the past have generally been designed to water the park surface, median or nature strip grass using manual or automatic surface sprinklers. Although this method of watering keeps the grass green it is not efficient in watering trees as it encourages them to develop surface root systems. Regardless of the species of trees and because of historical horticultural practices and the perception that water is a

limitless commodity, trees have become dependent on regular surface watering and are less drought tolerant. Of the City's tree stock approximately 15,000 trees have grown in turf areas with regular irrigation.

Many of the trees in the City of Melbourne have been stressed over recent years as a result of low soil moisture. The severity of the problem has increased over the last couple of years. There are a number of factors that could have contributed to this situation.

These include:

1. Reduced rainfall in recent years. Melbourne has experienced 10 years of drought.

2. Reduced application of supplementary water through changes to irrigation management. Initiated by water restrictions.

3. Reduced uptake of rainfall through increased hydrophobicity of soils. Extended dry periods as a result of less rainfall and reduced irrigation.

4. Reduced uptake of water by trees as a result of damage to tree root systems through construction works e.g. paths, service trenches.

TREE WATER MANAGEMENT STRATEGY

Council Policies and Strategies

The City of Melbourne has a range of different policies which are applicable to the water management of tree: *Growing Green 2003, Total Watermark 2004, Tree Policy 1997* and Parks Water Management Strategy.

The *Growing Green* Vision and *Growing Green* Theme 2 statements are important reference points for the development of a water management strategy.

Growing Green Vision

The City of Melbourne will have the highest quality parks, gardens, trees and recreational facilities easily accessible to and enjoyed by all who live in or visit the City. These assets and the life they support will be sustainably managed on behalf of the community and future users with a reduced ecological footprint.

Growing Green Theme 2 – *Melbourne- A leafy city*

Retain and enhance Melbourne's international reputation as a 'garden city' by increasing the number of trees, plants and green spaces across the City. Increase the robustness and diversity of tree species with selection considering local climatic conditions, urban setting and heritage values.

As part of *Total Watermark 2004* a water saving target of 40%, by year 2020, based on reference year of 1999/2000, has been set for the Parks & Recreation Branch. This saving represents a volume of potable water of 550 ML.

Some strategies available, within the Parks and Recreation Strategy, to meet the water reductions include:

a. Changing water sources

b. Improved efficiency of irrigation

and, in some cases,

c. Reduction in the amount of irrigated landscape

Response to Water Restrictions

In response to the imposition of water restrictions The City of Melbourne has developed a Water Conservation Plan which has been approved by City West Water and South East Water and commits the Council to achieving a minimum 50 per cent reduction in water use from the base year (2005/06), while using potable water in a responsible way to protect the City's horticultural assets, principally, its significant and heritage tree stock.

From January to December 2007, the City achieved more than a 60 per cent reduction in water use in its parks, gardens and open spaces, compared to a similar period in 2006 prior to the water restrictions.

Soil moisture readings continue to be taken in the City's main gardens and boulevards in order to monitor the available water for the trees. The City's irrigation systems are being adjusted in order to ensure that the trees are provided with adequate water.

An additional 40 kilometres of sub-surface dripper piping has been installed in the last 4 months which augment the 100 kilometres of dripper lines that had been installed last summer. The health of some of the older Elm trees has improved with the rollout of the drip lines and the move away from surface turf irrigation. However this improvement has been apparent in the second summer after installation.

A fleet of water tankers and water-filled barriers have been brought in to supply water to drought stressed trees that cannot be adequately watered using the irrigation systems. The water tankers are taking reclaimed water from the Royal Park Wetlands and where possible, will no longer access water from water hydrants.

The Royal Park Wetlands have been working very well and have provided (depending on need) more than 3 million litres of reclaimed water each week for the City's trees, the Royal Park North sports grounds and the Royal Park golf course.

Recycled mulch has been placed under a large number of trees in parks that may be more susceptible to the dry conditions. This mulching program is continuing.

The "No potable water" 2012 Target

Development of a sustainable water plan is well underway to achieve the target of 'no potable water to maintain used in parks and gardens in the City of Melbourne by 2012' Five strategic focus areas are being developed:

(1) Landscape change – retaining existing valued landscape qualities while identifying where changes to landscape character can be accommodated;

(2) Efficiencies – reducing consumption and elimination of waste and loss through improved irrigation and water use practices, systems and technology;

(3) Management of use – developing sustainable carrying capacity for parks whilst ensuring ongoing community use and enjoyment;

(4) Alternative sources – investigation of a range of new water sources that fulfil 'City as a Catchment' principles;

(5) Offsets – balancing water use in parks against savings elsewhere.

TREE WATERING

The Challenge

The core aim of the Tree Planning Unit is to maintain all trees in a healthy condition. Avoiding stress, as a result of low soil moisture, is a very high priority for significant trees in the City of Melbourne.

Supplementary watering is required for many of the trees over the summer months, including natives, exotics, evergreen and deciduous, and the task is to deliver water efficiently in a sustainable way. Street trees present particular challenges in terms of irrigation. These challenges include:

a) Tree roots contained within median and street structures – limited water storage volume and limited catchment opportunity

b) Tree root distribution highly variable and non symmetrical

c) Access to root systems often limited by hard surfaces.

d) Tree roots in competition with turf roots for irrigation water

e) Significant roots located deep within the soil profile – water needs to be delivered at depth

f) Canopy interception of rainfall can be significant

g) Compacted soils (low infiltration rates) - particularly on nature strips

h) High peak daily water requirement

i) Street trees are often high traffic and high maintenance areas

j) Root disturbance and damage e.g. excavation reduce the effectiveness of parts of tree root systems

k) The street trees may already be stressed due to pests, disease, damage or environmental pressures

Tree Watering Options

The choice of irrigation delivery method and the operation or control of the system is very important in the watering of trees. There are potentially numerous irrigation delivery options including:

a. Sprinklers
b. Sprays (short throw, high precipitation rate)
c. Microsprays
d. Surface drip (sub mulch)
e. Shallow drip (top 100 mm)
f. Subsurface drip (100 mm to 500 mm deep)
g. Water wells (e.g. 50 mm diam. x 300 mm deep) supplied by bubblers
h. Watering rings (perforated pipe and drainage material) supplied by bubblers or similar
i. Tree watering trench

The City of Melbourne has had experience with the following tree irrigation methods in recent years:

Sprays on centre medians and nature strips
Shallow buried drip (up to 150 mm deep)
Drip under mulch
Subsurface drip
Drip in combination with traffic barrier storage

Drip is well suited to the watering of mature trees. Water should be applied slowly so that runoff does not occur and deep so that the soil volume, where the bulk of the roots are located, is watered rather than just the top layer of soil. Shallow watering is commonly experienced with sprinkler and spray systems irrigating trees.

Delivery of water to the middle root zone, rather than just to the surface soil layers is preferred. Applying water directly to the soil root zone is highly desirable. A subsurface drip system is one technique that allows direct application of water to the root zone. However, installing these systems into existing mature trees risks damage to tree root systems.

Criteria for Selection of Tree Watering Technique

Over the years many different techniques and approaches have been used by the City of Melbourne with varying degrees of success. Some of these have been permanent, some temporary and some intermittent watering using truck delivery.

A key consideration for the future watering of the trees will be the development of tree watering systems that will be permanently installed and supplied from a sustainable water source.

The following criteria were developed to establish the context within which a suitable tree watering technique could be identified.

a) Irrigation water effectively delivered to the tree root soil volume so that healthy growth can be maintained. Watering throughout the depth of the soil profile and lateral distribution are required

b) No overflow or surface flooding

c) Minimum damage to existing roots through installation

d) Installation technique not to impede root development

e) Technique to work effectively in a range of soil types

f) Plumbing of water delivery to allow regulated, low flow rate, delivery with minimum risk of blockage

g) Installation technique to be flexible and responsive should large roots, services and/or rocks be encountered

h) Installed technique to allow ground footprint area to be safely trafficked and not subject to subsidence. It should withstand loading that is expected from maintenance machinery and vehicles including trucks

i) Robust construction of water delivery system

j) Water delivery hardware to be accessible and protected using appropriate valve box and secure cover

k) Technique to remain functional, without need for major restoration works, for a period of ten years

l) Installation to be environmentally sensitive and responsible e.g. not waste water, any soil waste disposed in an environmentally friendly manner

m) Technique can be readily and safely installed and cost effective

n) Water delivery program to be able to be accommodated within existing irrigation scheduling capability

o) Technique to be repairable should tree root and soil conditions interfere with the functioning of the system.

TREE WATERING TRIAL

The City of Melbourne decided, in early 2007, to investigate watering techniques that could be used to maintain trees, located in high profile streets and boulevards, in a healthy condition. Restricted root systems, highly variable soils, high traffic and high exposure characterize these trees.

The aim of the trial was to investigate current watering techniques and to evaluate alternative systems. The trial initially included assessment of drip watering and tree watering well products. In July 2007 various combinations of watering wells, Hunter and Rain Bird, were installed in a typical streetscape situation. The watering well products used were Hunter Root Zone Watering System (75 mm diam. and 300 mm long) and Rain Bird RWS Root Watering System (100 mm diam. and 300 mm long).

The trial was carried out in Royal Parade, Parkville, where elm trees are positioned in both medians and nature strip areas. The medians are typically raised concrete structures, approximately 300 mm high and 4 metres wide.

Water was delivered to each watering well using pressure compensated bubblers. The supply to each group of water wells was through a water meter. The watering wells were operated from the existing automatic irrigation control system.

The key evaluation criteria included the (a) distribution of water (vertical and lateral), (b) presence of overflow and (c) installation requirements.

The watering well holes were constructed using both powered auger and water jets. Installation with a hand held powered auger was found to be time consuming and difficult to avoid root damage. The watering jet digging technique was found to be an effective means of constructing holes in this type of soil environment. The holes could be constructed without serious damage to the tree root systems. If a significant root or buried service (water, electrical and communication) was encountered, then the excavation could be readily moved to a less sensitive position. The waste products/solutions generated during the digging were collected (vacuumed up) and removed from the site.

The performance of the watering wells varied in terms of water distribution and the absorption of water during filling/delivery. Following experience with the watering wells, it was decided to investigate a form of watering trench. The trench was considered to potentially have the advantage of providing a wider distribution of water, allow a relatively large volume of water to be delivered rapidly and, if necessary, allow grass to be grown over the surface.

The basic dimensions of the trench was approximately 1.2 metres long, 300 mm wide and 300 mm deep. The total volume of the trench cavity is approximately 110 litres. Both sand and graded gravel (7 mm), referred to as quarter minus, was used as the trench medium.

The trench version which performed best consisted of quarter minus gravel. The quarter minus provided ample void water space for water storage (approximately 30%) was stable when saturated. The washed sand material was found to become soggy or slushy and provided virtually no top loading support. This is an important consideration for a watering system in these high profile and high use areas so that the watering system presents no undue risk to the public.

Water distribution from the trench was found to be variable however typically in the range of 500 mm laterally, beyond the edge of the trench, at a depth of 500 mm.

The water jet technique was considered to be the most effective in terms of constructing this type of trench. However, the watering jet technique is potentially expensive and requires considerable support in terms of roadway traffic management (lane closure) to accommodate the truck.

The experiences of this trial have been used by the City of Melbourne to develop a watering strategy that is being implemented in 2008.

SUMMARY

The recent drought conditions have caused much stress to the City of Melbourne trees. Council has responded in a number of ways, both short term and long term.

Significant water reduction, in excess of 60%, in water use in parks, gardens and open space, have been achieved compared to similar period in 2006, prior to the water restrictions.

Extensive shallow buried drip systems have been installed on significant trees in parks and boulevards. These systems have been successful in applying emergency watering to trees.

The new watering trench technique is to be installed in high profile avenue and boulevard tree sites in Royal Parade, St Kilda Road and Birrarung Mar.

Soil moisture monitoring is continuing to be used to inform on water management. These strategies together with tanker watering, water barriers, soil water injection, mulching and modification of irrigation schedules have meant that the City has been able to keep nearly all the significant trees in a healthy condition and most other trees in acceptable condition.