Street and Reserve Tree Technical Management Guidelines

Adopted 21 November 2018

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1.1 Guidance

Council will plant the right tree in the right place in the right way.

Council will proactively carry out tree planting to meet the following purposes:

- To preserve and enhance the local township character and the distinct areas within the townships;
- To increase the number of street trees;
- To increase the number of trees within parks and reserves;
- Select tree species for planting for their suitability to the site, biological diversity, adaptability to future climate changes, performance, and potential to contribute to the landscape without onerous management implications;

Council will:

- Set and maintain high tree planting and establishment standards;
- Ensure it is supplied with high quality tree stock and will allocate adequate resources to supervision of tree planting activities and levels of after-care maintenance.
- Consult and inform the community about all major projects involving tree planting.

Planting will be undertaken to reinforce and enhance landscape character within streets and reserves with the main objective of increasing the treed canopy across the townships. Tree planting in streets and parks and reserves will be undertaken in a programmed manner that addresses defined priorities.

Priorities for tree planting will be based on:

- Priorities outlined in the 10-year Tree Planting Plan for streets. The removal/replacement planting program based on condition or appropriateness of existing trees and the streetscape rating system (see appendix A). This will also incorporate the annual street tree planting program.
- The priorities outlined for planting within parks and reserves, assessed on canopy coverage and open space usage.
- Community requests.
- A recognised need for landscape enhancement during streetscape improvement works, such as incorporating streets nominated in the 10-year planting plan with Councils street construction works.

1.2 Introduction

Trees are the dominant component in landscapes and one of the most effective ways of improving the image and landscape character of a town is to upgrade the street tree / roadside and public open space planting.

Although the introduction of new trees to the streets and other Council managed land can be considered one of the simpler horticultural tasks for open space managers, trees create a long-term impression in the landscape and can alter the identity of the landscape and impact on management practices and subsequent resource allocation.

The urban landscape bears little resemblance to the natural landscape in which trees evolved. To ensure success for tree planting programs, a firm understanding of environmental resources that

allow trees to flourish and constraints that inhibit their growth is required. The basic requirements are: air (oxygen & carbon dioxide), light, water, nutrients and appropriate temperatures.

Council will implement a planned approach to tree planting within the municipality taking into consideration available funding, landscape requirements, environmental constraints, site and seasonal conditions, availability of stock and community expectations.

Tree planting may occur for the following reasons:

- A replacement for a tree removed as part of normal maintenance.
- 10-year planting program.
- Capital works programs.
- Community request to have a tree planted.
- Council officer request to plant trees.
- As part of an upgrade or Master Plan of the individual park or reserve.
- As part of asset or infrastructure upgrade redevelopment.

1.3 Design considerations

There are many planting situations within a township. Matching the site constraints or opportunities to tree/plant requirements will lead to more successful landscapes. There will be situations in which tree selection alone will be the best tool to achieve the desired outcome. Other sites, for example commercial/retail areas, may require site modification to reduce the limitations to plant growth.

Climate

Climatic variation throughout the municipality is small, as there are no major topographic variations that would cause marked climatic differences. The summers are typically hot, and the winters are mild. About 60 per cent of the annual precipitation is of low intensity and occurs during the winter months (particularly from May to October). Irregular thunderstorms during summer often produce intense rainfalls of short duration. Annual average rainfall is between about 400 and 500 mm. Severe frosts often occur during winter. It is noted that climate change modelling for Victoria will see average temperatures increase, annual rainfall decrease and extreme weather events such as storms and droughts increase in number and intensity. This will need to be taken into account when considering both tree species to be planted, and the growing conditions prepared for new trees. With this in mind, trees designed with and planted in passive water sensitive urban design systems are likely to thrive in changing climates. See following WSUD guidelines for appropriate concept designs for Hindmarsh

- https://www.melbournewater.com.au/planning-and-building/stormwater-management/options-treating-stormwater/swales
- https://www.sa.gov.au/__data/assets/pdf_file/0019/20917/WSUD_chapter_11.pdf
- https://www.brisbane.qld.gov.au/sites/default/files/wsud_chapt2.1_to_2.4.1_swales.pdf
- https://www.stormwater.asn.au/images/Conference_Papers/Victoria_2013/Ppt0000012.pdf
- https://www.naturalresources.sa.gov.au/files/sharedassets/adelaide_and_mt_lofty_ranges/plants_and_animals/green_infrastructure/green-infrastructure-waymouth-case-study.pdf
- https://www.bendigo.vic.gov.au/sites/default/files/2016-08/City-of-Greater-Bendigo-Water-Sensitive-Urban-Design-Resource-Kit-Document.pdf

Biological criteria

Selecting the right tree for the right space is critical to the success of the planting. The use of indigenous plant species should be encouraged, as far as practicable and where appropriate. Australian species from other localities and exotic species can also make positive contributions to the landscape and local environmental factors, such as local biodiversity. In some cases, these species are better adapted to the conditions of the highly modified environment and have positive attributes that can fulfil specific landscape functions.

Biological criteria will also consider factors such as a trees tolerance to drought, wind and modified soil environments.

Site conditions

The following road configurations will require a different approach to design and species selection:

- Main roads
- Residential streets in urban areas
- Streets and road reserves with substantial remnant vegetation
- Commercial / industrial precincts

The above categories may also have other factors that could affect the design, location and selection of trees. For example:

- The presence of powerlines
- The presence of footpaths and kerbs
- Width of planting area (nature strip / median strip)
- Different clearance and visibility requirements
- Landscape character
- Underground infrastructure

Locations of tree planting shall be determined by the Infrastructure Strategic Assets and Planning team and existing street features restrictions in conjunction with community consultation where appropriate. A common-sense approach should be adopted always.

1.4 Street tree planting styles

Several different styles of street tree planting could be utilised within the townships of Hindmarsh. The ultimate style will be dependent on the existing street tree character, street type, dominant land use and planting space. There are opportunities to utilise all the five street tree planting styles listed below within the townships. The powerline planting style will be the most common style to reduce maintenance requirements.

Formal

- Considered a homogenous avenue.
- Usually one species, but can also incorporate different species of trees, if they are similar in size, form and texture.
- Usually regular and equidistance spacing of trees.

The avenue effect of uniform species is the preferred planting style within the townships where appropriate.

Informal

- Combination of native or indigenous tree species at irregular numbers and spacing.

Group Trees & Shrubs

- Grouping either trees or mixed vegetation (trees & shrubs) together at irregular numbers and spacing.

Bushland/Indigenous Grouping

- Groups of indigenous vegetation.
- Can be in continuous sections along street.

Powerline Plant

- Using taller growing species on non-powerline side of the street and smaller growing species on the powerline side to negate the requirement to prune trees for clearance.
- Can also be used in situations where there is footpath only on one side of the road and consequently leaving a narrow planting site and a wider planting site on the other side of the street.

Powerline planting will be the most common planting style within the townships. This is the preferred planting style to minimise the potential for conflicts between vegetation and overhead electric lines and to reduce the requirement to undertake clearance pruning. Reducing the requirement to maintain trees under powerlines will be sought at every opportunity.

Any traffic features within a street may be planted if suitable, such as roundabouts, medians, kerb outstands.

Trees in commercial precincts

Commercial precincts, including central business districts and associated strip shopping centres, are often designed to include vegetation such as street trees and display horticulture. The issues and challenges associated with managing trees and other vegetation in this context are different to a typical street in a residential area.

Site constraints and community expectations will differ from site to site. This will require a design approach that considers site-specific constraints, at each commercial precinct. Examples of commercial precinct site constraints and community expectations can include:

- Limited space between shop fronts and back of kerb;
- Concentrations of underground services that prevent or reduce planting spaces;
- Height limitations due to eaves, awnings, covered walkways;
- Maintenance of sight-lines associated with intersections, road signage and crossings;
- Shop-front visibility;
- Desire to raise the profile of a commercial precinct through beautification vis-à-vis trees/vegetation.

Because of these constraints, the range of tree species that can be used in commercial precincts is limited. There may be instances in which the use of trees is not physically possible or undesirable.

How Council manages vegetation, including street trees, at commercial precincts will be different to residential streetscapes. General principles include:

- Vegetation may be chosen to be manipulated such as topiary trees and hedges;
- Trees may have shorter natural life spans due to heavy pruning techniques or due to root disturbance resulting from underground infrastructure works;
- The dynamic nature of commercial precincts may result in frequent replacement cycles as infrastructure refurbishment/replacement programmes are implemented at shorter intervals than would be the case in residential areas.
- Trees may require engineering solutions such as tree guards for protection in areas in which vandalism and higher volumes of traffic occur.

Street tree planting in residential areas

The aim is to plant trees at regular intervals and at a density that will provide a sense of continuity and scale to the streetscape.

Where reasonable, one tree will be planted in front of each property within residential urban streets of the townships or alternatively at approximately 20 metre spacing's. The growth characteristics of the tree and the capacity of the street will also determine spacing. Smaller trees, i.e. trees up to 9 metres in height, can be planted at higher intervals between 6 to 10 metre spacings.

Other considerations include:

- private or other vegetation that exists on or close to the road reserve precluding the growth of a street tree;
- established planting theme or available space (long nature strip or corner allotment) allow for more than one tree per property; and,
- location of other infrastructure.

Existing street features restrictions

Trees should be located as per the following criteria:

- Minimum of 10 metres from intersections in residential streets and further in residential streets where visibility may be a problem.
- Minimum of 20 metres from intersections with signals, pedestrian signals and pedestrian crossings.
- Minimum of 15 metres from streets intersecting with a main road.
- Minimum of 10 metres from a Stop or Give Way sign.
- Minimum of 3 metres from lane ways, bus stops/shelters.
- Minimum 4 metres from vehicle crossings.
- Minimum of 3 metres from electricity poles.
- Minimum of 4.5 metres from hydrants.
- Minimum of 3 metres from a storm water or drainage pits.
- Minimum of 2 metres from beneath service wires.
- Trees are not to be located over house connections to gas and water services.
- As a rule, if there is no existing footpath, allowance must be made for future footpath and pedestrian access, however there will be exceptions.

- Trees are not to be located where private overhanging trees will significantly reduce their health, vigour or shape or where foliage from the mature street tree will impinge upon traffic signals.

No new tree planting shall be undertaken in streets with a planting area less than 1.5 m wide. This may vary if special engineering solutions are incorporated into the planting design to mitigate root conflicts with infrastructure and to increase the volumes available for tree root growth.

Selection of tree species will be commensurate with the width of the nature strip / road reserve or planting site (As indicated in Table 1).

No new tree planting shall be undertaken within the carriageway (road pavement) unless Council adopts a designed solution in conjunction with relevant authorities.

Tree species planted in urban streets should be able to be pruned to a single trunk or have a clear trunk to minimum height of 1.5 m for visibility.

Tree planting is to comply with VicRoads Tree Planting Policy May 2016.

Tree planting in parks and reserves and other Council managed land and facilities

The objective is to establish or reinforce the presence of a tree canopy within a Council managed park or reserve. Tree planting will also be undertaken in other assets managed by Council, such as civic centres, pre- schools, child-care centres, and car parks.

Trees will be planted annually depending upon funding, seasonal conditions, availability of stock and park suitability. Tree planting in individual parks may also respond to Master Plans.

Locations of tree planting will be determined by the landscape objectives being sought at a particular park or Council property and by site constraints. A common-sense approach should be adopted always.

Trees will be placed in the landscape to allow them to develop to their full potential and form (shape of crown).

A range of trees will be utilised to achieve a diversity of species.

Using good design principles, the aim is to plant trees that will establish or reinforce the presence of a tree canopy within Council managed land.

Tree selection will be based upon the requirements of the Council managed asset, or park/reserve and any Master Plans, and the required characteristics of the tree species as determined by Council.

Tree location should consider the mature dimensions of the canopy height and width, trunk diameter and root development requirements to ensure that they do not have an eventual impact upon Council or privately-owned infrastructure.

Tree location should consider existing vegetation within the site and on adjoining properties to limit unnecessary competition between established and proposed plantings. Tree location should also take into consideration maintenance and access requirements.

Trees should be located as per the following criteria:

- Minimum of 4.0 metres from park furniture, paths, driveways and lane ways.
- Specimen trees shall be planted a minimum 5.0 metres from adjoining properties and Council buildings.
- Minimum of 3.0 metres from electricity poles.
- Minimum of 2.0 metres from hydrants or drainage pits.

- Minimum of 2.0 metres from beneath service wires.
- Trees are not to be located over incoming gas and water services.
- Trees are not to be located where overhanging trees will significantly reduce their health, vigour or shape.

Tree planting within Council managed facilities must incorporate adequate tree protection, including tree guards and mulch appropriate to the social context of the site.

1.5 Providing adequate space for trees

The further a tree is away from infrastructure the less likely that damage will occur. Combined with this is the understanding that the smaller the size of the mature tree the narrower the planting site can be, within reason. No planting is to occur where the planting site is less than 1.5 m wide unless solutions to mitigate potential root damage are first identified.

Table 1 can be used as a guide in the selection of appropriate species for planting areas. Larger trees could be considered for the commercial areas only if engineering solutions are incorporated into the planting site.

Table 1: Planting area guidelines (Adapted from Gilman, 1997)

Total Planting Area (Lawn, island, or soil strip)	Planting strip width	Distance from trunk to pavement or wall	Maximum tree size at maturity
9.5m^2 to 18.5m^2	1.5m to 2.5m	1.2m	Small (Less than 9m tall) to Medium (Less than 15m tall)
More than 18.5m^2	> 2.5m	> 1.5m	Large (Taller than 15m)

The potential for direct mechanical damage and upheaval is one factor in street tree planting. It is also necessary to consider soil type and the proximity and design of structures.

1.6 Tree planting technique

Along with appropriate species selection and selecting quality stock, planting if done correctly, will have a lasting influence on future tree development.

Trees will be planted properly, and an after-care maintenance program implemented to achieve a successful tree establishment rate of greater than 90%.

Tree planting should take place between May and September; it can extend between April and October if prevailing weather conditions are conducive.

Planting and establishing trees is all about managing air and moisture in the soil. Manage these correctly and trees will grow quickly following planting. Four of the most common causes of poor plant establishment are 1) planting too deeply, 2) under watering, 3) over watering, and 4) over-mulching.

Planting too deeply in compacted soil can also lead to very slow root development. Each of these problems can lead to tree death, poor growth, or a slow decline after planting. If appropriate trees are planted at the right depth and they are irrigated properly, the planting has a good chance of success. See Figure 1 below for tree planting detail.

The following points need to be considered:

- The depth of the planting hole is determined by the depth of the root ball of the stock. The depth of the root ball is measured from the bottom of the trunk flare to the bottom of the root ball. Dig the hole slightly shallower than the root-ball depth and as wide as possible.
- Trees benefit from larger planting holes; a larger hole means a greater volume of loose cultivated soil for rapid initial root growth. Widening the planting hole is the only way to increase this volume. The planting hole must be three times the width of the root ball (Dig a much wider and shallower hole in compacted soil).
- The planting hole should have sloping sides rather than vertical walls. The sides are to be scarified. The root ball must be supported by firm soil underneath to prevent settling.
- The bottom of the trunk flare shall be at or slightly above finished grade. The top of the root ball should be set slightly above the soil level to account for any drop in the soil level at the base of the planting hole. Allowing the roots to be too deep in the hole is the most common mistake made during planting and it is nearly impossible to rectify.
- Backfill should be like the soil at the planting site. Backfill soil can be amended to meet specific objectives. Fertilising is not required on newly planted trees. Most nursery-grown trees are well fertilised during production and seldom respond to fertilising at planting except in the most infertile soils.
- The soil backfill must be free of large soil clumps and rocks (fine tilth) and should be installed and settled in layers, finely tamped or left to settle on its own, to limit future settling and exclude air pockets. The top of the root ball should not be covered with any soil. Backfill soil must not be compacted to a density that inhibits root growth.
- It can be beneficial to form a temporary basin (berm) around the outside edge of the root ball, make the wall about 75 mm to 100 mm high and firm the soil into place with hands. This will greatly decrease soil moisture run-off and will also direct water down into the root zone.
- Water the root ball and backfill soil to bring the root ball to field capacity.
- Approved mulch is to be applied near, but not touching, the trunk out to the perimeter of the planting; as a minimum. A 75 mm to 100 mm layer of approved woodchip mulch is ideal. Mulch should be thinnest over the root ball. Mulching further out from the planting hole has good benefits.
- If good quality tree stock has been purchased staking for support will not be necessary in most landscape situations. Two stakes used in conjunction with a wide, flexible tie material on the lower half of the tree will hold the tree upright, provide flexibility, and minimise injury to the trunk. Support staking and ties should be removed after the second year of growth (by the conclusion of the 2-year maintenance program). Trees that have been grown well in the nursery may not require any structural pruning at planting. Some damaged branches during transporting, storage or planting may need to be removed.
- Consider using ‘watering well’ type systems in surfaces with low permeability during establishment.

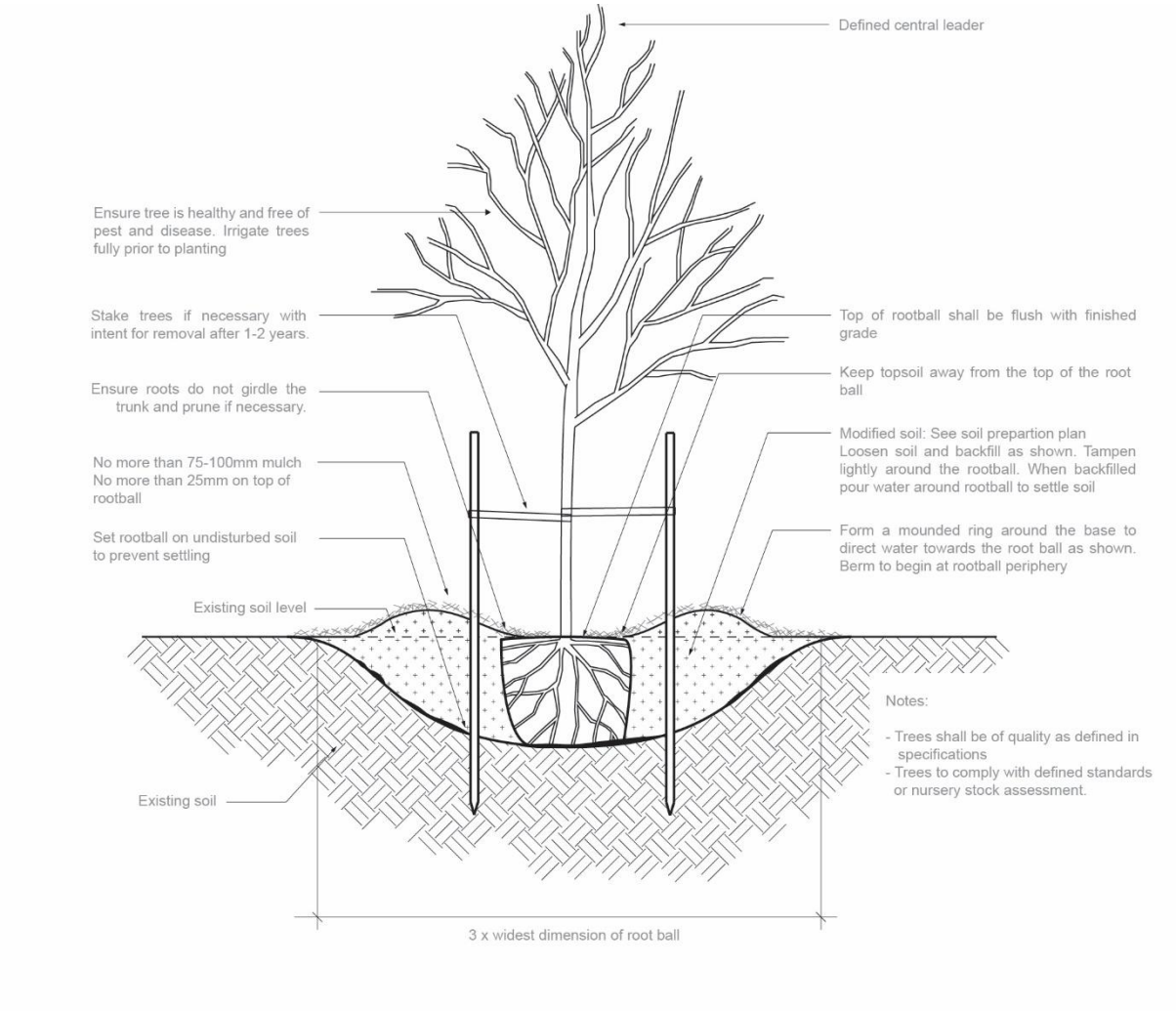


Figure 1: Typical street tree planting detail in nature strip

Planting in compacted soils

Because roots grow poorly in compacted soil, it should be tilled or broken up with specialised heavy equipment prior to planting. This must not be done beneath the canopy of existing mature trees as significant root damage could occur leading to decline.

Several 60 cm to 90 cm deep, 7 to 10 cm wide trenches can be dug from the planting hole like spokes in a wheel as shown in Figure 2. A backhoe or chain trenching machine can dig trenches quickly. This technique is also referred to as vertical mulching and can be used for decompacting soil around established trees (using sympathetic excavation methods). Amended or original soil can be placed back into the trench although there is no evidence that amended soil increases root growth more than backfilling with original soil.

The same technique can be used in nature strips with the trenches running parallel with the footpath and kerb (dependent on location of any underground services).

Although this may not provide all the benefits of loosening the soil around the entire planting hole, it may be less expensive, and roots should be able to grow well in the loose, aerated soil in the trenches.

Figure 2: Radial trenching used in compacted soil for newly planted tree

Tree planting by residents

Council is responsible for the planting and maintenance of street trees. Council seeks to develop uniform streetscapes that compliment landscape character and meet design and maintenance requirements. Without Council approval, residents are not permitted to plant trees within the nature strip or other sites within the road reserve. Council may remove such plantings and no compensation will be available to residents for the removal of these trees and shrubs (greater than 300 mm in height).

Council may support community groups planting vegetation within the townships. Council will consider upon request.

1.7 Tree establishment program

After-care tree maintenance requirements are vital to successful tree establishment and it must be considered an extension of the planting process itself. All previous expense and efforts to plant a new tree in the landscape will be wasted without proper after-care maintenance. This facet of the tree planting process can greatly increase the success of the planting if carried out rigorously. The establishment program shall include:

- A watering program to ensure an optimum soil moisture level is maintained and growth continues unaffected by drought or soil saturation;
- Monitoring and control of pest and disease;
- Replacement of planted trees that do not survive the maintenance period (excluding vandalised trees);
- Maintaining tree stakes and ties;
- Develop good tree architecture through formative pruning;
- Maintaining planting sites free of weeds;
- Maintaining specified depths of mulch; and
- Reporting

A program of post-planting maintenance should extend for a minimum two years after planting. The period of post-planting maintenance may be extended, depending upon size of planting stock, prevailing seasonal conditions and tree establishment success.

A regular watering program is the most important maintenance step. Monitoring of watering requirements is necessary to ascertain plant needs and watering frequency. This can be dependent on climatic and site conditions. Specific recommendations for watering are impractical due to the enormous variety of situations, edaphic conditions and tree requirements.

Watering regimes will also take into consideration any current water restrictions. During periods of water restrictions, a combination of recycled A class water, reclaimed storm water and bore water will be used to water all recently planted trees for the duration of the two-year tree establishment period.

Irrigation

Newly planted trees are under stress and have greater need for maintenance until the root system can fully develop at the new site (Watson & Himelick, 2013). Water stress can occur even with the of best after-care maintenance during extreme hot and dry conditions. Water is the most limiting factor required for root growth.

Allowance should be made for suitable irrigation, usually for a minimum of six months (possibly from late September through to early May) during the year, to avoid moisture stress and to promote plant growth across the site.

The amount of water necessary for successful plant establishment is dependent on the size of the tree that has been planted, the soil conditions and the climatic conditions. The root ball of the tree must have constant moisture until the tree has established. In the first two years after planting the most important place to check the soil moisture is in the root ball (Watson and Himelick, 2013). A component of the after-care maintenance program should be to randomly sample a range of newly planted root balls across the townships to ascertain moisture content. The moisture in the root ball should be checked with some form of a probe, either electronic, soil corer or a simple metal rod checking for penetrative resistance, that are all useful in gauging soil moisture levels.

The amount of water that needs to be applied through irrigation is dependent on the size of the deficit between the water available in the soil through rainfall and the total water used by the tree.

When a new tree is planted the amount of water available from the soil/media is relatively small and hence frequent applications of water are required to ensure the root system, which often has been damaged, has access to water on a continuing basis.

It is therefore very important that:

- Water be supplied regularly to newly planted trees to ensure survival and maintain growth, and,
- Development and expansion of the root system is encouraged so that the tree gains access to increasing volume of water in the surrounding soil.

Other additives can assist with tree establishment for example surfactants to improve infiltration of water, and carbohydrate drenches (sucrose) to stimulate root growth.

Fertilising is not required on newly planted trees. Most nursery-grown trees are well fertilised during production and seldom respond to fertilising at planting except in the most infertile soils.

Formative pruning

Formative pruning, also referred to as structural pruning, is a method generally performed on young and establishing trees, which influences the orientation and spacing of branches to enhance form and improve structure or directionally shape trees, such as around electric wires (as they continue to grow).

There are three basic tree architecture development issues that should be addressed with formative pruning during the two-year post planting maintenance program:

- Removal or reduce codominant stems
- Removal of vigorous branches and stems that develop low on the trunk
- Reduction (shorten) of vigorous lower branches that will tend to over-extend

1.8 Tree selection

There is no one perfect urban tree.

It is also important to understand that there is no one urban environment. The urban environment is a varied conglomeration of micro-climates and heterogenous soil conditions. Above ground or below ground site conditions can change dramatically within the space of a few metres. Consequently, a site analysis of each major planting site will allow more appropriate tree selections. Climate change and increases in temperatures will also require consideration when selecting tree species.

The most successful strategy is to match the planting site limitations with the right tree for that site.

Appropriate site assessment and tree selection can have the following benefits:

- Mitigate conflict between tree roots and adjacent infrastructure/buildings.
- Reduce the incidence of pest and disease outbreaks. This can be achieved through selecting resistant varieties of trees and increasing species diversity through the municipality.
- Increase plant performance by attributing species to site conditions.
- Utilise drought tolerant plants to cope better with climatic changes; particularly increases in temperatures and incidence of drought.
- Increased tree longevity so that tree benefits exceed the costs. The benefit of an urban tree is directly proportional to its crown size or volume and longevity in the landscape (See Figure 3).
- Reduced maintenance costs, particularly pruning. Pruning requirements can be reduced by selecting smaller trees under powerlines or narrow canopy form for main roads.
- Attractive streetscapes that reinforce the pervading landscape and architectural character.
- Reduced environmental demand; trees that have tolerance of drought and generally do not require additional resource inputs, such as irrigation or fertiliser, to perform satisfactorily.

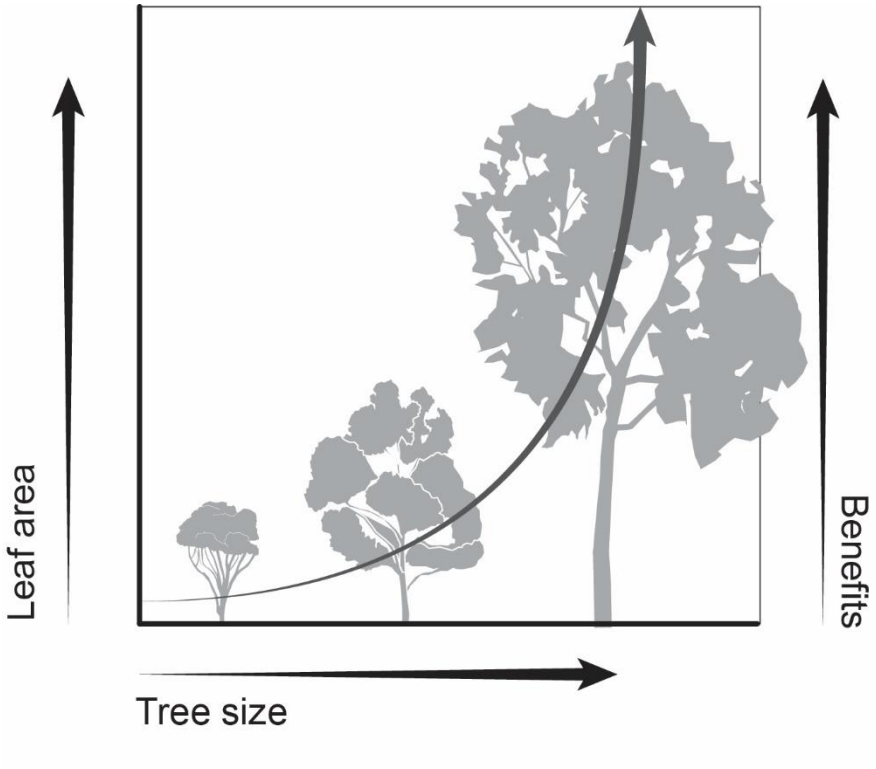


Figure 3: Benefits derived from trees increase with tree size

Tree selection will consider relative plant tolerances and adaptability, and integration into surrounding planting themes.

The basic issues regarding tree selection can be summarised as follows:

- Biological requirements relate to a tree's ability to tolerate urban conditions. The species selected should have high tolerance levels that will allow establishment and sustained growth while producing desired benefits with low management inputs. It also relates to available root space to sustain the potential tree size.
- Ecological issues include tree diversity, maintaining and enhancing existing significant areas of native and remnant indigenous vegetation. Selecting plants that do not have the potential to become woody weeds and impact on natural systems.
- Functional and spatial issues include the trees ability to be pruned to provide required clearances. It also relates to the trees root system and its limited impact on adjacent infrastructure. It considers the above ground and below ground restrictions.
- Aesthetic issues consider the ability for trees to enhance the visual amenity of a streetscape or area, without negative impact to surrounding infrastructure.
- Tree longevity should also be considered as the longer a tree can grow in a site the greater the benefits to the landscape and return on initial investment the trees will have.
- Availability. The selected trees will need to be commercially available to provide the desired numbers and size for planting programs.
- Using tree species that are known to have low litter drop, such as leaves, flowers, fruit and bark.

- Using tree species known for their structural integrity and stock that are known to have received appropriate formative treatment whilst in the production nursery.

Native versus exotic species

Urbanisation has dramatically altered the conditions to which Australian and indigenous trees have adapted. Just because a plant is native to a site does not necessarily mean that the current site conditions are optimum for its growth. Few native soils mimic urban soils. Once a tree is planted in an urban environment, it ceases to be in its native environment.

Australian species from other localities and exotic species can make positive contributions to the landscape. In some cases, these species are better adapted to the conditions of the highly modified environment. They may have positive attributes and are able to fulfil specific landscape functions.

The focus should be on tree species adapted to a site and with acceptable characteristics relative to the desired purpose.

The wrong choice of species, placed in inappropriate locations has little to do with tree selection, rather it is an indication of poor planning. In many instances, requirement is often confused with tolerance.

Remnant, indigenous and native vegetation has an important role to play in urban landscapes. It should be noted, however that the maturity of existing vegetation is impossible to replace, and the diversity of natural plant communities is difficult to replicate. Preservation of existing natural and remnant vegetation is the most efficient way to incorporate biodiversity in urban landscapes.

The use of indigenous tree species in streets will have greater impact and benefit when used adjacent to open space that has significant remnant vegetation.

Tree species list

Appendix B contains tree species lists suitable for planting within the urban areas of the townships. A range of indigenous, Australian native and exotic, evergreen and deciduous species has been selected to ensure the best possible outcome given specific individual site outcomes and constraints.

The list of tree species is not definitive.

The species listed should be considered the ‘signature’ species that will contribute to the pervading landscape character of the township’s streets and parks and reserves. Council will review and investigate new tree species in line with aesthetic, functional and climatic/environmental requirements.

References

Center for Urban Forest Research, Pacific Southwest Research Station, USDA Forest Service, Davis, California and the Southern Center for Urban Forestry Research & Information, Southern Research Station, USDA Forest Service, Athens, Georgia. (2004). *The large tree argument. The case for large stature trees vs small stature trees.* Southern Center for Urban Forestry Research & Information, Southern Research Station, USDA Forest Service, Athens, Georgia. 2004.

Connellan, G. (2005) Water efficiency strategies in our cities - their impact on urban trees. International Society of Arboriculture Australian Annual conference proceedings.

Gilman, E. F. (1997) *Trees for urban and suburban landscapes.* Delmar Publishers.

Miller, R. W., Hauer, R. J., & Werner, L. P. (2015). *Urban forestry. Planning and managing urban greenspaces. Third edition*. Waveland Press, Inc.

Urban, J. (2008) *Up by roots. Healthy soils and trees in the built environment*. International Society of Arboriculture.

Watson, G. W., and Himelick, E. B. (2013). *The practical science of planting trees.* International Society of Arboriculture.

2. Tree pruning

2.1 Guidance

The Hindmarsh Shire Council (HSC) will provide adequate resources to carry out tree pruning in streets, parks and reserves and other Council-managed land to meet the following objectives:

- Undertake tree maintenance works as required to protect, enhance and preserve existing trees to a high standard.
- Undertake all pruning to comply with Australian Standard – *AS 4373 – 2007 Pruning of amenity trees*.
- Integrate latest technology to ensure tree maintenance programs continue to meet best tree care practices.

HSC is not responsible for maintaining specified tree clearances from around electric wires.

Australian Standards and known best practice relating to tree management will be implemented and any operation known to be detrimental to long-term tree health is not appropriate.

Council managed trees will be pruned by operations team staff.

Tree selection will consider a tree's ability to be pruned to meet the above ground site constraints and will endeavour to utilise tree size and form (shape of the canopy) to reduce pruning requirements.

Maintenance work on trees will also occur in response to unexpected events or emergencies, such as tree or branch failure resulting from severe storms.

2.2 Current tree maintenance programs

The street trees within the townships are maintained according to requests from residents.

Trees are pruned to meet the legislative requirements of the Electricity Safety under the Electric Line Clearance Regulations (2015) - Code of Practice for Electric Line Clearance by the Powercor contractor.

Trees may also be pruned in response to customer requests or storm damage.

Tree pruning is carried out regularly as identified by operations team staff.

2.3 Tree pruning

Properly maintained trees develop fewer hazardous defects and pose less risk to public safety.

Any pruning that is required must be carried out by trained staff/contractors, as stipulated in Contract No. 1516-03, who have a thorough knowledge of tree physiology and pruning methods and carry out pruning to the AS 4373-2007.

AS 4373-2007 provides guidance on tree pruning but does not describe how to prune a tree.

AS 4373-2007 encourages pruning practices and procedures that reduce the risk of tree defect development, branch failure, pathogen infection and premature tree death.

To ensure that pruning is appropriate for the species and tree/site conditions, it is important to have a clear understanding of the specific needs of the tree and the objectives for pruning.

Pruning objectives include the following:

- Improve structural strength and reduce failure potential (including dead branch removal)
- Prevent or mitigate a pest problem
- Improve aesthetic characteristics

- Provide clearance for pedestrians, vehicles, overhead services and structures
- Improve safety (visibility) and security for road users
- Repair structural damage from wind loading
- Reduce maintenance costs (i.e., when applied to young trees)

Council undertakes pruning programs on publicly managed trees to:

- Reduce the risk to public safety,
- Decrease potential damage to property,
- Provide clearances for pedestrians, vehicles and sight lines,
- Provide clearances around services and electric power lines,
- Manage tree health, and
- To formatively shape young trees.

Operations team staff will be trained to ascertain the pruning needs and objectives and to undertake tree pruning to AS 4373.

Pruning will endeavour to retain the natural form of the tree, while allowing for the necessary electric line, pedestrian, and vehicle clearances required. The least possible reduction of foliage cover and change to the natural form of trees are the aim of all pruning works. No tree shall have more than 33% of live crown removed at any time without approval.

Trees may be pruned away from properties upon request. Such works will be completed with sensitivity to the trees shape and only in an arboriculturally appropriate manner

Trees will not be lopped or indiscriminately pruned.

2.4 Tree Clearance Requirements

Table 2 below provides the crown clearance requirements when conducting pruning work on street trees within the municipality.

Powercor will maintain clearances around overhead electric lines in compliance with the Electricity Safety (Electric Line Clearance) Regulations, or subsequent updates, which prescribe the Code of Practice for Electric Line Clearance. Council has an existing agreement with Powercor to prune Council trees with the aim to achieve a three-year interval of pruning of trees for electric line clearance (Refer Council Doc ID: 151492 – Township Tree Management Plan and Agreement) Some trees within the municipality require annual pruning for electric line clearances. Most of these trees are large established trees with species that exhibit strong growth rates and are within close vicinity to High Voltage power lines.

Council is not responsible for the clearance of vegetation around non-electrical aerial conductors.

Table 2: Tree crown clearance requirements for street tree pruning.

ACCESS TYPE AND CLEARANCE LOCATION	CLEARANCE
Electric line clearances (H.V. and L.V.)	Maintain clearances as per the Electric Line Clearance Plan
Service wires, including street light cables	0.3 m
Vehicular/Over roadways	

Local roads Main roads (Declared roads) Driveways/crossovers	4.1 m 4.5 m 3.5 m
Pedestrian Over footpaths, walkways, nature strips Motorist/pedestrian visibility Along user sight lines (Generally single, clean trunk). Above ground (nature strip).	 3.5 m 3.5 m
Approved road signage, lines of sight and traffic control devices	Allow for driver and pedestrian visibility in accordance with VicRoads/Council sight clearance standards.
Buildings on private property	Maintain 2.0 m clearance off structures through pruning cycle.

2.5 Formative pruning

In the first year of its 2-year maintenance cycle and through the cyclic pruning program trees will be formatively pruned. Formative, also called structural, pruning will be undertaken on younger street trees within the cyclic urban area pruning program.

Formative pruning is a method generally performed on young and establishing trees, which influences the orientation and spacing of branches to enhance form and improve structure or directionally shape trees. The objective of the formative pruning program is to develop good branch architecture that enhances and anticipates future form and improves structure.

Reasons for implementing a formative pruning program.

- Reduction in tree failures due to the removal of structural defects, early in the life of a tree.
- Formative pruning assists in sustaining long-lived trees of all sizes in many urban landscape locations.
- It is more efficient to prune trees early and often with small cuts than to delay pruning until trees have serious structural problems.
- More hours and higher debris disposal costs will be incurred when pruning larger, neglected trees.
- Develops anticipated future form and function by training and directional pruning early, particularly important for larger tree species growing under electric lines.
- Younger trees can sustain a larger pruning dose which is the amount removed.

2.6 Pruning of Canary Island Date Palms (CIDP) and other palms

Palms are pruned to remove dead or chlorotic lower fronds or remove flower and fruit stalks.

Palms are often over pruned however, with the removal of green fronds rarely necessary. Removing green fronds from a palm can slow growth rates and cause a narrowing of the trunk and potential root problems. Over pruning of CIDP can cause trees to become susceptible to Fusarium Wilt.

Excessive pruning, particularly the older fronds low down the canopy, can also cause potassium (K) deficiency. Potassium deficiency can cause crowns to become greatly reduced in size, fronds appear

‘frizzled’ and trunk taper is reduced resulting in ‘pencil pointing’. Without treatment, palms affected by severe K deficiency will die.

If there is a need to undertake pruning, only remove those fronds drooping below an imaginary horizontal line drawn through the bottom of the canopy (see Figure 4).

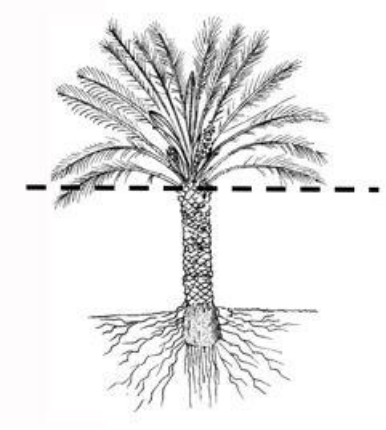


Figure 4: Dashed line indicates acceptable pruning height

2.7 Unauthorised tree pruning

Council urges residents to utilise the service provided by Council and have all pruning of publicly managed trees undertaken by the Council.

Should a resident or property owner inadvertently or knowingly damage a Council street or park tree, makes the tree structurally unsound or compromise the aesthetics of the tree, Council may seek reimbursement of the damage for loss of amenity and value of that tree.

3. Management of pests & diseases

3.1 Guiding principles

- Pest and diseases are a component of the urban landscape and Council recognises that control measures will be required at times to maintain healthy and aesthetically pleasing landscapes.
- If a pest outbreak is identified and damage thresholds exceed accepted levels and other trees are at risk, all possible action will be taken to effectively decrease the risk to other trees from the pest outbreak.
- Council will adopt the principles of integrated pest and disease management (IPDM) to address pest and disease management with a focus on problem prevention through appropriate tree selection, planting and tree maintenance.
- Council officers will be trained to understand the biology of the plants and key pests in relation to the ecosystems they are managing. On-going training and education will occur for the officers to maintain current best practice approach to pest management.
- Council will support research into biological controls for pests and diseases that pose a threat.
- Constant monitoring of the urban forest will allow timely and appropriate responses.
- An integrated approach to pest management will be adopted that employs methods and materials that preserve and augment the ecosystem while facilitating permanent control of the pest.
- Advice and management programs will be sought from other agencies or pest control regulator, for example Department of Economic Development, Jobs, Transport and Resources (DEDJTR), to ensure the best approach is adopted for any pest outbreak.
- Trees will be removed when they are infected with an epidemic insect or disease where the recommended control is not applicable, and removal is the recommended practice to prevent transmission.
- Species of tree will be selected that are known to be pest and disease resistant.
- Monitoring systems will be developed to check pests and tree health regularly; and
- Trees that are recognised woody weed species will be removed when opportunities are presented through the normal management of the municipalities tree population.

When selecting tree species for the township streets and parks all effort will be made to select species that are known to be pest and disease resistant. However, there will be situations where the existing street tree species may be under threat, but their on-going use is imperative considering the strong landscape character or the cultural importance they present.

It would also be very difficult to select a palette of tree species for urban streets that are immune from potential infestation from pathogens, particularly when some potential threats could impact on entire plant families such as Myrtle Rust on the family Myrtaceae (*Eucalyptus* spp., *Corymbia* spp., *Callistemon* spp., *Melalueca* spp., and *Lophostemon confertus*).

Constant monitoring of the urban forest will allow timely and appropriate responses to pathogen infestations with the following more serious pest and diseases need to be considered during the tree selection process.

4. Root management

4.1 Guidance

- The conflicting requirements of trees and infrastructure will be minimised where possible.
- Council will consider a range of strategies, such as species selection, root pruning and infrastructure modifications, to avoid or manage tree root conflicts with adjacent infrastructure.
- Root pruning of Council managed trees will always be undertaken in accordance with AS 4373 Pruning amenity trees to ensure the health, stability, and longevity of the tree.

Aspects of tree root management also relate to tree protection – Section 5.

4.2 Introduction

Root systems are vital to the health and longevity of trees. However, in urban areas where there is competition for available space, tree roots are often associated with situations that cause damage to structures, footpaths, and underground services. There can be dichotomy between sustaining a healthy urban tree population with all the associated benefits, while endeavouring to reduce the negative impacts that these trees can have on adjacent infrastructure.

In addition to the costs directly associated with repair, municipalities are usually responsible for injuries allegedly resulting from uneven pavement surfaces.

Although tree roots are often blamed for the cracking and lifting of concrete, it is worth noting that these structures can also fail because they have not been properly engineered to function in a landscape that contains growing trees and their root systems.

It is not possible to avoid or eliminate all conflicts between tree roots and hard surfaces or pavements within urban landscapes. Given that trees are vital to the urban landscape it is accepted that trees come with inherent levels of risk as do all public assets such as roads and buildings. In this regard Council accepts that there are some increased costs associated with the repairing of roads and pavements damaged by tree roots as a trade-off for having tree lined streets.

It is not possible to remove all risk associated with trees and infrastructure, but strategies for addressing conflict can be preventative, to reduce the risk of damage occurring or remedial, to correct damage or avoid further damage. Understanding the various factors associated with root conflicts on adjacent infrastructure will allow the most appropriate actions to be developed to minimise the risk of damage occurring.

A coordinated, multidisciplinary approach to reducing the risk of root damage to infrastructure within the townships of Hindmarsh is required.

Key aspects of the HSC's tree root management approach:

- Implement appropriate species selection – right tree in the right place.
- Investigate alternative treatments such as flexible pavement options (asphalt, pavers) and kerbstones or concrete sections that can bridge over roots.
- Consider the relocation or realignment of infrastructure and utilities away from trees.
- Coordinating capital works, street renewal/maintenance work programs with street tree renewal program.
- Undertake selective root pruning and/or the installation of root barriers. The circumstances necessitating root pruning vary, but the key is to ensure it does not impact on the health, stability or longevity of the affected tree.

4.3 Tree root growth characteristics

Tree root growth is opportunistic, proliferating at random in conditions that are conducive to growth i.e. where the soil provides water, oxygen, and nutrients. Tree roots do not actively seek out water. The topsoil layer is the most conducive to root growth because it is usually well aerated, high in nutrients and decomposing debris, and friable. Most tree roots, including larger lateral roots, are found within the top 600 mm to 1000 mm of the soil profile and can spread out well beyond the canopy dripline.

The pattern of root development can vary considerably, but generally, a tree has 5-15 or more primary structural roots that emanate from the root collar and descend obliquely into the soil before becoming horizontal within a short distance of the trunk. Functionally, these roots are often referred to as structural roots with their primary role in anchoring the tree and creating a framework for the root system. In some tree species, horizontal structural roots near the trunk produce sinker roots that plunge vertically into the soil, providing supplemental anchorage, and where available down to lower water tables.

This zone of the root system is important when considering the management of tree roots and their influence on risk because tree stability depends heavily on both root system architecture and the anchorage of roots in the soil. Root/soil resistance gives rise to the characteristic mass of roots and soil seen on uprooted trees, known as the root plate. Uneven distribution, as is often the case with street trees, or large sections without roots reduces anchorage.

4.4 Types of damage

Direct damage to footpaths, kerbs and low-structures

Damage to pavements and kerbs due to the proximity of tree roots is a common occurrence, especially in the close confines of urban settings. It is almost always the case that most of the damage that the roots cause occurs close to the base of the tree where the expansion of the trunk and adjacent roots is greatest.

Damage occurs as roots increase in diameter and displace the concrete or other materials to the point at which they break or are seriously deformed. In simple terms, the further a tree is away from infrastructure, particularly hard surfaces, the less likely damage will occur.

Roots rapidly taper away from the base of the trunk of the tree and keeping hard surfaces away from this area close to the stem where heavy structural roots and butt flare occurs, can minimise or eliminate direct mechanical damage.

Root conflicts are unavoidable when infrastructure abuts the tree buttress or the Structural Root Zone (SRZ) which is sometimes referred to as the zone of upheaval.

The likelihood that the root will dislodge or fracture a structure depends on the ability of the structure to resist the force exerted by the root. Given the magnitude of the forces that growing roots can exert (MacLeod and Cram, 1996), it seems likely that direct damage is usually limited to more lightly loaded structures, such as pavements, kerbs, roads, and low walls.

Management options

Appropriate species selection and placement should be considered the primary tool available to tree managers to mitigate potential root conflicts. The issue of tree selection centres on the guiding rule of the ‘right tree, right place’.

The California Department of Forestry noted that urban foresters accept that appropriate species selection can be 90% effective at reducing damage to pavements (Gilman, 2001).

The ‘right tree’ in some instances may be the tree with a large canopy because the environmental benefits delivered by a large-statured tree will be greater than a small tree. There will be instances

where the provision of shade from the sun is a major role for street trees, and species may be selected to produce the necessary canopy size as the major benefit over potential root conflicts. There will also be instances where there are significant avenues of large trees and historical precedence dictates that these trees should be retained, and that other root management techniques or engineering solutions be implemented. If a large tree is the right tree, then a positive design outcome is to provide appropriate planting sites to sustain these trees. If this cannot be achieved, then a smaller tree should be chosen.

In general, conflicts with adjacent infrastructure occurs in locations where the existing planting strip or tree pit is too small to accommodate the tree that has been planted.

See Table 3 for appropriate sized planting sites suitable to sustain certain sizes of tree species.

Table 3 below can be used as a guide in the selection of appropriate species for planting areas. Larger trees could be considered for smaller sites or hard-paved and commercial areas only if engineering solutions are incorporated into the planting site.

Table 3: Planting area guidelines (Adapted from Gilman, 1997)

Total Planting Area (Lawn, island, or soil strip)	Planting strip width	Distance from trunk to pavement or wall	Maximum tree size at maturity
9.5m² to 18.5m²	1.5m to 2.5m	1.2m	Small (Less than 9m tall) to Medium (Less than 15m tall)
More than 18.5m²	> 2.5m	> 1.5m	Large (Taller than 15m)

Root upheaval may also occur because the subgrade soils are severely compacted or dense and do not allow root penetration. Damage seems to be less severe for soft or loose soils that can deform as the roots grow, rather than dense or hard soils, often the result of compaction during pavement construction.

Other considerations

If the value of the tree can be established, then the relative costs of infrastructure repairs should be weighed up and a compromise solution sought that improves the planting site with options including:

- *Kerb realignment involves shifting the kerb location for a significant distance such as along an entire block to widen the planting strip and provide more space for trees. Many of the road pavement widths within Hindmarsh could accommodate a reduction.
- Flexible pavement options (asphalt, pavers).
- Other alternative treatments such as kerbstones or concrete sections that can bridge over roots (Could create a gap at the surface of the road pavement level).
- Widening sections of verges into road reserve and creating kerb outstands.
- Enlarging planting sites/pits, especially for trees planted in the road or other hard surface. Also, consider the use of permeable pavements around the tree.
- Root pruning and/or installation of root barriers/defectors.
- Remove trees if they are in poor condition with a low ULE.

*It is acknowledged that efforts like kerb realignment are usually done as part of a large-scale street repair or reconstruction effort such as a capital improvement project. Where possible consideration

should be given to provide additional space for new trees or existing significant trees, and/or where other benefits can be achieved such as improved amenity and environmental benefits for pedestrians and improve the traffic flow.

Certain tree root treatment work, including root pruning and root barrier/deflector installation, is occasionally required to be undertaken. Where necessary, root pruning may be required to undertake repairs or prevent damage to property, roads and pavements. Root pruning of Council managed trees will always be undertaken in accordance with AS 4373 to ensure the health, stability, and longevity of the tree.

The minimum tree protection distance

A Structural Root Zone (SRZ) comprises the area around the base of a tree where structural roots required to maintain the tree's stability in the ground are typically located. The SRZ is calculated using the formula provided in the Australian Standard *AS4970-2009 Protection of trees on development sites*.

According to AS 4970 the SRZ is "The area around the base of a tree required for the tree's stability in the ground. The woody root growth and soil cohesion in this area are necessary to hold the tree upright. The SRZ is nominally circular with the trunk at its centre and is expressed as a radius in metres."

It is important to note that the SRZ relates to a tree's structural stability only, it does not include the absorbing root system involved with maintaining the tree's vigour and long-term viability.

In every instance the SRZ must be considered. Dependent on the extent of root damage within the SRZ, other tree management will be required, such as tree pruning (crown reduction) or tree removal.

Maintaining the structural integrity of Council managed trees is paramount in the risk management process.

Table 4: Structural root zone (SRZ) calculated from AS 4970-2009. Trunk diameter refers to basal trunk diameter. Distances are measured as a radius from the centre of the trunk

Trunk diameter (cm)	SRZ (m)
10	1.3
20	1.7
30	2.0
40	2.3
50	2.5
60	2.7
70	2.8
80	3
90	3.2
100	3.3

Council is to be notified prior to the root pruning of a street tree being undertaken to facilitate repairs to infrastructure.

Damage to underground drains

Tree roots can sometimes inadvertently impact sewer and stormwater pipes. It is important to establish the cause of the problem and who is responsible for rectifying it.

A property owner is responsible for the services to their property. This includes sewer and stormwater pipes and services that run through or adjoin private and public land until they reach the legal point of discharge.

The most common cause of pipe leakage is from old terracotta pipes. Movements in the surrounding soil cause joint failure or cracking causing moisture and nutrients to leak into the soil. Failure of joints between PVC and terracotta pipes is also common. PVC pipe systems have fewer joins and rarely fail. It is rare for a tree root to crack into a properly installed and well-maintained pipe.

Once a pipe has deteriorated or is damaged, roots from all different types of trees, plants and even grasses can grow into the pipe. Once a pipe cracks or some joint fails, then pipes start to leak oxygenated and nutrient rich water into the surrounding soil, effectively establishing a water gradient. If a root encounters this ideal growing environment it proliferates to take advantage of the available resources.

Root intrusion can be avoided by ensuring that all joints are watertight and fitted correctly and pipes are manufactured from watertight materials such as PVC rather than earthenware.

The cultivation of soil through the installation of services by open trenching also provides ideal conditions for root growth adjacent to underground services. Compacting the backfill with appropriate material in trenches can deter root growth around the services.

Direct damage to services

Direct damage to services is caused by the incremental growth of roots encountering underground services. Generally, the forces generated by this contact are minimal and will cause deformation of the root or the soil around the root rather than damaging the service. Damage can occur where services encounter heavy structural roots, which put on large increments of diameter growth. These heavy structural roots are usually found laterally within 3 m of the base of the trunk. It is possible that in very confined spaces, such as those likely to be found in built up areas, structural root growth may displace pipes or may exert new direct pressures on the pipes, sufficient to cause them to break.

What do residents/property owners do if they suspect Council managed trees contribute to damaged pipes?

Where possible the resident/property owner should carry out the repairs. If it can be proved that Council-owned trees have caused the damage, the resident/property owner may be able to claim for the cost of the repairs. In any event, it is best if the resident/property owner undertake the following:

1. If the works require an excavation on a Council road or footpath, the resident/property owner will need to obtain a ‘Consent to work within a road reserve’ from Council.
2. Carry out any necessary repair work to avoid any further damage and/or reduce the hazard. This does not mean that Council has accepted any liability for damages. It is the property owner’s decision to carry out repairs.
3. Most importantly, notify the Council of the scheduled works so that Council can arrange for an appropriate Council Officer to inspect the exposed pipe during the works. This will enable all parties to confirm if Council tree roots have caused the problem or if the pipe has been damaged for some other reason.
4. While on site, the Council officer will take photos to keep on record. The resident/property owner should also keep your own records of the damage and repairs.

If the above investigations reveal the damage has been caused by council-owned trees, the resident/property owner can make a formal claim for the cost of repairs. Council will assess liability and decide as to whether Council can assist the resident/property owner with the cost of the repairs.

This approach is required for insurance and governance purposes because the works relate to a private asset and may involve spending public funds on the repair. It is important to have clear

evidence for any insurance claim, particularly if there is a chance the initial damage may have been the result of other causes. The clearer the evidence provided, the greater the likelihood of a positive result in any claim.

Tree roots and buildings – indirect damage

Roots from trees can sometimes damage buildings, however the phenomenon of soil shrinkage and associated subsidence damage is a complex issue and there may be many reasons a building may start to show signs of damage. It is important to have expert advice to establish the cause of a problem, who is responsible and how it can be resolved.

It is well known that the presence of trees can contribute significantly towards the problem of subsidence, especially in clay soil areas where the soil shrinks and swells according to its moisture content. However, the assertion that tree roots have taken water from a clay soil causing it to shrink and the foundations to subside resulting in structural damage is an over-simplification. The damage is often many metres distant from trees and usually involves a variety of arboricultural, spatial, geotechnical, climatic, engineering and utility issues acting at the same time.

The Australian Standard *AS2870-2011 Residential slabs and footings*, acknowledges that minor foundation movements occur on nearly all sites and that it is impracticable to design a footing system that will protect the building from movement under all circumstances.

The best way to prevent root damage to new buildings or other structures is to ensure they are built to the relevant industry code. If a new building will be close to existing trees, particularly on a reactive clay soil, the standard design and construction methods may need to be altered to account for these factors.

If the resident/property owner is concerned about cracks developing within their building or structure they should engage a structural engineer to assess the damage and provide advice of the likely cause. The engineer must base their assessment on evidence rather than theoretical assumptions.

Steps to take in undertaking an investigation:

1. The property owner needs to undertake an investigation into the damage and document the reasons or evidence that clearly show why the property owner believes the council owned tree is the cause of the damage. If a structural engineer is engaged to assist in the investigation the engineer must base their assessment on evidence rather than theoretical assumptions.
   This may involve root sympathetic excavations within the property to locate and photograph roots and their proximity to the building or structure. Lawson (2000) indicates that a drying force such as root growth below the footings is a fundamental characteristic associated with subsidence damage where tree roots are involved. If the investigation or repair works require an excavation on a Council road or footpath, the property owner will need to obtain a 'Consent to work within a road reserve' from Council.
2. For a claim to be considered, if tree roots are exposed at or under the footings and foundation of the building or structure, these roots would need to be identified as being those from the Council managed tree. Claimants may need to engage an arborist to verify the origin of the root at their own cost.
3. If the property owner intends to make a formal claim, it is important to notify Council and allow an appropriate Council officer to inspect the damage before undertaking any repair works. While on-site, the officer will collect information, such as photographs and root samples, to keep on record. Council may engage a consultant structural engineer or other industry professional to assist in this assessment.

A tree root damage claim investigation process, which takes into consideration the MAV Insurance tree root risk assessment tool, should also be considered (MAV Insurance 'Tree root risk assessment tool workshop, 2014).

Council has a right to abate the nuisance once brought to its attention to curtail any potential claims against Council in the initial instance.

Under their duty of care, Council should adopt a proactive approach to planting the right tree in the right place in the right way. This includes design solutions to mitigate potential root impacts if it is deemed that the 'right tree' is a large, significant tree.

References and bibliography

ANSI (2013). American National Standards for Tree Care Operations - Tree, Shrub, and Other Woody Plant Management - Standard Practices. ANSI A300 (Part 8) Root Management.

Biddle, P.G. (1998). *Tree Root Damage to Buildings, Vols 1 & 2*. Willowmead Publishing Limited, Wantage, England, ISBN Vol 1 09533086 1 8 Vol 2 09533086 2 6.

Biddle, P.G. (1983). Pattern of soil drying and moisture deficit in the vicinity of trees on clay soils. *Géotechnique*, 1983, 33, No. 2, 107 – 126.

Gilman, E. F. (1995). Root Barriers affect root distribution, paper presented to an international workshop on trees and buildings, Morton Arboretum, May 31 to June 2.

Gilman, E. (1997). Trees for urban and suburban landscapes. Delmar.

Goodfellow, J. W. & Detter, A. (2012). Assessing the Potential of Reduction Pruning in Mitigating the Risk of Branch Failure. Tree Risk Assessment Symposium: The Biomechanics of Stability, Strength, and Structure. Morton Arboretum, September 24-25, 2012.

Harris, R. W., Matheny, N. P., and Clark, J. R. (2004) Arboriculture: integrated management of landscape trees, shrubs, and vines. Fourth edition. Prentice Hall.

Hartley, M., (2012). Tree root damage to pipes. V1.2. The arborist network. NSW.

Kopinga, J. (1993). Aspects of the damage to asphalt road paving's caused by tree roots, paper presented to an International workshop on tree root development in urban soils, Morton Arboretum, September 30 and October 1.

Kuhns M. (1999) Are small trees always appropriate as street trees? Brochure, Utah state university forestry extension, Utah.

Lawson, M. (1993) Trees, Clay & Climate, in Proceedings of Geological Society Conference, "Housing Subsidence".

Lawson, M. (1995) Pruning Trees Promoting Pollution, Report for the natural and built environment, No 7 ISSN 1358 - 2399.

Lawson, M. (2000) Tree Related Subsidence of Low Rise Buildings and the Management Options. A dissertation presented to the Institute of Biology in fulfilment of the requirements for entry as a Member of the Institute of Biology (MIBiol).

MAV Insurance (2014) Risk Management Update presentation. Tree root risk assessment tool workshop.

MacLeod, R.D. & Cram, W.J. 1996. Forces exerted by tree roots. Arboriculture Research and Information Note 134. Arboricultural Advisory and Information Service, Farnham, UK.

5. Tree Protection

5.1 Guidance

Council managed trees shall be protected always, reducing where possible the negative impacts of construction and other activities such as maintenance that threaten tree condition, safety or amenity.

- Council managed trees will be protected from construction works and other activities that threaten tree condition, safety or amenity.
- The conflicting requirements of trees and maintenance or enhancements will be minimised where possible.

Relevant Australian Standards:

- Australian Standard AS 4970-2009 Protection of trees on development sites
- Australian Standard AS 4373-2007 Pruning of amenity trees
- Australian Standard AS 4687-2007 Temporary fencing and hoardings

5.2 Introduction

Street trees are subject to a variety of pressures, conflicts, changes to land-use and public requests. These pressures lead to damaged trees which may affect their function and viability in the landscape. The primary goal of tree protection is the long-term survival and viability of a tree.

Protecting street trees is a multi-departmental, community wide endeavour. Protecting and maintaining healthy, safe and aesthetically pleasing street trees is vital to Council achieving its desired landscape, social and environmental objectives for the townships.

Major principles:

- Tree preservation programs that respect tree physiology and natural patterns of tree growth,
- Prevention of injury to trees, and
- Allocation of appropriate space for trees, as per Section 1.5 ‘Providing adequate space for trees’.

Trees vary in their ability to adapt to altered growing conditions. Mature trees have established stable biological systems in the pre-existing physical environment. Disruption of this environment by construction activities interrupts the tree’s physiological processes, causing depletion of energy reserves and a decline in vigour, often resulting in the tree’s death. Expected tree reactions to construction or excavation damage vary resulting in: immediate to out-right death; single year decline and death; multiple year decline and death; and decline with major living mass loss. The last two reactions are the most commonly observed among urban trees, but also the most difficult symptoms to link a cause and effect relationship with construction activities because symptoms are exhibited long after the event. Trees are living organisms and they will respond to dramatic changes in their growing environment, with structural damage and chronic stress problems being evident in a tree for the duration of a trees’ life.

Consequently, it is much easier and more beneficial to prevent damage to trees than to try and rectify damage.

Typical negative impacts that may occur during construction include:

- mechanical injury to roots, trunk or branches;
- compaction of soil that degrades the functioning roots and inhibits the development of new roots and restricts drainage, which desiccates roots;

- changes in existing grade which can cut or suffocate roots;
- alteration of the water table - either raising or lowering;
- micro-climate change, exposing sheltered trees to sun or wind;
- sterile soil conditions associated with stripping off topsoil; and
- chemical damage due to leaking or spilling of fuels, lubricants, hydraulic oils or other toxic substances.

Tree protection requirements are intended to guide disruptive activities to ensure that appropriate practices will be implemented in the field to preserve trees while eliminating undesirable consequences that may result from uninformed or careless acts.

The Australian Standard *AS 4970-2009 Protection of trees on development sites*, provides guidelines for the allocation of tree protection zones and other tree protection measures.

AS 4373-2007 Australian Standard - Pruning of amenity trees, provides the principles of tree pruning to encourage practices that reduce the risk of hazard development, branch failure, pathogen infection and premature tree death.

5.3 Protection measures for Council managed trees

Council trees will be protected from construction and maintenance works and other activities that threaten their health and stability. All construction, maintenance works, events and development activities in proximity to Council trees and trees shown on endorsed plans to be retained must abide by the following requirements:

1. All Council trees will be protected from construction and works activities in accordance with Australian Standard *AS 4970 Protection of trees on development sites*.
2. A Tree Protection Zone (TPZ) shall be established for the duration of any works in proximity to a Council tree. The structural root zone (SRZ) shall be treated as the minimum tree protection requirement*.
3. All Council trees to be retained and protected plus the corresponding TPZ must be clearly identified on all submitted landscape plans.
4. Care will always be taken to ensure no damage is sustained to tree stems, crowns and roots.
5. Removal of trees will not occur unless approved by Council consistent with the removal criteria within these guidelines (See section 6).
6. Trees may not be pruned in any form and branches or roots may not be removed unless authorised by a Council officer. Any pruning undertaken on Council trees must conform to *AS 4373 Pruning of amenity trees* and be undertaken by experienced, qualified and insured personnel.

*Due to site constraints, it is impractical to prescribe a symmetrical tree protection zone to street trees. To preserve the structural integrity of Council trees and maintain public safety, as a minimum, the structural root zone (SRZ) distance, as outlined in AS4970, needs to always be maintained for street trees.

Maintaining the structural integrity of Council managed trees is paramount in the risk management process.

5.4 Determining the tree protection zone

The tree protection zone (TPZ) is the area of root zone required to maintain the tree's health and structural stability. The Australian Standard *AS 4970-2009 Protection of trees on development sites* is

used as a guide in the allocation of TPZs for trees. The TPZ for individual trees is calculated based on trunk (stem) diameter (DBH), measured at 1.4 metres up from ground level. The radius of the TPZ is calculated by multiplying the trees DBH by 12. The radius of the TPZ should not be less than 2.0 m or greater than 15 m. The method provides a TPZ that addresses both the stability and growing requirements of a tree. TPZ distances are measured as a radius from the centre of the trunk at (or near) ground level. The TPZ of palms should be not less than 1.0 m outside the crown projection.

The TPZ area of street trees could include area within private property.

Given the complexity of some developments, it may be necessary to encroach the allocated TPZ of a Council managed tree. Encroachment into the TPZ is permissible under certain circumstances though it is dependent on both site conditions and tree characteristics. Minor encroachment, up to 10% of the TPZ area, is generally permissible and encroachment should be compensated for by recruitment of an equal area contiguous with the TPZ. See Figure 5 for examples. Encroachment greater than 10% is considered major encroachment under AS4970-2009 and is only permissible if it can be demonstrated that after such encroachment the tree would remain viable.

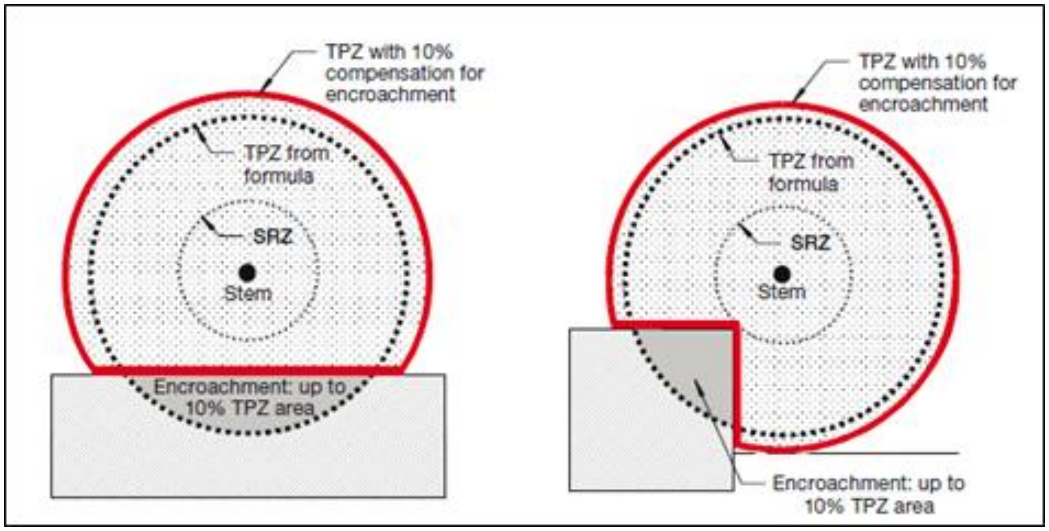


Figure 5: Examples of minor encroachment into a TPZ. Extract from: AS4970-2009

The most reliable way to estimate root disturbance is to find out where the roots are in relation to the demolition, excavation or construction works that will take place (Matheny & Clark, 1998). Exploratory excavation prior to commencement of construction can help establish the extent of the root system and where it may be appropriate to excavate or build.

The TPZ should also consider the canopy and overall form of the tree. If the canopy requires severe pruning to accommodate a building and in the process the form of the tree is diminished it may be worthwhile considering altering the design or removing the tree.

Minimum tree protection distances - Street trees

Due to the site constraints and the unpredictability of tree root growth in urban landscapes, it is impractical to prescribe a symmetrical tree protection zone to street trees. As a minimum the structural root zone (SRZ) distance needs to be maintained for the street trees. The SRZ is calculated using the method outlined in AS4970.

An SRZ comprises the area around the base of a tree where structural roots required to maintain the tree's stability in the ground are typically located. It is important to note that the SRZ relates to a tree's structural stability only, it does not include the absorbing root system involved with maintaining the tree's vigour and long-term viability.

Maintaining the structural integrity of Council managed trees is vital in the risk management process.

All proposed construction/excavation works within the root zones of Council managed trees should be approved by Council. Major root pruning will not be permitted without the approval of Council.

The minimum clearance distance required to maintain a trees stability will be implemented. If the proposed excavation/construction works encroach on this minimum distance, alternatives should be sought. See SRZ table 5 below (distances are measured as a radius from the centre of the trunk).

Table 5: Structural root zone (SRZ) calculated from AS 4970-2009. Trunk diameter refers to basal trunk diameter

Trunk diameter (cm)	SRZ (m)
10	1.3
20	1.7
30	2.0
40	2.3
50	2.5
60	2.7
70	2.8
80	3
90	3.2
100	3.3

If the SRZ is encroached an assessment of the tree will take place and any ramifications on tree health and/or safety because of the encroachment needs to be clarified by an arborist.

5.5 Tree protection guidelines

Tree protection requirements guide a construction project so that appropriate practices are implemented to preserve Council trees, and undesirable consequences resulting from uninformed or careless acts are eliminated.

Council's tree protection guidelines include:

- Establishment of a Tree Protection Zone around trees, with protection fencing installed where required (Section 5.7).
- No persons, vehicles or machinery shall enter the TPZ without Arborist permission.
- No stockpiling of building materials, debris or soil within the allocated TPZ shall occur without Council permission.
- No fuel, oil dumps or chemicals shall be permitted or stored in the allocated TPZ and the servicing and re-fuelling of equipment and vehicles should be carried out away from the root zones.
- Soil levels must not be altered within the allocated TPZ without Council permission.
- A layer of organic wood chip mulch between 75 and 100mm is to be spread throughout the Tree protection zone.
- No tree root from a Council tree, greater than 50 mm in diameter (dependent on tree size, see how to ascertain how to determine a significant root) is to be severed without Council permission. Prune roots that must be removed using a sharp tool, making a clean cut and leaving as small a wound as possible.

- Apart from electric line clearance, Council undertakes pruning on Council managed trees. No Council tree shall be pruned, or branches removed without Council permission. All pruning shall be undertaken by a Council approved contractor and in accordance with AS 4373.
- A Council tree shall not be used to attach anything including, temporary services wires, nails, screws or any other fixing device. The use of tree trunks as a winch support or anchorage is prohibited.
- Care shall be taken to ensure that no damage is caused to Council tree trunks, roots and structural branches. Any operation known to be detrimental to long-term tree health is not appropriate.
- Supplementary watering should be provided to all trees through any dry periods during and after the construction process.

The Tree Protection Zone will be the major factor in determining techniques for protecting each tree. If the TPZ is designated and protected by fencing and there is no infringement into that zone, no further preservation techniques would need to be employed.

Where existing street trees will be impacted by a proposed development, the developer/resident should commission a tree management plan prepared by a qualified arborist that outlines measures to protect and preserve the street trees affected by a development project. This plan shall include requirements for preconstruction treatments during demolition and/or construction; establish a tree protection zone for each street tree; tree monitoring and inspection schedule; and provide for continued maintenance of affected street trees after construction. The tree management plan needs to meet the requirements of tree preservation within the City and be to the satisfaction of Council.

5.6 Root pruning

There will be instances where the roots of Council managed trees will need to be cut.

Watson (1998) found that under certain circumstances and in the absence of other construction impacts, vigorous trees may be able to tolerate and recover from trenching in the root zone. Watson (1998) also concluded that compensatory crown pruning increased twig growth for trees that have experienced trenching treatments and appeared to be most beneficial in reducing dieback after severe root loss from trenching.

Where there is no option but to sever roots, they should be cut using a sharp axe, pruning saw or chainsaw with the aim of creating the smallest possible wound. The smallest wound will often be created if the cut is made at right angles or 90 degrees to the direction of the root.

During trenching operations with machinery, the process of excavating the trench will generally result in some root damage and severance. Tree roots are to be severed with an appropriate cutting device and not with an excavator, bob cat or trenching machinery.

Freshly pruned roots should not be painted with any product. However, if freshly cut roots are expected to be left exposed for more than 24 hours, they should be covered with wetted hessian until the soil is replaced.

Where there is no option but to sever roots, they should be cut as far away from the stem or trunk as possible. If roots are exposed during trenching operations, trenching machinery should stop and the roots should be pruned to provide sufficient clearance from the trenching machinery, before works continue.

Any root pruning that is required must be carried out by trained personnel who have a thorough knowledge of tree physiology and pruning methods and carry out pruning to the Australian Standard AS 4373.

How to determine the diameter of a significant root

As indicated, most trees can tolerate some root loss. To ensure the longer-term viability of the tree, however, it is advisable to avoid severing major or significant roots beyond the SRZ distance. The size of a significant root will vary according to the distance of the exposed root to the trunk of the tree. The further away from the trunk of a tree that a root is, the less significant the root is likely to be to the tree's health and stability.

The determination of what is a significant root is often difficult because the form, depth and spread of roots will vary between species and sites. However, because smaller roots are connected to larger roots in a framework, there can be no doubt that if larger roots are severed, the smaller roots attached to them will die. Therefore, the larger the root, the more significant it may be.

Gilman (1997) suggests that trees may contain 4-11 major lateral roots and that the five largest lateral roots account (act as a conduit) for 75% of the total root system. These large lateral roots quickly taper within a distance to the tree, this distance could be referred to as the SRZ. Within the SRZ distance, all roots and the soil surrounding the root is deemed significant.

No root or soil disturbance is permitted within the SRZ.

In the area outside the SRZ, the tree may be able tolerate the loss of one or several roots. The table below indicates the size of tree roots that would be deemed significant compared to the height of the tree outside the SRZ. The assessment of combined root loss within the TPZ would need to be undertaken by an arborist on a case by case basis because the location of the tree, its condition and environment would need to be assessed.

Table 6: Estimated significant root sizes outside the SRZ.

Height of tree	Diameter of root
Less than 5m	More than 30mm
Between 5m - 15m	More than 50mm
More than 15m	More than 70mm

If significant roots are encountered, hand, hydro-excavation, pneumatic and other root sympathetic excavation methods should be used to retain as many roots as possible while creating sufficient space for undertaking the repairs and/or installation of new infrastructure.

All work should proceed with hand operated tools, with care taken not to damage roots as they are exposed. Roots greater in diameter than 50 mm should be retained and worked around. Clumps or masses of small fibrous roots collectively greater than those specified in Table 6 should also be retained.

5.7 Tree protection fencing

Street tree protection fencing used must:

- allow for free and clear passage of pedestrians on the footpath and adjacent portion of the street;
- provide for clear visibility of fire hydrants, driveway access, crosswalks, etc. (mesh fencing should be used).

Australian Standard *AS 4687-2007 Temporary fencing and hoardings* provides guidelines for temporary fencing. The TPZ fencing must be secured to restrict access. Existing perimeter fencing can be incorporated into the protective fencing. Signs identifying the TPZ are to be placed on the fencing.

Tree fencing shall be erected before demolition or construction begins and remain in place until final inspection. No advertising material is to be placed/displayed on the TPZ fencing at any time.

Groups of trees can be incorporated into one fenced area using linear fencing to encapsulate the group.

Figure 6: Photograph above left - example of signage for TPZ. Photograph above right - example of appropriate TPZ fencing around a street tree.

Tree fencing shall be erected before demolition or construction begins and remain in place until final inspection.

No fencing

If no fencing can be installed around a street tree to protect it during construction activities, then the street trees will require trunk and branch protection. An example of trunk protection can be seen in Figure 7. The trunks are to be loosely wrapped in hessian to approximately 50 mm thick to act as padding. This could be secured with some form of tape while 45 mm thick wooden slats are placed around the trunk and firmly secured. Caution shall be used to avoid damaging any bark or branches. Major scaffold limbs may also require this treatment (dependent on any scaffolding or gantries installed). To finish off, para webbing is to be wrapped around the timber slats to improve visibility and reduce public risk.

Figure 7: photo of trunk protection

5.8 Ground protection systems

The TPZ area can be temporarily encroached if the area is protected. This area will require ground protection to prevent root damage and avoid compaction. Measures may include a permeable membrane, such as a geotextile, to cover the TPZ area beneath a 100 mm layer of crushed rock below rumble boards (See Figure 8). This will allow temporary access.

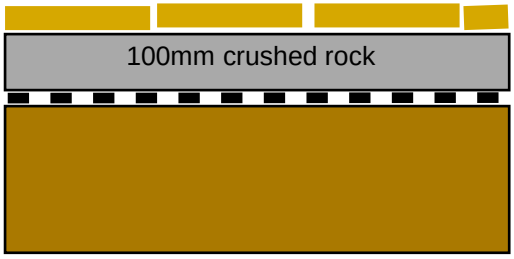


Figure 8: Indicative ground protection system - adapted from AS4970 Clause 4.5.3 Ground protection

5.9 Developments and new vehicle crossovers

There will be instances where development and the placement of a new vehicle crossover, may impact on a street tree.

A minimum clearance of 4 metres or the SRZ of a Council managed trees, whichever is greater, must be provided between the trunk of any street tree and the edge of any new crossover. This tree protection requirement is to be specified in standard drawings.

There is no guarantee that a street tree will be removed to accommodate a new vehicle crossover. Council officers will assess the proposed removal. Trees considered low to medium retention value can be removed as a customer funded tree removal. Trees considered of high retention value will not be recommended for removed.

If alternatives cannot be established and the new vehicle crossover cannot be reasonably placed away from the tree(s), and the works may compromise the structural integrity of the tree by severing/damaging major roots and impact on the health of the tree, it may be proposed for removal.

Any tree recommended for removal shall meet one or more of the tree removal criteria listed in ‘Tree removal criteria’ in the ‘Tree Removal and Retention Policy’.

Where approval is granted for removal of a nature strip tree/s for development purposes the resident, owner or developer shall be responsible for arranging through Council, the removal and all associated activities including compensation for removal and replacement costs.

The following compensation costs will be sought:

- Tree > 15 m in height requires costs recouped for 6 replacement trees.
- Tree 8 m – 15 m in height requires costs recouped for 3 replacement trees.
- Tree 1-8 m in height requires costs recouped for 1 replacement tree.

In addition to the replacement trees the following compensatory costs will also be sought; cost of existing tree removal including stump, tree inspection, and cost of supply, planting and 2-years maintenance of replanted trees.

Existing trees will not be considered for transplanting to accommodate new vehicle crossovers.

5.10 Underground service installations adjacent to trees

For the installation or maintenance of services near Council trees, the service should be diverted or re-aligned to run beyond the tree protection zone (TPZ). Where this is not practical, trenchless excavation or root sympathetic hand excavation is recommended. A combination of these methods may be used where necessary.

Acceptable techniques in order of preference are:

1. Diversion of service around the TPZ
2. Trenchless thrusting and directional boring at an appropriate depth beneath the TPZ.
3. Root sympathetic trench excavation within the TPZ.

Open trench excavation by machinery is not permitted within the TPZ without prior written approval from the Arborist.

1. Diversion of service around the TPZ

Diversion or re-alignment of the service is the most appropriate method to minimise the damage to both services and the root system of the tree. By excluding the services from areas of heavy lateral rooting within the TPZ, damage to services would be minimised.

Prior to installation or maintenance activities, the TPZ should be determined according to the method outlined in Section 5.4 'Determining tree protection zone'. The service should be installed or re-aligned around the TPZ in accordance with the tree protection guidelines.

2. Trenchless thrusting and directional boring

The action of 'thrusting' or 'directional boring' is the preferred method for service establishment within the TPZ. When these methods are used, the overall impact to the tree is minimised.

All machinery associated with the action of thrusting or directional boring must remain outside the TPZ. Entry and exit points should be located at a safe distance outside the TPZ to ensure that machinery, slurry and work activities are kept clear of the TPZ. This will minimise any root loss or ground compaction that may arise from the works. If the thrusting rod or directional drill-head becomes stuck within the TPZ, the Arborist should be contacted prior to the retrieval process. Any retrieval of a thrusting rod or directional drill-head from within the TPZ should be undertaken with hand tools unless otherwise stated by the responsible arborist (CA, 1999).

Boring according to the Multinet directional boring standard EP-DD-4136 (2003) at a depth of 800-1100 mm to the top of the pipe (TOP) will ensure that the excavation is below the major zone of absorbing roots.

3. Root sympathetic trench excavation within the TPZ

Where trenchless techniques cannot be used, hand, pneumatic, hydraulic and other root sympathetic excavation methods may be used within the TPZ. The objective of root sympathetic excavation should be to retain as many roots as possible while creating sufficient space for the installation of the service. Hand or other root sympathetic excavation will require greater supervision to ensure that the tree protection measures are maintained.

All work should proceed with hand tools with care taken not to damage roots as they are exposed. All roots greater than 50 mm in diameter should be retained and worked around. Clumps or masses of small fibrous roots collectively greater than 50 mm in diameter should also be retained.

Where there is no option but to sever roots that are greater than 50 mm in diameter, the Council officer or nominated representative must inspect the roots. Where their removal is approved, the roots should be cut using a pruning saw, sharp axe or chainsaw and creating the smallest possible wound (Adapted from: NJUG, 1995).

Hand excavated trenches within the TPZ should be aligned to pass directly under the trunk of the tree. This will minimise the root loss (Harris, 1992). Root frequency and concentration is generally greater along hard barriers such as concrete curbing and pavements. By keeping trenches away from these areas, root loss can also be reduced.

General guidelines for underground service installation:

- Pipes must be installed at a depth of greater than 600 mm below natural soil level to the top of the pipe throughout the TPZ.

- Service risers within a TPZ must be installed using hand or other root sympathetic excavation methods.
- Where two sections of pipeline are to be joined, work is to be conducted outside the TPZ.
- Excavation to anchor or inspect pipes should be undertaken outside the TPZ, where this is not possible hand excavation methods or root sympathetic excavation techniques must be used.

Boring:

- Entrance and exit pits must be outside the TPZ.
- Verification of the bore depth and offset readings must be undertaken outside the TPZ.
- Where excavation within the TPZ cannot be avoided, then this should be done by root sympathetic excavation techniques. Machinery should not be permitted within the TPZ.
- Where possible, align the bore or trench to pass directly under the trunk of the tree.

Backfilling of trenches

Compaction of soil to a bulk density of greater than 1.8 g/cm^3 will inhibit root growth in all soil types (Coder, 2000). By compacting the backfill soil immediately surrounding the service, root growth in this area should be excluded. In the trench above the service, the soil should not be compacted, but tamped lightly and left proud of the surrounding soil to allow for natural settlement and root growth. Other materials should not be incorporated into the backfill.

5.11 Changes in soil levels

Soil levels are often changed within a development site. Because of topography, this may entail both soil stripping (to lower the soil level) and the addition of fill (to raise the soil level). The danger from soil stripping is root severance and removal of nutrient-rich soil layers, resulting in deficiencies, particularly for potassium and phosphorus (Craul, 1992; Harris et al, 1999).

When a significant amount of fill is added to a landscape, soil conditions will change, as will the root growth potential of existing trees. It has been estimated that 80-90% of all tree problems are related to soil and its effects on root growth potential and health of the trees' entire root systems (Smiley, et al, 1998).

The effects of placing fill over root zones does vary dependent on several factors, such as species, age, type and compaction levels of the fill. Research has revealed that as little as 100 to 150 millimetres of fill placed over the roots of some tree species has caused serious deteriorating health conditions (Koetter & Johnson, 2014), yet two metres of fill placed over the roots of one tree caused no obvious damage (Costello, et al, 2004). Species and site conditions can vary and there can be other factors that impact on one tree and not another. Indications are however, that tree injury does not occur in all cases where fill is placed over root systems.

Compacted fill can dramatically impact soil aeration. The alteration of soil aeration has in the past been considered the primary impact to a tree's root system because of fill. Reduced soil aeration restricts the supply of oxygen to roots, which is required for aerobic respiration. In poorly aerated soils, consequently, root respiration becomes anaerobic, which is inefficient and causes root growth and essential functions such as mineral uptake to reduce or stop altogether, which can threaten the health of the whole tree. Yelenosky (1963) found that oxygen was severely depleted from soil air beneath 0.3–1.0 m of clay fill.

Although aeration deficit may play a role in fill-induced plant injury, other factors may play an equal or greater role. Altered water relations, soil compaction and mechanical injury to roots are possibly as problematic if not more so than aeration. Reductions in the availability of water to trees can result

from changes in runoff and infiltration, reduced water-holding capacity, diversion of streams and drainage of the water table.

Site wide changes as described above also has the potential to be more problematic on older trees as their ability to adapt to changes, based on available energy (less vigorous), is reduced.

Although it is difficult to predict the ramifications of placing fill over the root zone of a tree it is generally not recommended.

In general;

- Younger trees are more capable than older trees.
- Trees in good health are often less sensitive.
- Trees that have recently suffered other injuries may be more susceptible to damage from fill.
- The larger the area covered and the deeper the fill the greater the potential for impact.
- The fill soil should be similar in texture to the base soil.
- Avoid base soil compaction during installation. Light cultivation may be required.

Where there is no option but to lower or raise soil levels, Council must inspect the tree to ascertain viability and recommend tree management.

5.12 Tree Management Plans

A Tree Management Plan (TMP) is required where any demolition or construction activity encroaches a Tree Protection Zone (TPZ) as described in AS 4970-2009 or; has the potential to impact on the viability of any Council tree due to any of the following:

- Demolition
- Installation of hoarding and gantry
- Building and construction
- Loading zones and crane lifting/hoisting
- Traffic management
- Other activities associated with construction including the placement of skips, crane bases, travel towers, scissor-lifts, cherry pickers, plant, site sheds, and concrete pumps.

The TMP must be developed in accordance with AS 4970-2009 and follow the layout of Section 5 (i.e. General, Tree Protection Plan, Pre-construction, Construction stage and Post Construction). This must be prepared by a certified project arborist (minimum Australian Qualification Framework Level 5 and/or equivalent experience).

The TMP must contain:

1. The TPM will assess the impacts of activities on public trees, recommend mitigation efforts to minimise identified impacts and identify methodologies to guide works and activities through all stages of a project.
2. The TPM will include an arboricultural assessment of each tree including photos of the tree's current condition.
3. Any specific damage/faults evident within the tree prior to demolition or construction. These photographs must be supplied within the TMP as a preliminary dilapidation report.
4. An assessment of the impacts to Council trees, including images of pruning requested.

5. Recommendations to reduce impact to public trees and tree protection guidelines to be followed through all phases of development.
6. A statement that the property owner/developer will be liable for any damage caused to public trees during the development process, including damage by privately engaged contractors. Replacement and/or repair costs shall be calculated by Council. All rectification works including but not limited to pruning, soil de-compaction, irrigation, fertiliser application and tree removal and replacement will be undertaken by Council contractors and invoiced at scheduled rates. Council reserves the right to determine and undertake appropriate rectification works for all damages which may occur due to the development project

The TPM must be endorsed by Council prior to commencement of the works.

A project arborist may be required to oversee all works near Council trees for the duration of works.

A single TPM will be required for each project, development or event and cover all phases of demolition, construction and post-construction activity. The Principal Contractor will be responsible for the implementation of the TPM by all contractors and personnel onsite.

A Council officer or authorized contractor will complete a final inspection prior to tree protection removal at project completion to document any tree damage, provide rectification or amelioration recommendations.

5.13 Damage to trees

Any damage or injury to public trees shall be reported to Council.

All costs incurred in reinstating, rectifying or replacing Council trees, including any maintenance and establishment costs for a defined period following the completion of works, are the responsibility of the contractor, relevant authority or property owner. Replacement costs shall be calculated by Council.

Council trees are regularly pruned to maintain health and to achieve appropriate clearances. Construction and temporary works may require trees to be pruned to clear structures and building activities that would not normally be required through scheduled tree management programs.

Any required pruning shall be undertaken by Council or approved contractors with a thorough knowledge of tree physiology and pruning methods and performed to the Australian Standard *AS 4373-2007 Pruning of amenity trees*.

No more than 25 percent of the live crown area may be removed within one calendar year from any Council managed tree. Pruning must also not remove foliage to cause the unbalancing of the tree.

All costs incurred in pruning Council trees are the responsibility of the contractor, relevant authority, property owner or applicant.

There will be instances where utility companies, Council and other public authorities require the removal of trees to facilitate the construction of infrastructure or the maintenance of existing infrastructure. If the SRZ, minimum root distances, as outlined in the Section 5.4 are encroached the structural integrity of the tree may become compromised.

Council shall assume all responsibility for the assessment of and recommendation for removal of trees that have been compromised by construction works. Removal of trees is subject to the procedures outlined in the Tree Removal section 6.

5.14 Vandalised trees

Vandalism is a significant cause of young tree mortality (Matheny & Clark, 2008). Trees damaged or vandalised to the point that the integrity of the tree is compromised, and their replacement is required shall be removed, the site made safe and the vacant site noted for subsequent planting programs.

The illegal action of tree vandalism has led to the destruction of many valuable public trees and requires intensive management regimes that impact on Council's time and resources.

To address the wider issue of tree vandalism, Council may undertake the following steps:

- Educate the public and improve public perceptions of trees, including:
    - Encouraging people to report vandalism when seen; offer rewards
    - Reminding people that it is a crime to vandalise a tree
- Where street trees are suspected of vandalism, erect signs to inform the public as to what has happened to the tree and reinforce Council's commitment to trees.
- Where appropriate replace vandalised trees as soon as possible to reinforce Council's commitment to trees. The management of urban landscapes to ensure they are of a high standard can help to reduce the prevalence of crime and vandalism.
- Larger tree stock will be used in areas known to be prone to vandalism.

In cases where Council trees have been drilled and poisoned, Council is not obliged to immediately remove the tree. The tree will be given optimum time to allow for its potential recovery. The tree may be habitat pruned to ensure safety of the tree and monitored for two years before fully removed.

Interpretive signage may be attached to educate on the costs of tree vandalism to the community.

If it can be proved that someone deliberately poisoned, removed or irreparably damaged a Council tree, Council will seek compensatory costs for the removal and replacement of a vandalised tree. Replacement and/or repair costs shall be calculated by Council.

References and bibliography

Coder, Kim D. (1996). Construction Damage Assessments: Trees and Sites. University of Georgia.

Costello, L.R. and Susan D. Day. (2004). A New Look at the Impact and Management of Fill Soil around Trees, pp. 25-29. *Arborist News*. August 2004.

Craul, P.J. (1999). *Urban Soils: Applications and Practices*. John Wiley and Sons, New York.

Cue, K.P., S. Josiah. (2002). Landscaping around established trees. Retrieved June 15, 2005 from NebGuide Website: http://ianrpubs.unl.edu/forestry/g1452.htm.

Day, S. (1999). Growth and Physiology of Several Urban Tree Species in Soils Disturbed by Construction Fill or Compaction. Dissertation submitted to the faculty of Virginia Polytechnic Institute and State University.

Day, S, D., Seiler, J. R., Kreh, R., Smith, D. W. (2001). Overlaying compacted or uncompacted construction fill has no negative impact on white oak and sweetgum growth and physiology. *Canadian Journal of Forest Research*; Jan 2001, Vol. 31 Issue 1, p100

Harris, R.W., Clark, J.R. & Matheny, N.P. (2004). *Arboriculture: Integrated Management of Landscape Trees, Shrubs and Vines. Fourth edition*. Prentice Hall.

Johnson, Gary R., (1999). Protecting Trees from Construction Damage: A Homeowner's Guide. University of Minnesota Extension Service, FO-6135.

Koetter, R. & Johnson, G. R. (n.d.) Will fill kill? The truth about adding soil over the roots of existing landscape trees. [Online]. University of Minnesota Forest Resources Extension. Available at: http://www.myminnesotawoods.umn.edu/2008/12/will-fill-kill/. [Accessed 2 June 2014].

MacDonald, J.D.,Costello, L.R., Lichter, J.M., and Quickert, D. (2004). Fill soil effects on soil aeration and tree growth. *Journal of Arboriculture* 30(1).

Smiley, E.T., T.R. Martin and Bruce R. Fraedrich. (1998). Tree root failures. *Landscape Below Ground II: Proceedings of an International Workshop on Tree Root Development in Urban Soils*. D. Neely and G. Watson, Eds. International Society of Arboriculture, Champaign, IL.

Spencer, R., Hawker, J., & Lumley, P. (1991). Elms in Australia. Royal Botanic Gardens, Melbourne

Tusler, P.E., J.D. MacDonald and L.R. Costello. (1998). Fill soil effects on soil aeration. *Landscape Below Ground II: Proceedings of an International Workshop on Tree Root Development in Urban Soils.* D. Neely and G. Watson, Eds. International Society of Arboriculture, Champaign, IL.

University of Rhode Island, (n.d.). Maple Tree Decline. Retrieved June 16, 2005, from Greenshare Factsheets Web site: www.uri.edu/ce/factsheets/sheets/mapletreedecline.html.

VanDerZanden, A.M. and J. McNeilan. (2001). Conserving Water in the Garden: Landscape and Lawn Care. Retrieved June 16, 2005 from Orgeon State University Extension Service Website:

http://eesc.orst.edu/agcomwebfile/EdMat/html/EC/EC1531/EC1531.html.

Watson, G.W. (1998). Tree growth after trenching and compensatory crown pruning. *Journal of Arboriculture*, 24.

Watson, G.W., Kelsey, P. & Woodtli, K. (1996). Replacing soil in the root zone of mature trees for better growth. *Journal of Arboriculture*, 22.

Yelenosky, G. (1963). "Soil aeration and tree growth." International Shade Tree Conference Proceedings. 40:127-147.

6. Tree Removal Guideline

6.1 Introduction

This guideline applies to all trees in the municipality that are either owned or managed by Hindmarsh Shire Council; such trees shall be referred to as public trees. (A public tree includes any tree which has most of its trunk growing from Council managed land.)

Council will manage its public trees by monitoring their condition and by removing and replacing them where appropriate.

Council will investigate all tree management options before recommending tree removal wherever possible. Tree removal will only be authorised when no other viable options are available. Council's Tree Officers are responsible for undertaking tree inspections, assessments and reports in relation to tree removals.

Council has a duty to do all that is reasonably practicable to ensure that people and property are not exposed to risk from Council managed trees.

Consideration will be given to the contribution each tree makes to neighbourhood character as well as environmental benefits when making all tree removal decisions.

Where a Council tree is removed, a suitable replacement will be established unless it is impractical within the guidelines of this policy.

Residents and ratepayers are not authorised to remove trees from Council property.

6.2 Tree removal criteria

Street trees provide considerable benefit to the community by way of improved amenity and environmental benefits such as by reducing the urban heat island effect or improving biodiversity and raising property prices. Therefore, Council will not support individual requests to have trees removed, for a range of reasons including:

- Reducing or eliminating leaf litter or tree debris (that is not causing an unacceptable risk to health)
- Establish and maintain turf on nature strips
- Reduce overshadowing and/or preservation of solar access
- Satisfy unjustified private property damage claims.

There are circumstances, however, in which tree removal is an acceptable management option in nature strips, parks and reserves and other Council managed land when required for human health and safety, to protect infrastructure, to facilitate approved development and infrastructure improvements, to maintain a healthy urban forest or for ecological restoration. In this regard, tree removal may be required:

- If the **tree is declining or dead** - to maintain a healthy urban tree population or for ecological restoration.
- If the **tree is dangerous** - when trees pose an unacceptable risk to human health and safety or infrastructure.
- If the **tree is causing excessive damage**, which cannot be rectified with contemporary arboricultural techniques, or to facilitate approved development and infrastructure improvements.

Tree removal may also occur in response to emergency, such as a burst water main, or storm events.

Tree removal and replacement programs will also be instigated based on the low useful life expectancy (ULE) trees or unsuitable tree species identified in the 10-year street tree planting plan.

Requests to remove street trees will only be accommodated when one or more of the following criteria are met:

- The tree is dead or in severe decline (low Useful Life Expectancy - ULE).
- The tree or tree group poses a very high-risk potential that cannot be corrected by pruning or other contemporary treatments. In this case, a recognised tree risk assessment method, such as QTRA or TRAQ is to be used by qualified arborists to identify that the tree or tree group pose an unacceptable level of risk. This may not be required if Council's delegated officer(s) perceive an unacceptable risk, which includes emergency works resulting from storm events.
- After appropriate investigations, the tree is found to be substantially contributing to damage to public or private property and no other viable means are available to rectify the situation.
- The tree or tree group is infected with an epidemic insect or disease where the recommended control is not applicable, and removal is the recommended practice to prevent transmission.
- The tree or tree group is recognised as an environmental woody weed species or noted problem/inappropriate species.
- The tree is unsuitable under electric lines requiring substantial and ongoing pruning to maintain clearances (see next point).
- Where the retention of the tree is not cost effective compared to the tree's monetary, conservation or heritage value.
- The tree or group of trees is included in Council's 10-year street tree planting plan.

All tree removal requests will be assessed by Council's Tree Officers.

Council acknowledges that all trees will shed debris, leaves, bark, flowers, fruit, at some time during a given growing season. Tree selection will aim to avoid the use of trees that drop excessive debris, particularly fruit, which can cause trip hazards. Debris alone will not be the sole criteria for the removal of a street tree.

Similarly, street trees will not be automatically removed if they are reported as causing hay fever or other allergies.

If a resident reports a tree as causing hay fever or an allergy, they will be advised to provide a medical certificate from a specialist in the relevant field. The certificate should certify that the specific tree a person identifies as causing the allergenic problem is significantly diminishing the quality of life for that person.

Decisions on tree hazard and associated risk rating will be made after the tree has been inspected and assessed by a suitably qualified person.

6.3 Trees removed for emergency purposes

Emergency work is defined as tree removal required due to the immediate risk of damage to property or personal safety as deemed by Council's delegated officer(s) or qualified arborists. Immediate attention may be required if the tree has a condition, which suggests failure is imminent or a tree is deemed to be structurally unstable due to:

- The potential to shed a major portion of the canopy; or
- Being unstable in the ground and susceptible to root plate failure and/or wind-throw.

Decisions on tree hazard and associated risk rating will be made after the tree has been inspected and assessed by a Council arborist. A structurally unsound tree in an area with no target is not considered a high risk.

Trees may require immediate removal to undertake repairs on infrastructure such as broken water pipes.

In emergency situations notification prior to removal may not be possible.

6.4 Tree removal requests

Tree removals requests may be generated by:

- Council officers
- Approved Parks contractors as part of on-going maintenance work and inspections
- Service company (infrastructure maintenance / improvements).
- Developers
- Residents/Community

A request for a tree removal can be made through Council's website 'report an issue' or contacting the customer service team. All requests for tree removal shall be recorded, inspected and assessed by Council's delegated officer(s).

For urgent requests after hours please contact the Customer Service Centre on (03) 5291 4444 for the appropriate contact number.

6.5 Community consultation in relation to tree removals

Written notification to relevant parties requesting a tree removal(s) will be provided. The notification will indicate whether approval for removal has been granted or not. If removal is approved, the notification will include any proposed action and timing and relevant arrangements for stump removal, site reinstatement and tree replacement, if applicable.

Prior to the tree removal work being undertaken on Council managed land, any residents immediately adjoining or adjacent to the site ("visually" affected by the trees removal) are to be given no less than seven (7) days notification of the proposed works. For example, where trees are removed from streets, the properties either side and across from the property where the tree is in front of will be notified.

When considerable community concern is expressed following notification of the removal of a tree or group of trees, the matter will be referred to the Manager Operations.

- The Council's delegated officer(s) will provide a brief 'tree removal project overview' report to the Manager Operations that describes the arboricultural issues concerning the removal of the tree or group of trees.
- The Manager Operations will either base his/her decision upon the information contained within the report from Council's Asset Inspector or,
    - determine to obtain an independent report from a qualified arborist to confirm the arboricultural issues or,
    - determine to obtain independent report from other disciplines if removal has a higher degree of environmental significance, or
    - refer the matter to the Director Infrastructure Services (DIS) for review

- The DIS will inform the Ward Councillor(s) of the issues regarding the tree removal or retention.

Depending on the community response a public meeting may result in which the issues associated with the proposed work will be presented. Proposed tree removals may be part of a broader landscape concept plan in which case other representatives of the project can be present to convey their views of the works.

The decision to hold a public meeting will be at the discretion of the DIS in accordance with Council's commitment to community consultation.

When more than 30% of street trees are to be removed from a given street or location and their removal may impact upon the wider community the following will apply.

- Notification to affected residents and Ward Councillor.
- All properties within the street will be given written notification.
- Undertake public meeting or other strategies, if deemed appropriate.

In emergency situations notification prior to removal may not be possible.

Appeals relating to tree removal

If a resident insists on the removal or retention of a tree despite advice and assurances from the arborist or delegated officer(s) to the contrary or an alternative is more appropriate, this request must be in writing and addressed to the DIS.

6.6 Tree removal associated with infrastructure improvements by Council or other public authority

There will be instances in which utility companies, Council and other public authorities require the removal of trees to facilitate the construction of new infrastructure or the maintenance of existing infrastructure.

The Councils delegated officer(s) is to be consulted by the relevant authorities or Council department seeking tree removal. As part of a consultation process with the relevant authorities or Council department, design and construction alternatives should be sought.

If alternatives cannot be established and the project cannot be reasonably re-routed away from the tree(s) and the infrastructure works could compromise the structural integrity of the tree by severing/damaging major roots and impact on the health of the tree it may be proposed for removal.

Ideally, the tree protection zone distances outlined in Section 5.4 should be applied to protect the health and safety of trees. The minimum clearance distance required to maintain a trees stability will be implemented. If the proposed excavation/construction works encroach on this minimum distance (Structural Root Zone - SRZ), alternatives should be sought. See Table 5 SRZ table in Section 5.4

If the distances listed in the SRZ table are encroached on and roots are damaged / severed, then the tree should be proposed for removal. Council's delegated officer(s) is to undertake a tree inspection and assessment prior to the approval for tree removal.

6.7 Removal of inappropriate trees

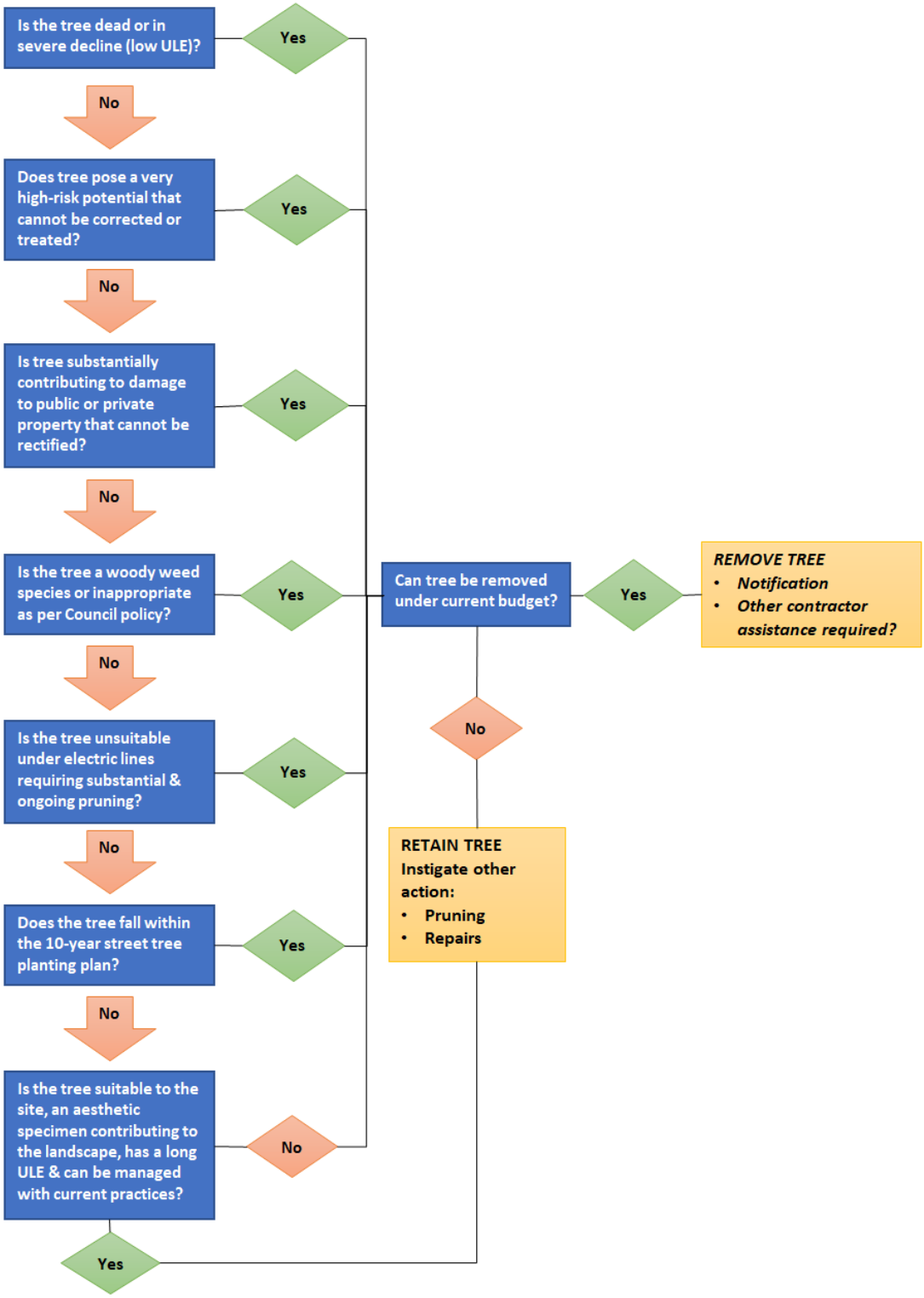
Inappropriate trees or plant species may be removed from the road verge and/or parks and reserves.

This may include trees that are poorly located, particularly in relation to overhead electric lines.

Tree species deemed inappropriate may include:

- Desert Ash (*Fraxinus angustifolia* ssp. *angustifolia*) – environmental woody weed species (seed)
- Norfolk Island Hibiscus (*Lagunaria patersonia*) – irritating fibres in seed pods, unsuitable under electric lines.
- White Cedar (*Melia azedarach*) – excessive fruit drop

Tree removal flow chart
Assessment process
Other than for emergency purposes



Appendix A: Street tree planting priority assessment process (Treelogic©)

If unlimited funds were available for street tree planting, all vacant sites would be planted achieving full-stocking, inappropriate trees would be removed and replaced, and the municipality would achieve the preferred planting styles to reinforce the pervading landscape character and meet community expectations. However, funds for planting programs are limited so it is important to develop priorities with an understanding of the condition of the tree resource, the land use and site characteristics and perceived needs to achieve the greatest benefit back to the community.

To endeavour to achieve this an overview approach would be developed, which focuses on street trees as groups; either as a whole street or where there is distinct character, soft or hard landscape differences, in sections. The impetus for this approach is to efficiently identify and understand the composition and quality of the tree population within streets and/or street sections. An underlying assumption to this approach is that tree management on the street scale should address and consider groups of trees rather than micro managing the very specific management needs of individual trees.

If a current street tree inventory is available a desktop evaluation would be undertaken to identify streets and/or areas that require more detailed assessment. Other layers such as neighbourhood character, identified urban heat islands, activity zones, habitat corridors, and pedestrian and cycling routes, could be incorporated into the assessment to magnify where street trees may be required.

The desktop assessment could be complimented by field assessment work. The following list could be captured as polygons (within a GIS) for the development of a priority planting plan. Not all streets within the town will be included in this assessment; it is presumed that most streets would fall outside of the defined cycle for removal and replacement. It is presumed that many recently planted streets or sub-divisions will not require assessment.

1. Street name
2. Street section. May be used for long streets or main roads where the road configuration or landscape character changes along its length.
3. Dominant tree species – most common tree species planted in the street (up to 3).
4. Planting site - Categories. Generally, nature strip but could also include paved sites, granitic gravel.
5. Width of planting site – Average, captured in categories to nearest 0.5 m. The width of the planting pit/cut-out will be captured in hard surface areas.
6. Electric lines – Yes/No
7. Side of street (east/west/north/south, etc.)
8. Total trees in street or section
9. Total vacant sites in street or section
10. Optimum sites (combination of total existing trees and vacant sites)

Criteria can be modified to suit specific applications.

Table 1. Street tree assessment table

Criteria	Score attributes	Score
1. Condition of trees	Majority of trees in poor condition, in severe decline.	10
	Majority of trees in decline with deteriorating condition.	6
	Majority of trees starting to show decline symptoms. Trees are ultimately not suited to the site.	4
	Majority of trees are in semi-mature to maturing phase displaying typical condition.	1
	Young, recently planted trees, 7-10 years old, growing vigorously.	0
2. Useful Life Expectancy (ULE)	1-5 years (Transitory, Brief) Trees are exhibiting severe chronic decline; some trees may be dead. Reduced crown densities. Crowns may be mostly epicormic growth. Dieback of large limbs is common (large deadwood may have been pruned out). Some trees may exhibit major structural faults. Excessive infrastructure conflicts/damage with heightened risk potential that cannot be remedied. Trees have outgrown site constraints, such as planting site and requirement for excessive pruning to maintain clearances. Majority are weed species, adjacent to site with environmental significance.	10
	6-10 years (Short) Trees are exhibiting chronic decline. Crown density will be less than typical and epicormic growth is likely to present. The crown may still be mostly entire, but some dieback is likely to be evident. Dieback may include large limbs. Over-mature and senescing or early decline symptoms in short-lived species. Early infrastructure conflicts with potential to increase regardless of management inputs. Trees inappropriate to site, such as non-preferred, weed species or too large for site, poor structure due to electric line clearance.	8
	11-30 years (Moderate) Trees not showing symptoms of chronic decline, could be considered typical for the species under growing conditions, but growth characteristics are likely to be reduced (bud development, extension growth etc.). Trees may be in late maturity. Trees may be growing in restricted environment and/or have potential for infrastructure conflicts.	2
	31-60 years Semi-mature and mature trees exhibiting normal growth characteristics. Juvenile trees in streetscapes.	1

Criteria	Score attributes	Score
	Trees suited to site conditions.	
	>60 years Long-lived species exhibiting normal growth characteristics well-suited to site conditions. Newly planted trees suited to site conditions.	0
3. Assessment of necessity of new street tree planting	High priority; Inappropriate species, causing excessive damage to adjacent public and/or infrastructure; few existing trees and no limiting factors.	10
	Medium priority: Majority of existing trees in decline and/or starting to conflict with adjacent infrastructure or have potential. Opportunities for substantial planting.	6
	Low priority; Existing streetscape reasonable but requires enhancement. Could list for in fill program.	1
	Existing trees suitable. No opportunity to plant trees	0
4. Percentage of vacant sites	80% or higher vacant sites	10
	50-80% vacant sites	8
	30-50% vacant sites	4
	Less than 30% vacant sites	2
	Full stocking of street	0
5. Road hierarchy	Main road or collector road; entrance to City	5
	Local residential / Access street	3
	Industrial road / commercial precinct	1
6. Design considerations (could be cumulative based on several factors being present)	Street within identified heat island area	5
	Link to or adjacent to open space that has significant remnant vegetation; habitat link.	4
	Pedestrian or cycling route. Adjacent to school or shopping precinct.	4
	Large/wide planting site (＞2.5m wide) with no electric lines	3
	Large/wide planting site (＞2.5m wide) with electric lines	2
	New planting could be incorporated with other street infrastructure works, such road and/or footpath reconstruction and underground services maintenance.	2
	Street requires design solution and hard surface modification.	1
	Significant contributing private canopy or borrowed landscape, prohibiting good street tree development	0

The above factors would be included as numbers in the data to allow the development of a priority program. The detail listed above would be included in the method statement within the Street Tree Management Plan report.

Other consideration

Public receptive to removal/replacement program (deemed from petition or group letter)	A. Majority of residents included in petition/group letter	
	B. Some support from residents	
	C. No support or opposition to program	

Recommended works

Infill planting	Yes/No
Partial renewal	Yes/No No. of trees recommended for removal
Full renewal	Yes/No No. of trees recommended for removal
Reinforce existing species	Yes/No
Recommended species	Specific species recommendations (no more than 3).
Priority	Based on above table results

Opportunity sites

The field assessment may also identify individual tree sites, such as in traffic treatments that do not currently have trees planted that could also be considered for planting during a planting plan. This could also include sections of open space where tree planting could reinforce the streetscape. These sites could be captured as point data within the GIS layer.

Data fields

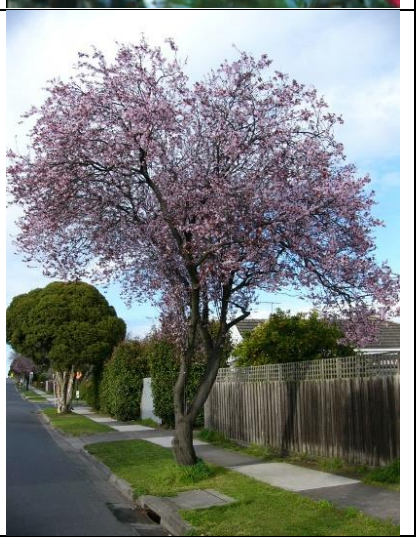
- ID number
- Street name
- Planting site – traffic island, open space, paved area, nature strip, in road
- Planting site width – In metres (if applicable)
- Electric lines – Yes/No
- Design/Infrastructure change – Yes/No

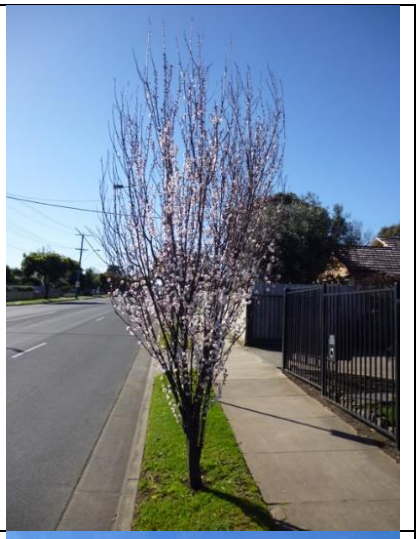
Appendix B: Tree Species List

Small trees 3-8 metres in height

Deciduous

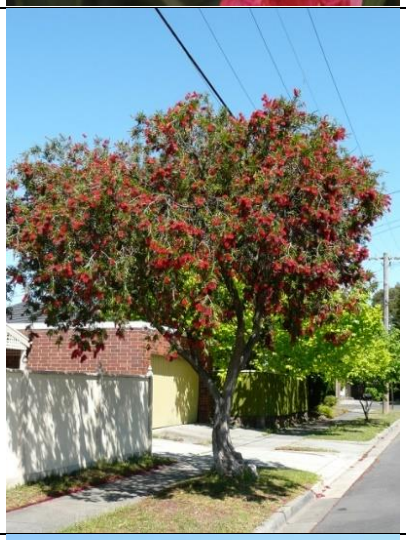
Name: Montpelier Maple (*Acer monspessulanum*) **Height:** 6-8 metres **Width:** 5-8 metres **Description:** Small tree with oval to rounded form. The leaves can be variable, but typically three-blunt lobes, shiny dark green. Foliage is typically thick, leathery, turning yellow in autumn. The flowers are yellow-green and held in pendulous flower clusters. The flowers appear simultaneously with the new leaves. The fruit is a samara (winged seed) with many being sterile. Montpelier Maple is tolerant of dry conditions. It is intolerant of saline and sodic soils. It will grow in full sun to part shade.	
Name: Crimson Sentry Norway Maple (*Acer platanoides* 'Crimson Sentry') **Height:** 7-8 metres **Width:** 4-5 metres **Description:** Broadly columnar in form with a dense canopy of dark purple leaves with five sharp lobes. Leaves turn from purple to golden-brown autumn foliage. Moderate to high tolerance of dry conditions. Very tolerant of a wide array of soils. Adapts to extremes in soils; sand, clay, acid to alkaline.	

Name: Sioux Crepe Myrtle (*Lagerstroemia indica* x *L. fauriei* 'Sioux') **Height:** 4-5 metres **Width:** 3-4 metres **Description:** Small tree with upright vase form becoming rounded with age. Oval green foliage turning good autumn colour. Ornamental bark. Panicles of medium to hot pink flowers. Moderate to high tolerance of dry conditions once established. Adapts to a range of soils and transplants easily. Good small urban tree. Useful for narrow spaces. Low root impacts, low litter drop, no invasive potential.	
Name: Tuscarora Crepe Myrtle (*Lagerstroemia indica* x *L. fauriei* 'Tuscarora') **Height:** 4-7 metres **Width:** 4-6 metres **Description:** Small tree with upright vase form. Oval green foliage turning good autumn colour. Ornamental bark. Panicles of coral red flowers. High tolerance of dry conditions once established. Adapts to a range of soils and transplants easily. Good small urban tree. Useful for limited spaces. Low root impacts, low litter drop, no invasive potential.	
Name: Purple-leaf Cherry-Plum (*Prunus cerasifera* 'Nigra') **Height:** 5-7 metres **Width:** 4-5 metres **Description:** Small tree with upright vase form. Dark black-red foliage. Masses of single pink flowers in spring. Blackish-brown bark, blackish red younger branches. Prefers moist, well drained and fertile soils in full sun. Moderate drought tolerance. Low root impacts, low litter drop, no invasive potential.	

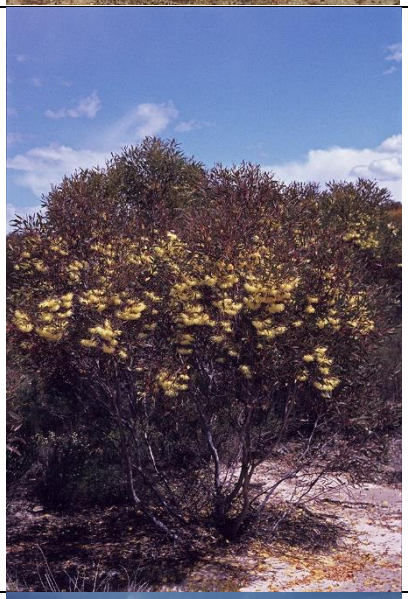
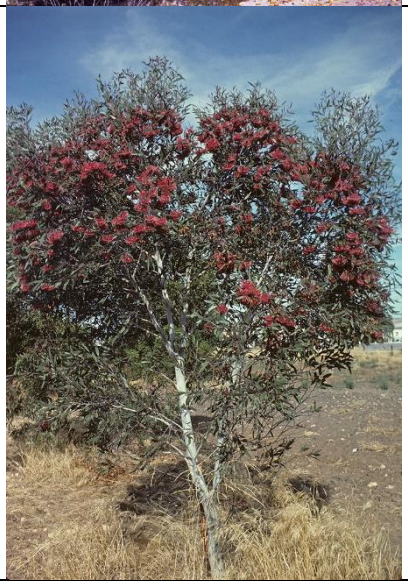
Name: Upright Purple Leaf Cherry Plum (*Prunus cerasifera* 'Oakville Crimson Spire') **Height:** 5-7 metres **Width:** 4-5 metres **Description:** Small tree with narrow, upright vase form. Dark black-red foliage. Masses of single pink flowers in spring. Prefers moist, well drained and fertile soils in full sun. Moderate drought tolerance. Low root impacts, low litter drop, no invasive potential.	
Name: Ornamental Pear (*Pyrus betulaefolia* 'Southworth' Dancer'™) **Height:** 5-8 metres **Width:** 4-7 metres **Description:** Small tree with vase form becoming oval to rounded. Silver-grey maturing to shiny, mid-grey foliage turning yellow in autumn. Profuse white flowers in spring. Different in form/texture to other pears. Adapts to most soil types and has high to moderate drought tolerance.	

Small trees 3-8 metres in height

Evergreen

Name: Jerilderie Red (*Brachychiton acerifolius* x *populneus* 'Jerilderie Red') **Height:** 5-8 metres **Width:** 4-7 metres **Description:** Small to medium tree with a dense canopy of simple, dull-green, lanceolate leaves with an acuminate apex. The leaves vary somewhat in size but have a long, slender petiole. Can be semi-deciduous. Clusters of dense, red bell-shaped flowers in spring/summer. Suits sandy or heavy soils, lime. Drought and frost resistant. Fire retardant. Also use the cultivars: *Brachychiton populneus* x *acerifolius* 'Bella Pink' and *Brachychiton acerifolius* x *populneus* 'Bella Donna' 4-5 metres **These Brachychiton, as well as the Kurrajong (*Brachychiton populneus*) are highly recommended for street planting in Hindmarsh townships.**	
Name: Harkness Bottlebrush (*Callistemon* 'Harkness') **Height:** 5-8 metres **Width:** 4-7 metres **Description:** Small tree with narrow-domed to rounded form. Branchlets semi-pendulous. Exceptional crimson-red bottlebrushes to 200mm long, borne in late spring and early summer; little to no fruit is produced. Fissured, blackish-grey bark. Very adaptable to most soils from sandy, skeletal soils, to heavy clay. Has high to moderate drought tolerance. Very useful small tree. Also known as *Callistemon* 'Gawler Hybrid'.	
Name: Weeping Bottlebrush (*Callistemon viminalis*) **Height:** 5-8 metres **Width:** 4-7 metres **Description:** Small tree with pendulous branches, and fine lanceolate foliage. Prominent red flowers are borne in spikes 40-150 mm long. Fissured, grey bark. Very adaptable to most soils from sandy, skeletal soils, to heavy clay. Has high drought tolerance. Can also use the cultivars: 'Hannah Ray' - a large shrub with weeping habit, 4 metres high by 3 metres wide. 'Prolific' - A small, fast-growing tree 4-6 m high by 4 m wide with large red brushes. Both useful for under electric lines.	

Name: Scentuous Lemon-scented Gum (*Corymbia citriodora* 'Scentuous') **Height:** 6-8 metres **Width:** 3-4 metres **Description:** Small to medium tree with aromatic narrow lanceolate foliage. Smooth white to pinky salmon bark. White/cream flowers in summer. Adaptable tree that grows in a range of soils and grows rapidly with or without moisture. Prefers well-drained soils in full sun position. Has moderate to high drought tolerance. Plants grafted onto specially selected rootstock ensures viability for growing in a wide range of soil types, improves disease resistance, guarantees flower colour and limits mature size. Care must be taken to remove all growth below the graft union or these shoots will grow through the grafted canopy and eventually overrun your plant.	
Name: Red-flowering Gum cultivars (*Corymbia ficifolia* 'Wildfire' and 'Wild Sunset') **Height:** 5-6 metres **Width:** 5-6 metres **Description:** Small tree with dense rounded canopy, and rough brown bark. Deep green leathery leaves with bronzy new growth. 'Wild Sunset' has orange flowers, and 'Wildfire' has red flowers. The species prefers well drained sites, although plants grafted onto specially selected rootstock ensures viability for growing in a wide range of soil types. High drought tolerance. Fruit drop can be a problem. Use grafted plants to assure flower colour and form. Ensure good production methods for grafted plants.	
Name: Cup-fruited Mallee (*Eucalyptus dielsii*) **Height:** 4-10 metres **Width:** 3-7 metres **Description:** Small Mallee with an erect, spreading form. Smooth grey, greenish to coppery bark. Clusters of yellow-green flowers. Grows naturally on low clayey ground. Adapts to a range of soil types; acidic to alkaline. High drought tolerance. Underutilised, small tree. Image: Holliday, I. c/o Dahms, R. (2009)	

Name: Fuchsia Gum (*Eucalyptus dolichorhyncha*) **Height:** 4-6 metres **Width:** 3-4 metres **Description:** Small mallet with a compact rounded form. Smooth bark shedding in small patches. Features of yellow flowers and red showy fruit. Prefers a sunny position with moist but well-drained soils and can tolerate frost and drought Could also use: *Eucalyptus forrestiana* 3-4 metres *E. dolichorhyncha* is often cultivated in southern Australia as an ornamental and has frequently been sold under the name *E. forrestiana*. Image: Holliday, I. c/o Dahms, R. (2009)	
Name: Tall Sand Mallet (*Eucalyptus eremophila*) **Height:** 5-8 metres (may get taller) **Width:** 3-8 metres **Description:** Single or several trunked tree with ascending branches forming a rounded crown with age. Bark is smooth, shiny, dark silvery-grey to coppery. Lance shaped, dark green, shiny leaves. Flower buds in 7s, elongated operculum, masses of lemon-yellow flowers. Usually grows on clayey soils, or sand overlying clay. Also found on skeletal soils over granite, and sand. On undulating plains, sand dunes, and hills. High drought tolerance. Moderate frost tolerance. Plant in full sun. Plant in clay, loam, and sand with acidic to neutral pH. Image: Holliday, I. c/o Dahms, R. (2009)	
Name: Red-flowered Mallee (*Eucalyptus erythronema*) **Height:** 3-6 metres **Width:** 2-5 metres **Description:** Single or multi-trunked Mallee, narrow form initially. Bark smooth throughout, dark satiny pink-brown to pink-grey or dark red shedding in thin sheets to reveal powdery creamy white. Olive-green to green, glossy lance-shaped leaves. Flower buds and fruit in groups 3-7. Bluntly beaked operculum. Flowers red/pink/cream-white. Adaptable to a wide range of climatic conditions and soils; found growing on sand or clayey soils, gravel, laterite. High drought tolerance. Full sun, open position with no other canopy competition. Image: Holliday, I. c/o Dahms, R. (2009)	

Name: Euky Dwarf Yellow Gum (*Eucalyptus leucoxylon* 'Euky Dwarf') **Height:** 5-6 metres **Width:** 3-5 metres **Description:** Rounded, spreading, pen canopied small eucalypt with smooth chalky bark, grey green foliage, and red flowers in spring. It performs best in well-drained, moist soils but, once established is tolerant of extended dry conditions. Adaptable to a wide range of climatic conditions and soils; clay, sandy or stony soils; neutral acid or alkaline pH. High drought tolerance. Full sun to part shade.	
Name: Round-leaf Moort (*Eucalyptus platypus*) **Height:** 5-6 metres **Width:** 3-5 metres **Description:** A spreading mallee with a dense crown of dark green foliage, orbicular leaves. Smooth grey bark. The flattened peduncles support stalkless buds with long, conical caps in clusters of up to seven. Yellow-green flowers. Adaptable to a range of conditions and soils, including heavy clay soils. Can also tolerate moderate waterlogged conditions.	
Name: Steedman's Gum (*Eucalyptus steedmanii*) **Height:** 4-8 metres **Width:** 2-6 metres **Description:** A small, erect, smooth barked tree (or mallet). Distinctive form with numerous ascending branches from low on its trunk, forming a dense crown. Smooth bark ranges from grey, to red-brown to bright coppery in colour. Olive-green, glossy leaves. 3-flowered typically cream or yellow, but occasionally pink or red, on long stalks. The buds are shaped in an elongated diamond ~ 3cm long with a pyramidal cap. Fruits are longitudinally winged Adapts to most soils in dry to moderate rainfall areas. *Image: Holliday, I. c/o Dahms, R. (2009)*	

Name: Scarlet Pear Gum (*Eucalyptus stoatei*) **Height:** 3-6 metres **Width:** 2-5 metres **Description:** A slender, erect mallet with a crown of thick, dark green leaves with a pointed apex. Smooth grey bark. Predominately ridged, red to greenish-yellow pear-shaped buds & fruits, sometimes in pendulous bundles. Yellow flowers. Adaptable to a range of conditions. High tolerance of drought. Useful for under electric lines.	
Name: Green Mallee (*Eucalyptus viridis*) **Height:** 3-9 metres **Width:** 1-5 metres **Description:** A slender, erect mallee, shrub to small tree, typically with multiple leaders. Bark rough at base otherwise completely smooth, coppery, tan to grey. Linear glossy green leaves. Profuse white flowers in summer & autumn. Adapts to a wide range of soils, from poorly drained clays to well drained sand. High tolerance of drought. When pruned to a single trunk, the low growth and low water requirements make it suitable to be used as a street tree. *Image: Holliday, I. c/o Dahms, R. (2009)*	
Name: Tucker Time® Honey Pots™ (*Eucalyptus wimmerensis* 'Honey Pots') **Height:** 3-5 metres **Width:** 2-4 metres **Description:** Small tree or multi-stemmed mallee with small narrow grey-green leaves. Profuse white flowers. Smooth bark Adapts to a wide range of soils, from poorly drained clays to well drained sand. Prefers moist well drained clay sandy or stony soils neutral acid or alkaline pH. High tolerance of drought. Prune to single trunk. The low growth and low water requirements make it suitable to be used as a street tree under electric lines.	

Medium trees 9-15 metres in height

Deciduous

Name: Elsrijk Hedge Maple (*Acer campestre* 'Elsrijk') **Height:** 8-10 metres **Width:** 5-8 metres **Description:** An oval to widely conical shaped tree with a dark, dense crown. Small dark green leaves, colouring yellow in autumn. Bark grey-black, lightly ridged and furrowed. Adapts to a wide range of soils, from poorly drained clays to well drained sand (except dry infertile sandy soil). Will tolerate drought, air pollution and soil compaction. Grows well in cut-outs in hard-paved areas.	
Name: European Nettle Tree (*Celtis australis*) **Height:** 10-15 metres **Width:** 6-12 metres **Description:** Smooth grey bark. Alternating leaves are narrow and sharp-toothed on margins. Dark green and rough above, pubescent, grey-green below. Foliage turns yellow in autumn. Small, green flowers, either singly or in small clusters followed by a small, dark-purple berry-like drupe. Adapts to most soils. Prefers light well-drained, sandy, and loamy soils, including those nutritionally poor; it can tolerate drought but not shade.	
Name: Jacaranda (*Jacaranda mimosifolia*) **Height:** 10-15 metres **Width:** 10-12 metres **Description:** Broad-domed to rounded, semi-deciduous to deciduous tree with an open canopy. Light green bipinnate (fernlike) soft, delicate, foliage. Dense terminal clusters of lavender-blue flowers in late-spring to summer cover the canopy. Grey furrowed bark. Adaptable to a range of well-drained soils; clay; loam; sand; slightly alkaline or acidic. High drought tolerance. Quick growing when in full sun position. Formative prune to develop good branch architecture and form.	

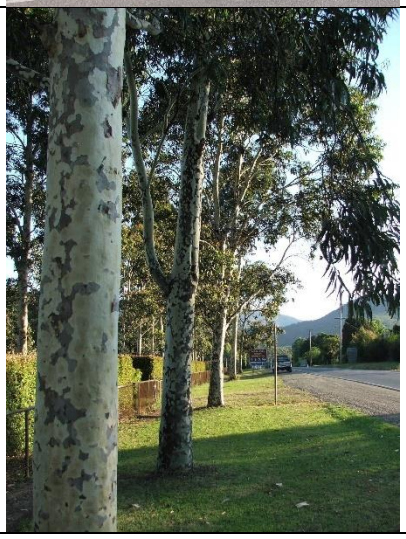
Name: Fantasy Crepe Myrtle (*Lagerstroemia fauriei* 'Fantasy') **Height:** 7-9 metres **Width:** 5-8 metres **Description:** Small to medium tree with upright vase form becoming oval. Oval green foliage turning good autumn colour. Ornamental bark. Panicles of white flowers. Moderate to high tolerance of dry conditions once established. Fantasy adapts to a range of soils and transplants easily. Good small urban tree. Useful for limited spaces. Low root impacts, low litter drop, no invasive potential	
Name: Capital Callery Pear (*Pyrus calleryana* 'Capital') **Height:** 10-12 metres **Width:** 4-5 metres **Description:** Narrow, upright form with dense, lustrous dark green foliage turning to reddish-purple late in autumn. Profuse white flowers in spring. Adaptable to a wide range of site conditions including quite dry conditions, slightly alkaline soils. Able to handle intermittently wet, heavy soils. Adaptable to a wide range of site conditions including quite dry conditions, slightly alkaline soils and air pollution. Tolerant of compacted soils in urban areas, including tree pits in paved areas & temporary waterlogged conditions. Shallow rooted tree.	
Name: Chanticleer Callery Pear (*Pyrus calleryana* 'Chanticleer') **Height:** 12-15 metres **Width:** 6-8 metres **Description:** Narrow, upright form with dense, lustrous dark green foliage turning to reddish-purple late in autumn. Profuse white flowers in spring. Adaptable to a wide range of site conditions including quite dry conditions, slightly alkaline soils. Able to handle intermittently wet, heavy soils. Adaptable to a wide range of site conditions including quite dry conditions, slightly alkaline soils and air pollution. Tolerant of compacted soils in urban areas, including tree pits in paved areas & temporary waterlogged conditions. Shallow rooted tree.	

Name: Allee Chinese Elm (*Ulmus parvifolia* 'Emer II' Allee) **Height:** 12-15 metres **Width:** 8-12 metres **Description:** Vase-shaped to broad domed tree with ascending branches. Small, glossy, dark green leaves. Orange-brown flaking bark. Adaptable to most soils and can cope with extreme conditions. Tolerates compaction and a restricted root zone. Good avenue tree. Also use: *Ulmus parvifolia* 'Todd'	

Medium trees 9-15 metres in height

Evergreen

Name: Weeping Myall (*Acacia pendula*) **Height:** 8-10 metres **Width:** 4-7 metres **Description:** Spreading or erect tree with pendulous branches with striking blue-grey, narrow foliage. Bark rough, fissured and dark grey. Bright yellow globose flowers. Suitable for a range of conditions, including clay soils. Prefers well-drained soils. Will grow in part-shade. High drought tolerance.	
Name: Cooba, Native Willow (*Acacia salicina*) **Height:** 5-14 metres **Width:** 5-12 metres **Description:** Rounded crown with pendulous branchlets with long pendulous foliage often drooping to near ground level. Narrow, slightly curved phyllodes. Racemes of pale yellow flowers. Adaptable to most soils including clayey, alkaline soils. Moderate to highly salt tolerant but severe frosts may limit its growth Grow in full sun. Tends to sucker.	

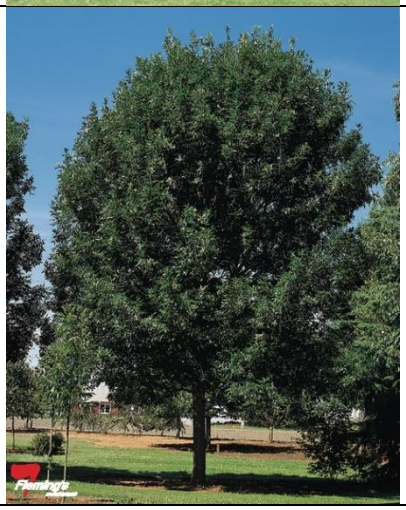
Name: Kurrajong (*Brachychiton populneus*) **Height:** 8-15 metres **Width:** 5-12 metres **Description:** Trees are typically stout, pyramidal to narrow-domed, with a canopy of variable, glossy-green foliage. Canopy provides dense shade. The flowers are bell-shaped and whitish-green in colour with the inner flower tube streaked purple-brown. Seeds are borne within woody, boat-shaped fruit 1-7 cm long. Deep rooted trees. Some trees are semi-deciduous in early summer. Kurrajong occurs in a wide range of habitats and soils, from deep sandy loams on plains, to skeletal types on rocky hilltops. High drought tolerance. A relatively slow growing tree that would benefit from cultivated soil and additional moisture while establishing. **Highly recommended species for the Hindmarsh townships.**	
Name: Yellow Bloodwood (*Corymbia eximia*) **Height:** 8-12 metres **Width:** 4-8 metres **Description:** Narrow-domed to rounded tree. Canopy provides dense shade. Flaky, patchy yellow-brown rough bark. Thick curved, broad lanceolate leaves. Profuse white terminal flowers for short period in early spring. Fruit are thick, and urn shaped. Adapts to a range of climatic conditions and soils, including heavy clays and on poor, gravelly or sandy soils. Grows on broad flat-topped ridges and steep, upper slopes of valleys. Found on sandy, often shallow soils derived from sandstone. High drought tolerance; moderate to high tolerance of temporary inundation. **Highly recommended tree for Hindmarsh townships.**	
Name: Lowanna Spotted Gum (*Corymbia maculata* 'ST1' Lowanna) **Height:** 7-10 metres **Width:** 5-8 metres **Description:** A smaller, narrow-domed, denser canopy version of Spotted Gum. Cream/grey smooth trunk. Dark green foliage that forms a dense canopy. Clustered small white flowers. Adaptable to a wide range of climatic conditions and soils. A recent introduction. Occasionally available from specialist nurseries. Image on left is indicative only. Cultivar too new to have an image see https://www.specialitytrees.com.au/library/corymbia/maculata/st1-lowanna.	

Name: Black Box (*Eucalyptus largiflorens*) **Height:** 10-20 metres **Width:** 10-15 metres **Description:** Dark grey and fibrous bark over most of tree. Spreading canopy on stout trunk, often multiple leaders. Leaves narrow, dull greyish-green. Found on heavy clay soils in areas subject to periodic inundation. tolerates drier conditions than River Red Gum. Extremely tolerant of heavy, poorly-drained and alkaline soils. Moderately salt tolerant. Endemic to the area.	
Name: Coral Gum (*Eucalyptus torquata*) **Height:** 7-9 metres **Width:** 5-8 metres **Description:** Rounded, dense canopied trees with rough, persistent bark on the trunk and larger branches. Greyish green, lanceolate leaves. Distinctive, corrugated buds with operculum tapers to a long point. Large flowers, typically coral-pink. Grows in most soil types but it ideally needs well drained soils in full sun. *Image: Holliday, I. c/o Dahms, R. (2009)*	
Name: Wilga, Australian Willow, Sheep Bush (*Geijera parviflora*) **Height:** 7-10 metres **Width:** 6-8 metres **Description:** Narrow-domed to rounded canopy with ascending structural branches with pendulous smaller branches and foliage. Elegant leathery linear foliage. rough, persistent bark on the trunk and larger branches. Typically found on lime-rich red clay loam or sandy soils with a variety of pHs. Species adaptable to a wide range of climatic and soil conditions. Full sun to part shade. High drought tolerance. **Highly recommended for Hindmarsh townships.**	
Name: European Olive varieties (*Olea europea* var.) **Height:** 7-10 metres **Width:** 5-9 metres **Description:** Grey-green foliage, silvery beneath. Pale-grey, rough furrowed bark. Adapts to most soil textures, prefers good drainage. Will not grow in highly compacted or waterlogged soils. Can be slow growing. Use the cultivars: 'Swan Hill'. Rounded canopy as broad as it is high. Does not produce fruit. 'Tolley's Upright' More Upright in growth. The foliage tends to be a paler, more silvery-green than other olive selections. Will produce some fruit	

Name: Canary Island Date Palm (*Phoenix canariensis*) **Height:** 8-15 metres **Width:** 8 metres **Description:** A medium sized palm with large deep green fronds with extremely sharp spines at the bases. The species is dioecious, with separate male and female trees. The fruit are orange, 2 cm long and 1 cm diameter, with a large seed. They are produced on long, densely branched panicles. Thick dull brown trunk, marked with broad, diamond-shaped leaf base scars. Canary Island Date Palm is adapted to more habitats and soils than almost any other palm. Suited to cooler climates. Best in Mediterranean climates. It can tolerate a wide range of exposures, including deep shade, and a wide range of soil types, including sand and heavy clay. It has a unique ability to tolerate both severe drought and waterlogged soil conditions.	

Large trees >15 metres in height

Deciduous

Name: Cimmaron Green Ash (*Fraxinus pennsylvanica* 'Cimmzam' Cimmaron™) **Height:** 12-18 metres **Width:** 8-12 metres **Description:** Pyramidal (while young), narrow domed to rounded tree with dense, lustrous foliage, which turns burgundy to red in autumn; which it can hold well into autumn. Attractive dark grey bark which becomes deeply furrowed. Reportedly seedless variety. An impressive, ornamental feature tree which provides great summer shade and is capable of withstanding relatively extreme climatic conditions, being tolerant of frost as well as drought. Suitable for a range of conditions, including clay and compacted soils. Transplants readily.	
Name: Urbanite Green Ash (*Fraxinus pennsylvanica* 'Urbdell' Urbanite™) **Height:** 12-18 metres **Width:** 8-10 metres **Description:** Broadly conical to narrow-domed crown with strong branch architecture and little-to-no seed set. Dense, lustrous foliage turns pale yellow to deep bronze in autumn. Attractive dark grey-brown bark which becomes deeply furrowed as it matures. Prefers well-drained, moist soils, however, it is very adaptable to poor soils, rocky soils, various soil pHs, compacted soils, wet sites, dry sites, pollution, and salt spray; an extremely urban tolerant cultivar (as the cultivar name suggest). Transplants readily.	

Name: Algerian Oak (*Quercus canariensis*) **Height:** 18-25 metres **Width:** 12-30 metres **Description:** Algerian Oak is tree growing broader than tall with a dense canopy of large, shallow-lobed leaves and dark brown bark. Tree is frequently evergreen but can also be semi-deciduous to fully-deciduous (marcescent). Algerian Oak is more tolerant of dry skeletal soils than other Oak species. It can adapt to most soil types and will grow well in a wide range of climates with moderate to high drought tolerance. If space permits, it can be an impressive, long-lived shade tree for the urban landscape. Consider for use in parks and reserves.	
Name: Turkey Oak (*Quercus cerris*) **Height:** 15-20 metres **Width:** 15-20 metres **Description:** Slender while young, it usually develops a broad pyramidal form with age. Narrow, oval or oblong, deep pointed lobed dark-green leaves. Leaves remain on the tree into late autumn, usually developing little autumn colour. The acorns are up to 4cm long, and the cups covered in bristly-fringed scales. Attractive, ridged bark. Flowers inconspicuous. Adapts to most soil textures, from slightly alkaline to acidic, prefers well drained. Tolerant of drought and temporary inundation.	

Evergreen

Name: White Cypress Pine (*Callitris glaucophylla* (formerly *C. columellaris*)) **Height:** 15-25 metres **Width:** 8-10 metres **Description:** Upright, columnar tree typically with a single trunk. Dense glaucous (bluish grey) foliage. Solitary cones cone scales thin, often with a very small dorsal point. Bark brown, rough and furrowed. Widespread tree found mostly on sandy soils, from isolated individuals to extensive forests, especially in inland areas. High drought tolerance. Tolerant of temporary waterlogged conditions. Endemic to the area.	

Name: River She-Oak (*Casuarina cunninghamiana*) **Height:** 15-25 metres **Width:** 10-15 metres **Description:** Tall, narrow to conical form with ascending branches with pendulous branchlets with pendulous fine foliage (cladodes). This species is dioecious with male and female flowers on separate plants. Small grey globular cones. Dark-brown to grey furrowed bark. Adaptable to a wide range of climates and most soils including clayey, alkaline soils. High drought tolerance. Tolerant of seasonal waterlogged conditions and slight to moderate salinity. Surface roots can create conflicts with adjacent infrastructure. Provide ample space.	
Name: Spotted Gum (*Corymbia maculata*) **Height:** 18-25 metres **Width:** 12-18 metres **Description:** Narrow to broad-domed tree with a solitary trunk and a dense crown of glossy leaves. Smooth mottled grey trunk. White flowers occur in winter to spring but are not as conspicuous as they are with several other corymbias. Spotted Gum's stately, tall growth habit and distinctive smooth trunk make this tree highly ornamental and a great feature tree for use in urban landscapes. Does require space to reach full potential. The tree has low litter drop. Can self-sow under certain conditions (not so much in drier climates). Adaptable to a range of soils, including heavy clay. Prefers well-drained; not tolerant of waterlogged soils. In its natural habitat it grows on a wide range of often shallow, well-drained, clayey soils on valley slopes and ridges.	
Name: River Red Gum (*Eucalyptus camaldulensis*) **Height:** 18-25 metres **Width:** 12-18 metres **Description:** Large, broad-domed tree on a solitary trunk. Attractive smooth white, cream and pale grey bark. White flowers summer. Extensive on grey heavy clay soils along river banks and on floodplains subject to frequent or periodic flooding. Grows in a range of soils. Moderate drought tolerance and high tolerance of waterlogged soils (temporary inundation). Endemic to area, particularly in Dimboola and Jeparit	

Name: Yellow Box (*Eucalyptus melliodora*) **Height:** 18-25 metres **Width:** 12-18 metres **Description:** Large narrow-domed tree, with ascending branches on a solitary trunk. Box like bark can vary from smooth to rough all the way down the trunk often in different colourings from grey, yellow to brown. Sometimes very dark and rough. Light green to grey or bluish, narrow foliage. White flowers in spring to summer. Adaptable to a range of soils, including heavy clay. Prefers well-drained; not tolerant of waterlogged soils. Species usually found on lower slopes and plains, on sandy or loamy alluvial soils. High drought tolerance. Common species in the grassy woodlands of the tablelands and western slopes of the Great Dividing Range.	
Name: Grey Box (*Eucalyptus microcarpa*) **Height:** 18-25 metres **Width:** 12-18 metres **Description:** Large tree with an open, spreading crown. Bark greyish, rough and finely fissured over most of the trunk; upper limbs smooth. Narrow, leathery, dull olive-green leaves. White flowers held in clusters. Adaptable to a range of soils, including heavy clay. Prefers well-drained; not tolerant of waterlogged soils. High drought tolerance. Species usually found on lower slopes and plains, on sandy or loamy alluvial soils.	
Name: Red Stringybark (*Eucalyptus sideroxylon*) **Height**: 18-25 metres **Width:** 12-18 metres **Description:** Narrow tending to spread into a rounded open crown with age. Dark rough bark hard and furrowed which is typical of Ironbark's. The bark is persistent and deep brown to black in colour. The foliage is dull, greyish-green to blue-green in colour. White or pink flowers in winter/spring. Species adaptable to a wide range of soil conditions, from heavy clay to sand. Tolerates alkaline soils and poor, shallow soils; typical of its natural range. Prefers well-drained soils, no tolerant of waterlogged soils. High drought tolerance.	

Name: Holm Oak (*Quercus ilex*) **Height:** 18-25 metres **Width:** 12-18 metres **Description:** Large broad-domed tree with a solitary trunk and a dense crown of grey-green, holly-like leaves. Dark-grey to black, finely cracked bark. Inconspicuous flowers followed by acorns. Holm Oak will tolerate many climatic and soil extremes in south-eastern Australia. Adapts to most soil textures. High drought tolerance. Slow growing.	

Trees to use under electric lines

Deciduous

Crimson Sentry Norway Maple (*Acer platanoides* 'Crimson Sentry')

Sioux Crepe Myrtle (*Lagerstroemia indica* x *L. fauriei* 'Sioux')

Tuscarora Crepe Myrtle (*Lagerstroemia indica* x *L. fauriei* 'Tuscarora')

Purple-leaf Cherry-Plum (*Prunus cerasifera* 'Nigra')

Upright Purple Leaf Cherry Plum (*Prunus cerasifera* 'Oakville Crimson Spire')

Evergreen

Harkness Bottlebrush (*Callistemon* 'Harkness')

Weeping Bottlebrush (*Callistemon viminalis*)

Red-flowering Gum cultivars (*Corymbia ficifolia* 'Wildfire' and 'Wild Sunset')

Fuchsia Gum (*Eucalyptus dolichorhyncha*)

Euky Dwarf Yellow Gum (*Eucalyptus leucoxylon* 'Euky Dwarf')

Round-leaf Moort (*Eucalyptus platypus*)

Tucker Time® Honey Pots™ (*Eucalyptus wimmerensis* 'Honey Pots')

The other listed small trees could be planted under electric lines but would require pruning when they aged to maintain clearances.

Other species to consider trialling for streets:

Salmon Gum (*Eucalyptus salmonophloia*)

Grows well near Deniliquin and could be trailed in Hindmarsh

Slender Pine (*Callitris glaucophylla)*

Can currently be found on roadside between Jeparit and Rainbow and could suit planting in streets

Other species to consider trialling for parks:

Red Capped Gum (*Eucalyptus erthrocorys*)

Irregular form so not suited to streets, but could suit parks.

Lemon Flowered Gum (*Eucalyptus woodwardii*)

Very weepy habit and fickle growth habit so not suited to streets but could trial in parks.

Smooth barked coolabah (Eucalyptus Vitrix)

Irregular form, usually more straggly large shrub form not suited to streets but could trial in parks.

Peppercorn Trees (Schinus molle)

Already planted in parks. Perform well. Not suited to streets due to large mature size and seed drop.

Image references:

Holliday, I. c/o Dahms, R. (2009) Russell Dahms Westflora. As seen at: https://www.flickr.com/photos/westflora. [Accessed: 10/5/2018]