Urban Street Trees

Policy Discussion Paper

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Contents

1. INTRODUCTION

WALGA is developing a street trees policy guidance note to assist Local Government decisions about street tree establishment and management. Local Governments are invited inform this this work by providing feedback on this discussion document and/or by participating in a workshop scheduled for June 2014.

This document was drafted to outline the background information about street trees and present questions to be answered in the upcoming WALGA Street Trees Workshop. This paper will be used to generate discussion, facilitate Local Government input, and will ultimately inform an official WALGA street trees policy guidance note.

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1.1. Why have a Policy?

According to the Australian Policy Handbook, a policy can be seen as "*an expression of general purpose or desired state of affairs*" and policy objectives need to be stated clearly and honestly. The desired outcomes for the Western Australian Local Government Association (the Association) from a Local Government Policy Statement on Street Trees are:

- To highlight the importance of street trees within the urban environment for local communities
- To outline the opportunities and constraints being encountered by Local Governments in WA
- To provide best practice research and practical examples from around the world and within Australia
- To provide guidance for Local Government when making their own polices and decisions about street trees.

1.2. Defining Street Trees

The City of Cambridge's definition of a street tree will be used in this discussion paper. The City of Cambridge defines a street tree as "*Any tree (irrespective who planted it) that has at*

least 50% of its base located within a road verge/road reserve and less than 50% in private property"[1].

This document only considers urban trees; native vegetation on road verges is out of scope.

[1] City of Cambridge (2014). Management of Street Trees. Retrieved 2 April 2014 from www.cambridge.wa.gov.au/files/fe8cfb20-e87b-4562-8003.../513.pdf

2. DISCUSSION

2.1. Background

The south west corner of Western Australia and the Perth region specifically, is recognised as an international biodiversity hotspot[2]. Perth has a particularly high level of endemic species that are not found outside the metropolitan area[2].

With Perth's high population growth and increased demand on environmental assets the issues of street trees, urban canopy and transport greenways are very topical. The latest metropolitan planning strategy released by the Western Australian Planning Commission, "Directions 2031" includes a chapter on greenways, in which transport greenways and urban tree canopy cover are specifically mentioned[3]. Perth's population grew by 14.9% between 2006 and 2011[4]. This population growth is leading to urban sprawl and increased housing densities which are resulting in the reduction in urban tree canopy cover[4].

As land managers, service providers and government regulators, Local Government can play an important role in seeking to balance infrastructure and community needs with environmental conservation and sustainability.

The benefits of street trees are numerous and include environmental, amenity and social benefits. However, there are also several constraints to planting street trees that occur in the planning phase, in the potential road safety impacts due to poor location or effect on sight lines, in the costs associated with planting and maintenance and in the potential of property and asset damage from falling branches or roots.

[2] Department of Environment (no date). International Biodiversity Hotspots. Retrieved 21 March 2014 from http://www.environment.gov.au/topics/biodiversity/biodiversity-conservation/biodiversity-hotspots/international-biodiversity

[3] Western Australian Planning Commission (2009a). Street Trees and Utility Planning Discussion Paper. Retrieved 10 March 2014 from http://www.planning.wa.gov.au/publications/1123.asp

[4] City of Cockburn (2013). Narrow lots and narrow verges. A guide to composing streetscapes. Retrieved 26 March 2014 from http://www.cockburn.wa.gov.au/documents/CouncilServices/EngineeringServices/guidelines/Narrow-verges-narrow-lots-a%20guide–to-composing-streetscapes.pdf

2.2. Sustainability Considerations

Trees should be considered as a type of infrastructure; street trees provide services that would otherwise require capital expenditure or reductions in human wellbeing[5]. Urban trees cool cities, conserve energy, reduce runoff, and absorb pollutants, substituting for more convention infrastructure that would otherwise be needed[5]. Street trees may even reduce air conditioning needs by providing shade on buildings, houses, streets and sidewalks[5].

2.2.1. Reduced Energy Use

Trees have the potential to reduce energy use by lowering temperatures and shading buildings during the summer, and blocking wind in winter[5]. Trees can cool buildings both by providing direct shading and through evapotranspiration[6]. Benefits vary based on species selection and the orientation and size of the plantings, as well as their distance from a building[6]. Large trees planted close to the west side of a building will generally provide the greatest cooling energy savings[6]. According to one study in the US the cooling energy savings of having trees planted around buildings range between 7 and 47% and were greatest when trees were planted on the warmer facing sides of buildings[7].

Reduced solar heat gain in winter may lead to small increases in energy use for heating[5]. However, with proper tree placement near buildings any increase in energy use for heating in winter can be minimised[5]. It has been estimated that trees planted on warmer facing sides of buildings will have a $122 increase in annual heating costs which will be off-set by $155 annual savings in cooling costs[5]. Although trees may increase heating costs through shading they may also reduce heating costs by acting as windbreaks[8]. Windbreaks reduce

[5] Killicoat, P., Puzio, E. & Stringer, R. (2002). The Economic Value of Trees in Urban Areas: estimating the benefits of Adelaide's street trees. Retrieved 10 march 2014 from http://treenetmedia.com/up/pdf/2002/02TS%20THE%20ECONOMIC%20VALUE%20OF%20TREES%20IN%20URBAN%20AREAS_Killicoat%20Puzio%20Stringer.pdf

[6] U.S. EPA (2013). Heat Island Effect – Basic Information Retrieved 6 March 2014 from http://www.epa.gov/heatisland/about/index.htm

[7] Akbari, H., D. Kurn, S. Bretz, and J. Hanford. 1997. Peak power and cooling energy savings of shade trees. Energy and Buildings. 25:139-148.

[8] McPherson, G., Simpson, J., Peper, P., Gardner, S., Vargas, K., Xiau, Q. (2007). Northeast Community Tree Guide- benefits, costs and strategic planting. Retrieved 4 March 2014 from http://www.itreetools.org/streets/resources/Streets_CTG/PSW_GTR202_Northeast_CTG.pdf

wind speed and resulting air infiltration into buildings by up to 50%, resulting in potential annual heat savings of 10 to 12%[9]. Where possible, street trees should be placed strategically to provide maximum summer cooling benefits and winter windbreak benefits to nearby buildings.

2.2.2. Stormwater Management

Trees, vegetation and soils can reduce stormwater runoff and adverse impacts to water resources[10]. Trees and vegetation intercept rainfall, and the exposed soils associated with plants absorb water that may be returned to groundwater or used by plants[10]. Trees can act as filters removing nutrients and sediments while also increasing ground water recharge, therefore increasing stormwater quality[10].

The impact of vegetation on stormwater runoff could save billions of dollars in infrastructure costs to Australia's cities[11]. Trees hold rainwater on their canopies, and through transpiration significantly reduce the amount of water entering drains[11]. Estimates suggest that trees may hold up to 40% of the rain water that falls on them and that as little as 40% of water striking trees may enter drains[11]. An additional benefit is that tree root systems may act as effective bio filters of the storm water before it enters groundwater or river systems[11]. A study carried out in Modesto, California in the late nineties found that the average annual benefit of storm water run-off reductions was $6.76US per tree[9].

Trees, leaves, fruit and nuts also have the potential to block stormwater drains, possibly leading to localised flooding, if not managed correctly[10]. Deciduous trees have the greatest potential to block drains as they lose large quantities of leaves in a short period of time[10]. The risk of stormwater drain blockage can be mitigated by correct species selection and street cleaning during times of heavy leaf fall.

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[9] McPherson, G. (2003). A Benefit-Cost Analysis of Ten Street Tree Species in Modesto, California, U.S. Journal of Arboriculture, Vol 29(1).

[10] U.S. EPA (2007). Reducing Urban Heat Islands: Compendium of Strategies. Retrieved 6 March 2014 from http://www.epa.gov/heatisland/resources/compendium.htm

[11] Moore, G. (2008). Urban Trees: worth more than they cost. Australian Arbor Age, Vol 14(4).

2.3. Social Considerations

2.3.1. Aesthetics

Street trees have a wide range of aesthetic benefits. They provide a natural, living contrast to the urban environment, softening the built urban nature of the city[12]. Street trees contribute to the visual appeal of the streetscape by providing shade and human scale, particularly in streets with all buildings[12]. Trees also provide seasonal interest and natural beauty through foliage, leaf patterns, flowers, bark and fruit[13].

2.3.2. Public Safety

Street trees can play a role in enhancing public safety, as areas with higher levels of trees of planting have been found to experience lower levels of crime[13]. The presence of trees increases surveillance and discourages criminals, as the 'green and groomed' appearance of a property is a cue that the owners and residents care about a property and watch over each other[14]. The presence of trees can also reduce crime as it helps people to relax, thereby reducing aggression[14].

2.3.3. Use of Outdoor Space

The presence of street trees has impacts on how people use outdoor space, for example, residents walk more on streets that are lined with trees[14]. In 2006, local streets and

[12] City of Yarra (2004). City of Yarra Street Tree Policy. Retrieved 10 March 2014 from www.yarracity.vic.gov.au/DownloadDocument.ashx?DocumentID=807

[13] Central Coast Council (2010). Street Tree Strategy. Retrieved 10 March 2014 from http://www.centralcoast.tas.gov.au/webdata/resources/files/Street_Tree_Strategy_Final.pdf

[14] Kao and Sullivan (2001). Environment and Crime in the Inner City: Does Vegetation Reduce Crime? Environment and Behaviours. Environment and Behaviour. Vol 33 (3), May 2001, Pp 343-367.

footpaths were the most frequently used facilities used by Western Australian adults for physical activity[15]. Due to this, it is important to provide footpaths that are comfortable enough to encourage their use.

Green environments also encourage people to be involved in social activities, therefore bringing residents together more often[13]. This promotes chance meetings and encounters which leads to residents getting to know one another, producing stronger, more cohesive neighbourhoods[13].

2.4. Urban Heat Island Effect

Air temperatures in densely built urban areas are higher than the temperatures of the surrounding rural country; this is often due to the urban heat island effect. The term "heat island" describes built up areas that are hotter than nearby rural areas[6].

2.4.1. Causes of the Urban Heat Island Effect

The rapid growth of Perth's metropolitan area has resulted in changes to urban form with an increase in paved surfaces, buildings and other infrastructure. As these impermeable surfaces absorb a greater amount of solar energy than the natural landscape, they can result in an increase in urban temperature[6]. The annual mean air temperature of a city with one million or more people (such as Perth) can be 1 to 3^{0}C hotter, and on a clear, calm night this temperature difference can be as much as 12^{0}C[6].

In a motorized city such as Perth, on average 30% of the land surface is devoted to roads which another 20% is required for on street parking[6]. On a hot sunny day, the sun can heat

[6] U.S. EPA (2013). Heat Island Effect – Basic Information. Retrieved from U.S. EPA (2003). Cooling Summertime Temperatures- Strategies to Reduce Urban Heat Islands. Retrieved 2 March 2014 from http://www.epa.gov/heatisland/about/index.htm

[13] Central Coast Council (2010). Street Tree Strategy. Retrieved 5 March 2014 from http://www.centralcoast.tas.gov.au/webdata/resources/files/Street_Tree__Strategy_Final.pdf

[15] Department of Sport and Recreation (2007). Walking for Physical Activity. Retrieved 2 April 2014 from http://www.dsr.wa.gov.au//assets/files/Fact_Sheets/Walking_for_Physical_Activity.pdf

dry, exposed urban surfaces like pavements and roads to temperatures 27 to 50^{0}C hotter than the air, while shaded or moist surfaces remain close to air temperature[6].

Heat released from vehicles, industry and other sources such as air-conditioning units can also contribute to increased urban temperatures[16].

2.4.2. Using Street Trees as Mitigation of the Urban Heat Island Effect

The presence of vegetation is important in mitigating the urban heat island effect as vegetation provides a natural cooling effect through evapotranspiration and absorptive and reflective processes[17]. Trees are particularly important as they can also contribute to cooling by providing shade[17]. As vegetation and trees are removed from the landscape their natural cooling effect is lost[17].

Shading is achieved by the leaves and branches reducing the amount of solar radiation that reaches the area below the canopy of a tree or plant[6]. Depending on the species, in summer, generally 10 to 30 per cent of solar energy reaches the ground below a tree. The remainder is absorbed by leaves and used for photosynthesis and with a small amount also being reflected back into the atmosphere[6]. Due to this shade effect, trees can significantly reduce the temperatures of pavements and roads[6]. Planting trees at regular intervals of 6 to 12 meters along both sides of a street, as well as along median strips is usually sufficient in providing valuable shading[6].

[6] U.S. EPA (2013). Heat Island Effect – Basic Information. Retrieved from U.S. EPA (2003). Cooling Summertime Temperatures- Strategies to Reduce Urban Heat Islands. Retrieved from http://www.epa.gov/heatisland/about/index.htm

[16] U.S. EPA (2003). Cooling Summertime Temperatures- Strategies to Reduce Urban Heat Islands. Retrieved from http://www.epa.gov/heatislands/resources/pdf/HIRIbrochure.pdf

[17] Brown, H., Katsherian, D., Carter, M. & Spikett, J. (2013). Cool Communities: Urban trees, climate and health. Retrieved 4 March 2014 from http://ehia.curtin.edu.au/local/docs/CoolCommunities.pdf

2.5. Health Implications of Street Trees

Increased tree canopy coverage has direct benefits on human health including clean air, clean water, protection from harmful UV rays, cooling and the positive psychological effects associated with proximity of natural environments. There are also indirect benefits of increased greenery including a more active lifestyle linked to increased outdoor activity.

2.5.1. Heat and Health

Heatwave related deaths in Australia's cities are predicted to double in the next 40 years as a result of climate change, population growth and an ageing population[18]. In Perth, the average number of annual heat-related deaths is forecast to increase from 137 in 2011 to 378 in 2050[18].

Temperature and humidity influence thermal comfort, for most people the optimal range for air temperature is between 20^{0}C and 27^{0}C and when relative humidity is from 35 to 60%[17]. Placing the body's coping mechanisms for dealing with additional heat under stress can lead to a range of serious and possibly fatal conditions[17]. The normal human body temperature is between 36.1^{0}C and 37.8^{0}C[19]. If body temperature rises above this a person may develop heat related illness[20].

Heat-related health problems include heat rash, heat oedema, heat syncope, heat cramps and heat exhaustion[19]. Certain groups in the community are more vulnerable to heat related illnesses, including, older people, very young children, people with disabilities, indigenous communities, homeless people and those whose health is already compromised by other conditions[17].

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[17] Brown, H., Katsherian, D., Carter, M. & Spikett, J. (2013). Cool Communities: Urban trees, climate and health. Retrieved 4 March 2014 from http://ehia.curtin.edu.au/local/docs/CoolCommunities.pdf

[18] Department of Infrastructure and Transport (2013). State of Australian Cities 2013. Retrieved 10 March 2014 from http://www.infrastructure.gov.au/infrastructure/pab/soac/

[19] World Health Organisation (2008). Heat-Health Action Plans Guidance. Retrieved 2 April 2014 from http://www.euro.who.int/__data/assets/pdf_file/0006/95919/E91347.pdf

[20] NSW Government (2013). Heat Related Illness Including Heat Stroke. Retrieved 12 March 2014 from http://www.health.nsw.gov.au/environment/factsheets/Pages/heat-related-illness.aspx

Prolonged periods of high temperatures can also interfere with daily activities as well as increase the potential for mistakes or injuries, reduce productivity, cause sleep deprivation and reduce physical and mental performance[17].

2.5.2. Air Quality and Street Trees

Air pollution is a major environmental concern in most major cities around the world and is also an issue in Perth[21]. Urban trees may provide several air quality benefits, one reason for this is that compared to hard surfaces, pollutant uptake by plants is much higher[21]. Trees remove gaseous air pollution primarily by uptake through leaf stomata, though some gases are removed by the plant surface[21]. Once inside the leaf, gases diffuse into intercellular spaces and may be absorbed by water films to form acids or react with inner-leaf surfaces[21]. Trees also remove pollution by intercepting airborne particles[21]. Some particles can be absorbed into the tree; however most particles that are intercepted are retained on the plant surface[21]. These intercepted particles are often resuspended to the atmosphere, washed off by rain, or dropped to the ground with leaf and twig fall[21]. Therefore, vegetation is only a temporary retention site for many atmospheric particles[21].

An increase in air quality may lead to an increase in health in well-treed areas. One study even found a lower prevalence of asthma in children who live in areas with more street trees[22]. Trees may help prevent asthma, either through an effect on local air quality, or by encouraging outdoor play[22].

[17] Brown, H., Katsherian, D., Carter, M. & Spikett, J. (2013). Cool Communities: Urban trees, climate and health. Retrieved 4 March 2014 from http://ehia.curtin.edu.au/local/docs/CoolCommunities.pdf

[21] Nowak, D., Crane, D. & Stevens, J. (2006). Air Pollution Removal by Urban Trees and Shrubs in The United States. Urban Forestry & Urban Greening, 4, 115-123.

[22] Lovasi, G., Quinn, J., Neckerman, K., Perzanowski, M. & Rundle, A. (2007). Children Living in Areas with More Street Trees have Lower Prevalence of Asthma. Journal of Epimiol Community Health, Vol 62, 647-649.

2.5.3. Mental Health Benefits of Street Trees

Street trees may be beneficial to mental health as research suggests that contact with, or visual appreciation of natural scenes and greenery can provide a means to stress recovery[23]. Exposure to green surroundings also reduces mental fatigue and the feelings of irritability that come with it. The ability to concentrate is refreshed by green views, along with the ability and willingness to deal with problems thoughtfully and less aggressively[14]. Evidence from research suggests that people feel more relaxed when viewing trees compared to urban settings[23].

[14] Kao and Sullivan (2001). Environment and Crime in the Inner City: Does Vegetation Reduce Crime? Environment and Behaviours. Environment and Behaviour. Vol 33 (3), May 2001, Pp 343-367

[23]Tabbush, P. & O'Brien (2002). Health and Well-being – Trees, Woodlands and Natural Spaces. Retrieved 17 March 2014 from http://www.forestry.gov.uk/pdf/health_wellbeing.pdf/$FILE/health_wellbeing.pdf

2.6. Economic Value and Costs of Street Trees

2.6.1. Property price and business implications of street trees

Increased property values, faster real estate sales turn-over rates, shorter unoccupied periods and increased numbers of customers have all been linked to tree presence[24]. Street trees, particularly avenues of trees have been found to increase property values and make the area more desirable to live in[12]. Trees can also contribute to an attractive commercial streetscape which provides a higher level of comfort for pedestrians[12]. This can attract a diversity of businesses that can improve the economic viability of the street[12]. Properties with tree cover are estimated to have sale values $9500 higher than properties with no trees[5].

2.6.2. Costs of Planting and Maintaining Street Trees

Local Governments are responsible for funding street tree planting, and the watering and pruning of street trees in existing developments. In Western Australia, developers are often required to plant street trees and maintain them for two years in new developments. Where trees cannot be planted during the development stage, a landscaping bond for the trees is taken and once building is completed Local Governments plant street trees. Surveys carried out in the United States indicate that local councils spend about $20 to $30US per tree annually for planting and maintenance[8]. Most of this amount is for pruning ($6 to $12US per tree), planting ($10US per tree), and administration ($4 to $7US per tree)[8].

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[5] Killicoat, P., Puzio, E. & Stringer, R. (2002). The Economic Value of Trees in Urban Areas: estimating the benefits of Adelaide's street trees. Retrieved from http://treenetmedia.com/up/pdf/2002/02TS%20THE%20ECONOMIC%20VALUE%20OF%20TREES%20IN%20URBAN%20AREAS_Killicoat%20Puzio%20Stringer.pdf

[8] McPherson, G., Simpson, J., Peper, P., Gardner, S., Vargas, K., Xiau, Q. (2007). Northeast Community Tree Guide- benefits, costs and strategic planting. Retrieved Retrieved 14 April 2014 from http://www.itreetools.org/streets/resources/Streets_CTG/PSW_GTR202_Northeast_CTG.pdf

[12] City of Yarra (2004). City of Yarra Street Tree Policy. Retrieved 15 March 2014 from www.yarracity.vic.gov.au/DownloadDocument.ashx?DocumentID=807

[24] Urban Design Forum (2013). Streets as Open Space. Retrieved 3 March 2014 from http://udf.org.au/udf-quarterly/udfq-104-december-2013/article/streets-as-open-space/

2.7. Infrastructure Considerations

When trees and power lines compete for the same space, the result can be power outages and fires[11]. High voltage electric current can arc out beyond the line if grounded by something like a tree, even without physical contact[25]. Trees beneath power lines require regular pruning and large trees planted too close to power lines inevitably require expensive trimming or removal[25]. In Western Australia, Local Governments are usually responsible for trimming trees on street verges[26]. Western Power issues notices to Local Governments with trees situated within a high fire risk area that are either within 700MM of bare high voltage power lines or touching low voltage power lines[27]. For trees on land managed by Local Governments this notice requires Local Governments to prune the trees within a 30 day period; otherwise Western Power undertakes the pruning and charges the Local Government a minimum of $419 per tree for the service[27].

Roads and footpaths with good tree canopy cover are partially protected from the sun and therefore last longer[13]. Tree shade lowers the street surface temperature and reduces heading and volatilization of the binder used[8]. A tree canopy of 75m^2 shading bitumen covering 30% of its canopy area can save up to $450 per square metre of pavement for its asset life of 20 years[11].

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[8] McPherson, G., Simpson, J., Peper, P., Gardner, S., Vargas, K., Xiau, Q. (2007). Northeast Community Tree Guide- benefits, costs and strategic planting. Retrieved April 5 2014 from http://www.itreetools.org/streets/resources/Streets_CTG/PSW_GTR202_Northeast_CTG.pdf

[11] Moore, G. (2008). Urban Trees: worth more than they cost. Australian Arbor Age, Vol 14(4).

[13] Central Coast Council (2010). Street Tree Strategy. Retrieved April 12 2014 from http://www.centralcoast.tas.gov.au/webdata/resources/files/Street_Tree__Strategy_Final.pdf

[25] Most, W. & Weissmen, S. (2012). Trees and Power Lines: minimizing conflicts between electric power infrastructure and the urban forest. Retrieved from http://www.law.berkley.edu/files/Trees_and_Power_Lines_March_2012.pdf

[26] Western Power (2014). Trees & Power lines. Retrieved 2 April 2014 from http://www.westernpower.com.au/safety/treespowerlines/

[27] Western Power (2013). Western Power's Vegetation Management Program. Retrieved 3 April 2014 from http://www.westernpower.com.au/documents/safety/vegetation_management_program.pdf

Poorly selected or maintained street trees also have the potential to damage footpaths, roads and other elements of urban infrastructure[8]. New York City spends about $6US per tree on the repair of footpaths damaged by tree roots[8]. Tree roots can also damage old sewer lines that are cracked or otherwise susceptible to invasion[8]. Sewer damage is minor until trees and sewers are over 30 years old, and roots from trees on private property usually cause more problems than trees planted along the street[8].

Another issue to consider is cleaning up after street trees. Street trees can drop leaves, flowers, fruit and branches throughout the year. Tree litter has the potential to clog sewers and drains which can cause localised flooding[8]. These risks can be reduced by planting evergreen species which don't lose large quantities of leaves[8].

2.7.1. Traffic and Pedestrians

2.7.1.1. Traffic Calming

The presence of trees close to roads has been found to reduce traffic speeds due to perceived risks associated with reduced visibility of the sidewalk and because an overhead tree canopy gives the street a human scale[12]. Therefore planting street trees has the potential to be used in place of or in addition to other structural traffic calming measures[12]. Tree planting also provides a physical barrier between vehicles and pedestrians, which improves the sense of pedestrian safety[12].

2.7.1.2. Line of Sight at Intersections

Poorly located street trees have the potential to obscure visibility of traffic signs and at intersections[28]. Traffic signs should be visible to drivers at all times for safety reasons and

[8] McPherson, G., Simpson, J., Peper, P., Gardner, S., Vargas, K., Xiau, Q. (2007). Northeast Community Tree Guide- benefits, costs and strategic planting. Retrieved from http://www.itreetools.org/streets/resources/Streets_CTG/PSW_GTR202_Northeast_CTG.pdf

[12] City of Yarra (2004). City of Yarra Street Tree Policy. Retrieved from www.yarracity.vic.gov.au/DownloadDocument.ashx?DocumentID=807

trees have the potential to hide signs from view. Safe and efficient vehicle movement through an intersection requires good visibility[28]. As drivers approach an intersection, they need to check each quadrant of the intersection for the presence of entering vehicles[28]. Drivers pulling out from a stop sign also need to have a clear view of oncoming traffic. A clear vision triangle at each corner of an intersection will help keep clear visibility[28].

Main Roads has specified clearances and sight distances for different intersection types and assessment of these is included in the Safety Audit Checklist they use[29]. Maintaining reasonable sight distances is most important at intersections with restricted lateral sight distance, intersections on or near crest vertical curves, on approaches to speed change and land drop areas, on the approach to underpasses and on the approached to rail level crossings[30]. The required clearance is determined by the design speed (normally the signposted speed plus 10km/hr), traffic volume and curvature of the road along with the slope[31].

2.7.1.3. Clear Zones

Trees can pose a risk to the occupants of vehicles that stray from the road, in Victoria in 2003, roughly one third of all fatalities involved roadside objects[32]. Vehicles sometimes

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[28] U.S. Department of Transportation, Federal Highway Administration (2008). Vegetation Control for Safety – A Guide for Local Highway and Street Maintenance Personnel. Retrieved from safety.fhwa.dot.gov/local_rural/training/fhwasa07018/

[29] Main Roads. (2007). Safety Audit Checklist for Road works. Retrieved 2 April 2014 from https://www.mainroads.wa.gov.au/Documents/SafetyAuditChecklistforRoadworks.doc

[30] Main Roads (no date). MRWA Supplement to Austroads Guide to Road Design – Part 4A. Retrieved 3 April 2014 from https://www.mainroads.wa.gov.au/BuildingRoads/StandardsTechnical/RoadandTrafficEngineering/GuidetoRoadDesign/Pages/MRWA_Supplement_to_Austroads_Guide_to_Road_Design___Part_4A.aspx

[31] Watson, S. (2008). Dealing with Barriers to Tree Establishment on Vicroads Roadsides. Retrieved from https://www.treenet.org/wp-content/uploads/07TS_DEALING-WITH-BARRIERS-TO-TREE-ESTABLISHMENT-ON-VICROADS-ROADSIDES_ScottWatson.pdf

[32] Road Safety Committee (2005). Inquiry into Crashes Involving Roadside Objects. Retrieved 20 March 2014 from http://www.parliament.vic.gov.au/rsc/inquiries/inquiry/147

leave the carriageway at speed for a number of unintended reasons[31]. Due to this it, is often thought that a roadside should be 'forgiving' and allow an opportunity for a driver to recover control of a vehicle or significantly reduce vehicle speed[31]. To achieve this clear zones are often used.

Clear zones, are areas free of features that are potentially hazardous to the occupants of errant vehicles[31]. To keep clear zones free of potential hazards, they must be kept clear of all non-frangible vegetation[33]. If it is not possible to provide the required clear zone then barriers must be used to protect road users from non-frangible objects[33]. To provide an adequate recovery area for all errant vehicles is impractical so clear zones are instead designed to accommodate approximately 85% of errant vehicles[33]. The required offset is determined by the design speed (normally the signposted speed plus 10km/hr), traffic volume and curvature of the road along with the slope[31].

[31] Watson, S. (2008). Dealing with Barriers to Tree Establishment on Vicroads Roadsides. Retrieved from https://www.treenet.org/wp-content/uploads/07TS_DEALING-WITH-BARRIERS-TO-TREE-ESTABLISHMENT-ON-VICROADS-ROADSIDES_ScottWatson.pdf

[33] NSW Road Transport Authority (2008). Landscape Guideline. Retrieved 12 March 2014 from http://www.rms.nsw.gov.au/roadprojects/community_environment/urban_design/documents/landscape_guideline.pdf

2.8. Planning Considerations

The Western Australian Planning Commission's Directions 2031 document encourages denser population levels while the WAPC's liveable Neighbourhood's policy has resulted in the promotion of narrower verges and lot widths[4]. With this current trend towards building larger houses on smaller blocks, trees are limited or precluded on private space, making trees in the public domain more important[3].

Street trees can generally occur either on median strips or on the verge (or nature strip). The median strip, which is located in the centre of the carriageway, can vary from 1 to 6 m in width, presenting a place to locate street trees[34]. It is particularly useful if there is no space for trees on verges and private property setbacks are small as it can provide foliage to both sides of the street[34]. The median strip may also provide planting locations if overhead power lines prevent planting on the verges[34].

The verge is located on either side of the road carriageway. Verges provide planting locations that can contribute to an avenue effect[34]. This space is also shared by pedestrian and cyclist paths, parking and public infrastructure such as overhead power lines and underground services which can create conflict for space[34].

2.8.1. Liveable Neighbourhoods

Liveable Neighbourhoods is an operational policy for the design and assessment of structure plans and subdivision, for new urban (primarily residential) areas in the metropolitan area and country centres, on greenfield and large urban infill sites[35].

[3] Western Australian Planning Commission (2009a). Street Trees and Utility Planning Discussion Paper. Retrieved from http://www.planning.wa.gov.au/publications/1123.asp

[4] City of Cockburn (2013). Narrow lots and narrow verges. A guide to composing streetscapes. Retrieved 26 March 2014 from http://www.cockburn.wa.gov.au/documents/CouncilServices/EngineeringServices/guidelines/Narrow-verges-narrow-lots-a%20guide–to-composing-streetscapes.pdf

[34] City of Wanneroo (2005). Street Tree Master Plan. Retrieved 4 March 2014 from www.wanneroo.wa.gov.au/files/a1cbe71f.../street_tree_master_plan.pdf

[35] Western Australian Planning Commission (2009). Liveable Neighbourhoods- a Western Australian Government Sustainable Cities Initiative.

There are many provisions in the current edition of Liveable Neighbourhoods indicating the need to create road reserves that can accommodate street trees as well as utilities, paths and car parking[3]. Liveable Neighbourhoods requires the following:

All road reserves must be of sufficient width to accommodate shade trees on both sides of the street with sufficient setback from paths and the edge of the nearest traffic lane[35].

An example of this can be seen in Element 2 R47 which states that "street trees that provide a generous canopy at maturity should be planted in most streets (except rear laneways) for pedestrian shade and shelter, streetscape amenity, and traffic management"[35].

Table 1 states that street cross sections are required prior to approval of most structure plans and subdivisions to show how trees will be accommodated[35].

Despite these provisions in Liveable Neighbourhoods, the practicality of implementation mean that street trees are rarely installed during the planning and construction phases and developers are left to add them at the end of a project which can cause problems when not enough space has been left[36].

2.8.2. Street Trees and Utilities and Buildings

Street trees generally exist in road reserves surrounded by public utilities including power, gas, water, sewer and built infrastructure such as footpaths, kerbs and roadways[34]. In many new subdivisions, 15 metres (instead of the 15.4 m recommended in Liveable Neighbourhoods) has become the new default minimum for road reserve widths, resulting in a lack of space in the road reserve to provide for utilities, services and street trees[3].

Tree roots may cause damage to underground services by direct pressure on conduits as roots grow and expand in diameter, or by entry to hydraulic services such as sewer and stormwater lines causing damage and blockage[37]. The size and location of underground

[3] Western Australian Planning Commission (2009a). Street Trees and Utility Planning Discussion Paper. Retrieved from http://www.planning.wa.gov.au/publications/1123.asp

[36] City of Gosnells (no date). Discussion Paper – Street Tree Constraints in the Road Reserve. Retrieved from http://www.gosnells.wa.gov.au/files/b20fcab8-bd95-4221-a734-9f640116699d/Biodiversity_Conservation_Management_Plan_2010.pdf.

[37] Landcom Projects (2008). Street Tree Design Guidelines. Retrieved 11 March 2014 from http://www.landcom.com.au/downloads/uploaded/2008_Street_Tree_Design_Guidelines_50b9_2965.pdf

utility services may also limit effect root growth, therefore limiting the optimum size, growth and performance of street trees[37]. Another issue to consider is that trees planted near underground utilities could have their roots damaged if the lines need to be dug up for repairs[38].

The proximity of street trees to adjacent buildings is another issue to consider. Regardless of where street trees are planted within the corridor, the expected mature crown spread or overhand should not exceed one-half the distance between the trunk or axis of the tree and the adjacent building[38]. This will minimize encroachment and avoid tree/building conflicts[38].

2.8.3. Street Trees and Footpath Alignment

Conflict between footpaths and street trees often occurs because of the preferred path alignments of Local Governments[36]. The Western Australian Planning Commission (WAPC) requires footpaths to be provided in new urban areas on at least one side of every street and if designed in accordance with Liveable Neighbourhoods the path must be constructed on the property boundary[36].

In a typical access street with a 15.4m road reserve and a verge width of 4.7m a path located adjacent to the kerb covers the allocated verge tree alignment (2.7m-2.9m from the property boundary) and no space is left for street trees[36]. However, if a path is constructed on the property boundary (as required by Liveable Neighbourhoods) a tree can be accommodated with a suitable clearance between the path and a tree[36]. Street trees will generally require a minimum clearance distance of 1 metre from all new or existing crossovers and paths[39]

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[36] City of Gosnells (no date). Discussion Paper – Street Tree Constraints in the Road Reserve. Retrieved from http://www.gosnells.wa.gov.au/files/b20fcab8-bd95-4221-a734-9f640116699d/Biodiversity_Conservation_Management_Plan_2010.pdf.

[37] Landcom Projects (2008). Street Tree Design Guidelines. Retrieved 11 March 2014 from http://www.landcom.com.au/downloads/uploaded/2008_Street_Tree_Design_Guidelines_50b9_2965.pdf

[38] Simons, K. & Johnson, G. (2008). The Road to a Thoughtful Street Tree Master Plan- A Practical Guide to Systematic Planning and Design. Retrieved 5 March 2014 from http://www.myminnesotawoods.umn.edu/wp-content/uploads/2008/12/Street-Tree-Manual.REVISED_20082.pdf

[39] City of Melville (2013). Street Tree Policy. Retrieved from www.melvillecity.com.au/.../3441_CP-029_Street%20_Tree_Policy.pdf

2.9. Other Considerations

2.9.1. Species Selection

Street trees provide wildlife habitat and food sources, therefore play a role in preserving biodiversity[13]. Street trees enhance existing wildlife corridors and planting of indigenous and native species in streets near bushland areas can complement native revegetation in open space reserves[12].

Species diversity of street trees is important. A high level of diversification of tree species and ages within an urban forest lowers the risk of losing the entire forest in one event, such as a pest and disease attack of an extreme heat event[40]. Tree species diversity is also important in terms of the biodiversity values the street trees of an area. For example, more birds, mammals and reptiles are found in areas with an abundance and diversity of trees and shrubs[41]. Large, older trees with hollows also create important habitats for many animals so these should be preserved where possible[41].

Trees provide important habitats for wildlife. Wildlife values of trees are derived from aesthetic, recreation and educational uses[5]. The annual ecological contribution of an average urban tree is estimated at $270[5].

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[5] Killicoat, P., Puzio, E. & Stringer, R. (2002). The Economic Value of Trees in Urban Areas: estimating the benefits of Adelaide's street trees. Retrieved from http://treenetmedia.com/up/pdf/2002/02TS%20THE%20ECONOMIC%20VALUE%20OF%20TREES%20IN%20URBAN%20AREAS_Killicoat%20Puzio%20Stringer.pdf

[12] City of Yarra (2004). City of Yarra Street Tree Policy. Retrieved from www.yarracity.vic.gov.au/DownloadDocument.ashx?DocumentID=807

[13] Central Coast Council (2010). Street Tree Strategy. Retrieved from http://www.centralcoast.tas.gov.au/webdata/resources/files/Street_Tree__Strategy_Final.pdf

[40] City of Melbourne (2011). Urban Forest Diversity Guideline, 2011 Tree Species Selection Strategy for the City of Melbourne. Retrieved 13 March 2014 from http://www.melbourne.vic.gov.au/Sustainability/UrbanForest/Documents/Urban_Forest_Diversity_Guidelines.doc

[41] Chalker, L. (2013). Are Native Species Planting Mandates Good for Biodiversity? Retrieved from http://www.isa-arbor.com/events/conference/proceedings/2013/CHALKER-SCOTT_Native_Species_Biodiversity.pdf

Most metropolitan Local Governments have lists of preferred street trees for their local area. Some Local Governments also specify what trees can be planted on particular streets to maintain the character of certain neighbourhoods.

There are many factors to consider when selecting species of street trees. It is important to select trees that are hardy enough to survive the specific climatic conditions of an area as they will require little maintenance. Other plant characteristics to consider when selecting tree species include the following:

- *The vegetation's projected height and canopy spread:* Tree species should be selected so that their ultimate mature size is in scale with the relevant street, taking into consideration the site constraints, such as verge widths, overhead power lines, building setbacks and vehicle clearances[37]. The optimum size range should not be so small that it does not make a contribution to the amenity of the street, and not so large as to dominate and cause damage to infrastructure[37].

  Where overhead power or communication lines occur, the size and/or types of trees suitable to be grown beneath are limited due to their branching habit and tolerance to severe pruning[37].

  Limb loss occurs occasionally for most trees due to wind induced mechanical breakage[42]. Trees that are known to have brittle branches and regular branch loss, or are likely to blow over in strong winds should be avoided for use as street trees[42].

- *Size and growth habits of the roots:* Tree species that have large and vigorous root systems may cause significant damage to public infrastructure, including roads, kerbs, footpaths, paved areas and underground services[37]. These tree species should therefore be avoided.

- *Sun, soil, water and temperature requirements:* Soil type requirements, the amount of water a tree requires and climatic conditions should be considered when selecting trees. It is important to match the ultimate tree size to the soil volume available for root growth[43]. Pest and disease resistance is also another factor to consider, trees which are known to succumb to diseases and pests should be avoided where possible[42].

- *The types of leaves, berries and flowers it produces:* Street tree species must have an acceptable level of nuisance created by the shedding of leaves and fruit for a

[37] Landcom Projects (2008). Street Tree Design Guidelines. Retrieved 11 March 2014 from http://www.landcom.com.au/downloads/uploaded/2008_Street_Tree_Design_Guidelines_50b9_2965.pdf

[42] City of Sydney (2011). Tree Species Selection. Retrieved 11 March 2014 from http://www.cityofsydney.nsw.gov.au/__data/assets/pdf_file/0017/130238/PartB-TreeSpeciesSelection.pdf

street environment[42]. Species with large or heavy seed pods, excessive leaf fall, or fleshy fruits or flowers which may lead to slip hazards should be avoided[42].

- *Risk of becoming an environmental weed:* Some species have the potential to become serious environmental weeds due to their ability to self-propagate and invade bushland areas[42]. Species which produce large quantities of either fleshy fruits or light windblown fruit are discouraged[43]. Some natives can become weeds, and the potential for hybridization between introduced "exotic" natives and local gene pools in considered a risk[43].
- *Life-span:* Some fast growing plants (e.g. Acacias) are also short lived. As many of the costs associated with the management of trees in the urban environment are associated with the establishment and then the over maturity phase, species that will live for several decades are required to justify these costs[42].

[42] City of Sydney (2011). Tree Species Selection. Retrieved 11 March 2014 from http://www.cityofsydney.nsw.gov.au/__data/assets/pdf_file/0017/130238/PartB-TreeSpeciesSelection.pdf

[43] Gilman, E. & Sadowski, L. (no date). Choosing Suitable Trees for Urban and Suburban Sites: Site Evaluation and Species Selection. Retrieved 2 April 2014 from http://hort.ifas.ufl.edu/woody/documents/EP310.pdf

2.10. Safety Considerations

All tree species occasionally shed limbs which can pose a potential threat to personal safety and property[12]. The risk from falling tree limbs can be mitigated by avoiding using trees with brittle branches and regular branch loss[42]. Tree roots can also create trip hazards if they cause lifting or cracking of footpaths[12].

The use of trees around buildings may increase fire risks[10]. This risk is higher in bush-fire prone areas, such as suburbs on the peri-urban fringe or adjacent regional or national parks. Fire risk can be reduced by selecting tree species with low flammability characteristics and smooth bark[44]. Tall trees should be planted away from buildings so branches do not overhang the roof and gutters do not fill up with debris[44]. Trees should also not be planted closer to buildings and power lines than the distance equal to their estimated mature height[44].

Trees can also cause safety issues if they grow to close to power lines. High voltage electric current can arc out beyond the line if grounded by something like a tree, even without physical contact[45]. This risk can be mitigated by planting trees away from power lines, if trees need to be planted under power lines, short species that are unlikely to interact with the power lines should be used[45].

[12] City of Yarra (2004). City of Yarra Street Tree Policy. Retrieved from www.yarracity.vic.gov.au/DownloadDocument.ashx?DocumentID=807

[42] City of Sydney (2011). Tree Species Selection. Retrieved 11 March 2014 from http://www.cityofsydney.nsw.gov.au/__data/assets/pdf_file/0017/130238/PartB-TreeSpeciesSelection.pdf

[44] Pittman, S. (no date). Reducing Fire Risk in Gardens. Government of South Australia. Retrieved from www.environment.sa.gov.au/.../bg-gen-reducingfireriskingardens.pdf

[45] Most, W. & Weissmen, S. (2012). Trees and Power Lines: minimizing conflicts between electric power infrastructure and the urban forest. Retrieved 13 March from http://www.law.berkley.edu/files/Trees_and_Power_Lines_March_2012.pdf

3. DISCUSSION AND NEXT STEPS

WALGA invites Local Governments to inform its street trees policy guidance note. Local Government has two options to engage:

- By participating a workshop, which will be held during the first week of June; and/or
- By providing written feedback.

WALGA is particularly interested in receiving feedback about the following topics:

1. What are the drivers for Western Australian Local Government to invest into street trees?
2. What problems/ issues do Local Governments encounter with street tree maintenance and establishment?
3. What are the possible solutions to these problems/ issues?
4. What guidance/ advice would assist Local Governments to establish and/or manage street trees?
5. What influences street tree species choice within your Local Government?
6. Any other feedback or comments?

The workshop will be held during the first week of June, and will be advertised through WALGA's usual communication channels, as soon as details are finalised.

Local Governments are requested to provide all written feedback by **COB, Friday, 6 June.**

For more information or to provide feedback, please contact Michelle Brent, Environment Policy Officer on email mbrent@walga.asn.au, or telephone (08) 9213 2027.