Urban Forest Strategy

City of Darebin

Contents

1. Summary

The Urban Forest is an integral part of Darebin contributing environmental, amenity, human health and well-being benefits. Given the current pressure on our 'green assets' due to climate change, medium density development and maintenance requirements, a focused effort is required to ensure the ongoing success of our Urban Forest.

The Urban Forest Strategy will increase liveability and provide a greater 'connection to nature' by building partnerships with the community and other key stakeholders to explore opportunities for planting in the City of Darebin.

2. Introduction

2.1 Purpose and How to use this Document

The Urban Forest Strategy is a strategic document that will facilitate greater collaboration with the community, support and inform Council staff in the planting and management of trees in Council and public land. Additionally, the strategy provides information for community members interested in understanding Council's methodology in the management of the Urban Forest.

The Strategy is divided into two main sections, the current Urban Forest and the implementation section. The implementation section is divided into three main sections; the first relating to maintaining and protecting the Urban Forest in the future, the second relating to planting opportunities and the third relating to monitoring canopy coverage.

Each section contains actions that will inform and guide the Council, in partnership with the Community, to achieve the Goals of the Urban Forest Strategy.

The appendices provide additional, relevant, information should it be required.

2.2 What is the Urban Forest?

The Urban Forest is comprised of trees, shrubs and other vegetation on both public and private land within the City of Darebin. Trees are a major component of the Urban Forest and are the focus of this Strategy. Trees and other vegetation are significant assets in urban areas providing environmental, health, social and economic benefits. Darebin focuses on the strategic management of the tree population in addition to the management of trees on an individual basis.

2.3 Benefits of the Urban Forest

The Urban Forest provides a diverse range of benefits in the categories of climate improvement, human health and well-being, environmental, landscape, cultural heritage values and economic benefits. Larger trees provide greater benefits and advocating for the provision of sufficient space for these types of trees within the City of Darebin is an important priority.

Health and Well-being benefits

Providing a green, tree lined streetscape can encourage people to choose active modes of travel, such as walking and cycling. As a result there are proven benefits for individuals with exercise linked to improved human physical and mental health.

The presence of trees, particularly mature trees, has the ability to cool highly urbanised areas leading to improved health benefits. Peak temperatures in summer can increase mortality rates in urban areas, particularly affecting unwell or elderly people.

Trees, as well as other landscape plantings, provide the community with a crucial connection to nature in an urban environment. Vegetated landscapes allow people to interact more with others, creating stronger social relationships. It can be essential in encouraging children to play outside as they feel safe and less anxious in a pleasant environment as compared to hard surfaced, noisy, car congested streets. Trees have a positive calming effect on people experiencing stress and anxiety.

Climate Improvement and Reducing Urban Heat Island Effect

Urban Heat Island Effect or local warming in developed areas is due to greater heat storage within cities associated with large amounts of hard surfaces (roads, roofs, buildings and car parks) and man-made heat sources. Tree shade and the transfer of water from plants into the air, both contribute to cooling of the local environment. Trees also provide shelter from the wind.

Trees reduce temperatures by 2-3 degrees by providing shading and reducing evaporation around tree canopies. Thermal imaging can be used to identify particular hot spots within the municipality.

Environmental benefits

Air quality

Urban vegetation can remove pollutants from the air including ozone, carbon monoxide, nitrogen dioxide and airborne and suspended particles. The economic benefits associated with these air quality improvements can be calculated using a software program (I-tree), which has been developed in the United States and is currently being calibrated for Australian conditions.

Carbon Reduction

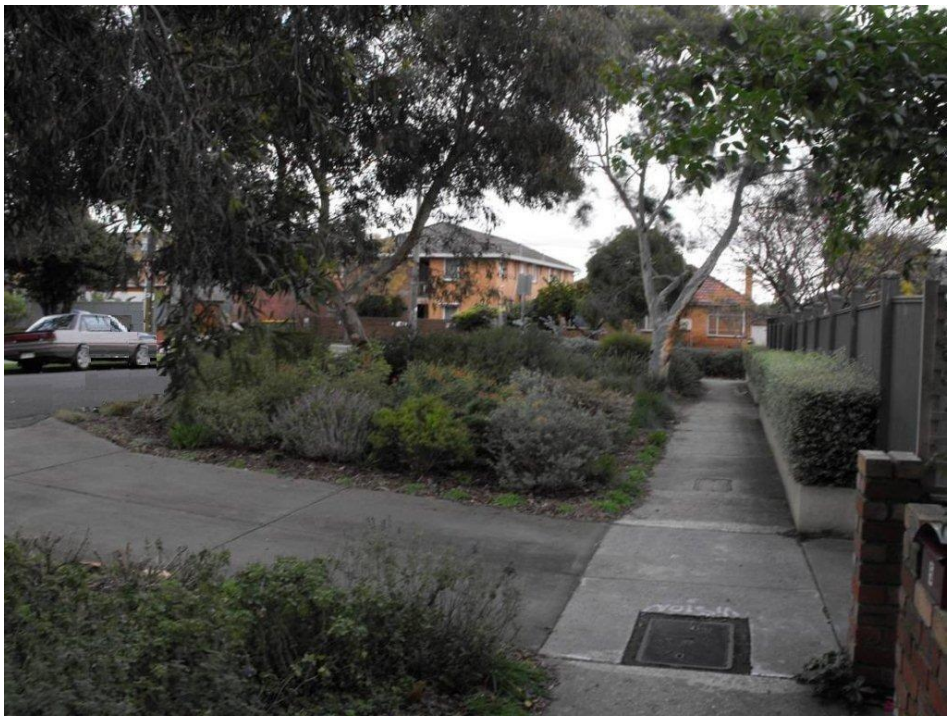
Carbon Reduction associated with the Urban Forest can be achieved both by direct (accumulation and storage) and indirect (reduced power consumption) mechanisms. Trees accumulate and store carbon as they grow. However, the carbon stored in trees is not indefinite and tree death leads to the eventual release of stored carbon. Therefore, the net long-term dynamics of carbon stored by the Urban Forest varies as trees grow, die and decay. Carbon storage rates will decline as the Urban Forest matures, as more carbon is lost through tree mortality than the accumulation through tree growth. Increasing the number of trees within Darebin will increase the cumulative carbon storage; however how Council manages its tree population in considering species, age, size and health will ensure optimum outcomes are achieved. Park trees are likely to have a better potential for long term carbon storage than street trees, due to more above and below ground space available for tree growth in these landscapes.

Indirect carbon benefits include energy savings from reduced cooling requirements due both to shading of buildings and urban heat island reduction. Shading of

buildings can reduce the energy used to cool the indoor space. Species selection and planting location affect the extent of shading and reduction in temperature. Traffic volumes influence Melbourne's daily pattern of carbon dioxide emission. Street trees provide more shaded and aesthetically appealing streetscapes and encourage people to walk, cycle and catch public transport rather than drive cars.

The following picture shows a barren landscape in Strathmerton Street Reservoir.

The picture below clearly shows the positive results achievable by good planting in Clyde Street Thornbury.



Stormwater Management
Stormwater management is an important service that street trees and vegetation can deliver. Urban vegetation plays a key role in reducing the effects of stormwater on local waterways by directing stormwater to vegetated landscapes helping to restore more natural water transfer patterns in cities. Water infiltration into the soil and water loss to the atmosphere is increased; therefore less stormwater runoff is generated and discharged to waterways. The speed of runoff entering waterways is also reduced minimising potential erosion. These systems can also reduce the amount of nutrients (nitrogen and phosphorus) and sediment entering the Darebin, Central and Merri Creeks. As climate changes, the impact of vegetation on stormwater run-off could provide large savings in terms of infrastructure construction costs in Darebin.

Urban trees are an important component of water sensitive urban design systems. Trees hold rainwater on their canopies which can be evaporated back into the atmosphere, significantly reduce the amount of water entering drains. Simple passive irrigation systems, more highly engineered bio filters, rain gardens or stormwater storage and reuse systems can be used to distribute stormwater to trees.

Multiple benefits can be achieved if stormwater is used to increase or restore soil moisture levels in vegetated landscapes. Greater plant growth (increased shade) and transfer of water from plants into the air can deliver local cooling for the community, as well as reducing the impact of stormwater discharge on the local waterways.

Biodiversity
Biodiversity is encouraged by planting avenues and groups of trees that provide homes and a food source for birds, animals and insects. The Urban Forest can encourage biodiversity in the municipality by providing links and expanding areas of natural habitat. The presence of locally native trees within the Urban Forest maintains the genetic diversity of these species. Parks and open space areas offer the best opportunity to grow a range of native plant species. Streetscapes within Darebin can provide habitat links between open spaces areas including the existing railway and creek corridors.

Landscape benefits
Trees soften the built landscape and provide an emphasis to seasonal changes, offering a variety of colour, form, texture and pattern. They provide a sense of scale, link and unify landscapes.

Cultural Heritage benefits
The City of Darebin is proud to acknowledge that we are located on and share the traditional lands of the Wurundjeri.
Council acknowledges the significant contributions of the Wurundjeri people and Darebin's Aboriginal and Torres Strait Islander residents in preserving and enriching our past and living Aboriginal culture and heritage. The Urban Forest Strategy supports and encourages good stewardship of the natural environment and the concept of 'caring for country'.

Economic benefits
Tree lined streets have been found to increase property values and also increase shopping activity in retail areas.

2.4 Strategic Framework
The strategic framework of this Urban Forest Strategy is shown in Figure 1.

The Darebin Open Space Strategy 2007-2017 makes recommendations about development standards in open space, including additional tree planting for individual parks as part of park master plans. The Open Space Asset Management Plan covers the management of assets within Darebin.
The GreenStreets Strategy aims to increase the number of trees and percentage tree canopy cover in streetscapes throughout the City of Darebin. Darebin's Tree Retention Policy, as outlined in the GreenStreets Streetscape Strategy, relates to trees on Council Managed Land and protected trees on Private Land. The Policy provides a framework that reflects the City of Darebin's commitment to tree retention. The Policy also provides a rationale for decision making on tree assessments to ensure consistency in the management of park, street and protected trees in Public and Private Realm in the City of Darebin.

An Urban Forest Strategy considers the ongoing establishment and maintenance of the Urban Forest of the City of Darebin on both public and private land in its entirety.

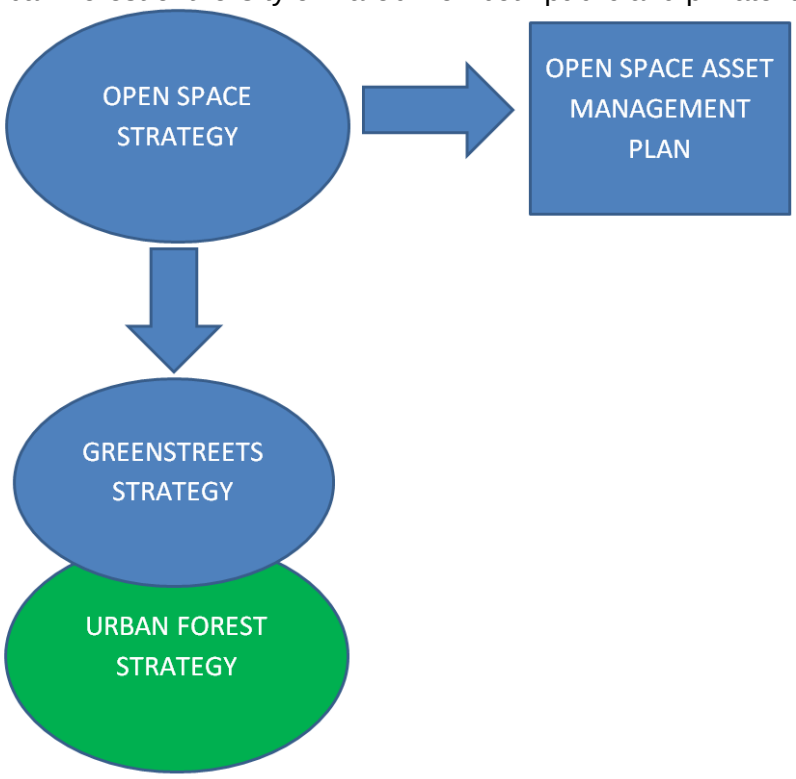


Figure 1 the strategic framework of this Urban Forest Strategy

3. Goals and Objectives

3.1 Goal

The Urban Forest Strategy will, in partnership with the community, increase liveability and provide a greater 'connection to nature' in the City of Darebin.

3.2 Objectives

The Urban Forest Strategy will:

- Develop and maintain a healthy, resilient, diverse and safe Urban Forest that will provide multiple and long-term benefits to the community and the environment
- Create a large scale community carbon reduction project through extensive community consultation and collaboration with community planting groups

- Aim to increase tree coverage on public lands to at least 25% over 15 years in the City of Darebin
- Act as a city-wide policy framework for tree planting and maintenance for Council departments, community based land management groups and other public land holders
- Increase indigenous and native tree diversity on public lands to enhance local habitats for native animals and birds

4. Darebin's Current Urban Forest

4.1 The Existing Urban Forest

4.1.1 Number of Trees and Canopy Coverage Percentage

The City of Darebin manages approximately 83,000 trees, 40,000 park trees and 43,000 street trees within the public realm. The Urban Forest also consists of an unknown number of trees in public utility land and private land.

The extent of canopy cover is an important indicator of the Urban Forest's ability to provide environmental and health benefits. To monitor changes over time, a baseline tree cover percentage needed to be established for the municipality. The Canopy Cover Project measured the percentage tree cover in a sample covering 20% of the municipality in late 2012. The sample was taken from each ward and was representative of the various landscapes across Darebin. This indicated a base level of 9.8%. The canopy cover on public land (13.8%) is higher than on private land (7.6%) and varies within the different land use zones.

			Area sampled	Canopy area	Canopy %
Public land			**3,945,749**	**544,792**	**13.8%**
	Roads		**1,970,783**	**222,432**	**11.3%**
		Streets in residential areas	1,065,538	155,089	14.6%
		Streets in commercial areas	268,142	17,641	6.6%
		Roads within Road Zones	637,102	49,702	7.8%
	Parks		**1,509,529**	**253,751**	**16.8%**
	Public utility		**465,438**	**68,608**	**14.7%**
Private land			**6,056,461**	**461,999**	**7.6%**
	Residential		3,834,868	397,219	10.4%
	Commercial		2,221,593	64,779	2.9%
City of Darebin - Percentage tree canopy cover					**9.8%**

The locations of planting opportunities in streetscapes were also identified by analysing aerial imagery in the Canopy Cover Project (Figure 2).

Figure 2 planting opportunities in Darebin's streetscapes have been mapped (purple circles)

4.1.2 Species Diversity

An Urban Forest with a diverse mix of species is necessary to provide more resilience against serious pest or disease attacks and during future climate change. The potential impacts of climate change on the Urban Forest are difficult to predict and monitoring the performance of a wide range of species will provide valuable information to guide future species selection. Both the number of species (genera and families) present plus the spatial distribution of these species within the municipality are elements of species diversity.

The City of Darebin currently plants a range of species, but accurate information on the current species diversity is not known. Darebin's current tree canopy consists of a mixture of natives and exotics including large numbers of Melaleucas, Water Gums, Melia, ornamental pears and Plane trees.

There can be a tendency to frequently plant a limited number of species that perform well in urban areas. To ensure adequate diversity of the species, genus and family is achieved over time, Cities of Melbourne and Sydney have recently set targets for their Urban Forests (Table 1). Such forest diversity targets should not apply to natural areas.

Table 1 Forest diversity targets set by other municipalities

Maximum percentage of forest to be any one	City of Melbourne (by 2030)	City of Sydney
Species	5%	10%
Genus	10%	30%
Family	20%	40%

4.1.3 Age Distribution

For the Urban Forest to deliver consistent and long-term benefits to Darebin it needs to have a wide age (or perhaps more critically useful life expectancy) distribution. While accurate data is not available on the age distribution of Darebin's Urban Forest, it is estimated that there is a range of trees from newly planted, immature, mature and senescent. Historically, tree planting has tended to occur in particular suburbs as they have been progressively developed, so the age distribution is expected to be spatially clustered within the municipality.

4.1.4 Weed Species

The interpretation of weediness is specific to the context where the trees are being planted. Darebin is bounded by the Merri Creek to the west and the Darebin Creek to the east. Some streets and parks close to the Creeks may contain existing species that have weed potential.

4.2 Current Management Practices

4.2.1 Tree Planting

Tree planting in Darebin has occurred for many years and is evident by the large number of trees that line many streets and the thousands of park trees. Species are selected based on the "right tree for the right location" approach and the planting palette includes indigenous (local Australian native trees), Australian native and exotic trees. Tree planting is undertaken between April and September each year. Tree planting within Darebin occurs through a number of different programs and community involvement is encouraged (Table 2).

The main planting program is the capital works funded street tree planting program which aims to plant approximately 1500 semi-advanced trees each year. These trees are mostly planted in nature strips within residential streets as part of street renovation planting. The annual planting program is determined by the GreenStreets Streetscape Strategy which is in part generated by resident requests for tree planting. Once a species is determined for a street, single or infill tree planting can occur to replace trees that require removal. The annual planting program also works in conjunction with Council's Road Reconstruction Program, including consultation for infrastructure changes and tree planting. In street renovation projects, trees in good condition with a medium to long useful life expectancy are generally retained. This transitional approach to street renovation planting, rather than replacing all trees, ensures that the reduction in canopy cover and loss of aesthetics in the short term is minimised. The retained trees are then replaced over time as they reach the end of their useful life. This may result in a less uniform landscape, however the maintenance of canopy cover over time is considered to be more important.

Trees are also planted into parks and open space areas each year, although the number of trees planted is not accurately known. Trees in parks are planted through several programs:

- Tree planting in general parks that are not part of any development plan is undertaken as operational works. Parks maintenance staff record if a tree is removed and a replacement tree is generally planted in the following planting season.
- Where a park is part of a capital works upgrade, such as the Pocket Parks or Play Space upgrade programs, tree planting is always considered in the planning process.

- Trees in Bushland areas are planted in large numbers often with the help of community groups and school groups. Generally these trees are mass plantings with very small stock used such as tube stock.

Table 2 Summary of tree planting in Darebin

Tree location	Program	Description	Approximate number planted each year	Community notification / consultation
Streets	Capital works (GreenStreets, including Road Reconstruction)	Whole street renovation, semi-advanced stock	1500	All residents in the street consulted on species selection (vote on 3 options)
	Operations (Infill or single tree planting)	Minor infill planting in streets with obvious dominant species, semi-advanced stock	300-500	Resident adjacent to tree planting location notified
Parks	Capital works	Tree planting considered in the planning process of upgrade projects, typically semi-advanced stock	400	Community consultation meetings as part of Master Plan development (Public Realm Unit)
	Operations	Replacement planting of removed trees, semi-advanced stock	150-200	None
Bushland areas	Capital works	Mass planting, young stock	2200	Community involved in community planting days

4.2.2 Tree Maintenance

New street tree planting within the City of Darebin includes a 2 year post planting maintenance program which includes irrigation, mulch top up, weed control, formative prune and stake and water well removal. Trees are generally not irrigated by the City of Darebin after the post planting maintenance period (2 years).

The maintenance of established trees is typically limited to pruning. Cyclic pruning works to maintain clearances and ensure safety, tree health and structure are undertaken in block areas across the City. On average each block area is currently revisited every 3-4 years. Reactive pruning works and removals are also undertaken by Council.

4.3 Key Challenges

There are several key challenges to establishing and maintaining a diverse and resilient Urban Forest:

- Lack of detailed data on the existing tree population
- Climate change
- Risk management / Reducing infrastructure conflict
- Formative pruning
- Electric Line Clearance

4.3.1 Lack of detailed data on the existing tree population

The City of Darebin has an incomplete inventory on the urban trees that it manages. Information on the composition and condition of the Urban Forest is required for Council to manage the Urban Forest more strategically. Details on tree species, location, condition, useful life expectancy and recommended maintenance works are important for decision making and effectively managing the Urban Forest. Reliable and current information can be used to budget and prioritise works proactively rather than reactively. Species diversity and age distribution of the population can be monitored and managed over time to ensure continual benefits are provided to the community.

Actions

- Develop and maintain a complete inventory of the Urban Forest over the next two years

4.3.2 Climate Change

Urban Forests, like all ecosystems, will be affected by climate changes that include increases in global air temperatures, increases in atmospheric carbon dioxide concentrations, changes in the patterns and amounts of annual rainfall, more frequent and intense storms and changes in the frequency and severity of wildfires (IPCC, 2007). However, it is difficult to predict the impact that these changes might have on trees growing in cities.

The most significant factors likely to impact on species making up Urban Forests are increased temperatures, changes to rainfall patterns, greater storm intensities and droughts. The impacts of climate change on Urban Forests will not be uniform on either a national or global scale. This will make decisions related to planning and managing us difficult, as there will be few, if any, approaches that will apply globally, across a continent, or across a nation. Both Australian native and exotic species will be affected by climate change.

Research on the global distribution of cultivated plants suggests that temperature is an important factor in determining where species are grown. Broad-leaved, deciduous species, commonly planted as street trees in south-eastern Australia, such as elms (*Ulmus* spp.), planes (*Platanus* spp.) and Pin Oak (*Quercus palustris*), are also commonly grown in cities cooler than Melbourne (Kendal 2012). These species may be at the upper edge of their temperature envelope in Melbourne and are likely to perform poorer in conditions of increased temperatures predicted with future climate change. To maintain a successful Urban Forest, it will be important to monitor the performance of trees species and trial a range of new trees, particularly species from warmer and drier climates.

Appendix 7.2.1 lists some implications on the management of the Urban Forest during climate changes which are likely to be relevant to Darebin. While there is good reason for concern over the impacts that climate change might have on Urban Forest tree species, there are also reasons for optimism. Many species that are widely planted in cities are renowned for their wide tolerance ranges and they should cope with the level of changes in temperatures and rainfall that are projected for many cities.

Some trees in Darebin that are growing in the hotter end of their span of temperature tolerance are:

- Platanus x acerifolia (London Plane)
- Quercus robus (English Oak)
- Fraxinus ornus (Flowering Ash)

Some trees that are more tolerant to temperature rise that are being grown in Darebin are:

- Geijera parviflora (Australian Willow or Wilga)

Other common urban trees come from populations that have wide and extensive natural distributions. Careful selection and breeding, sourcing specimens growing on appropriate soils but from lower rainfall or warmer regions, should ensure that there are suitable selections to meet urban planting demands. Even if species' ranges are limited, there is an option to select different species from within a genus. This is the case with Eucalyptus and Acacia trees, where there are large numbers of related species occupying a broad range of habitats.

For many species, higher temperatures will allow more rapid establishment and growth if water is available. Rapid tree establishment is an advantage in many areas. Frost sensitive species may be grown more widely and easily. For species with temperature dependent fruit or seed set, higher temperatures may result in trees that flower but which do not produce fruits and seeds; this would be an advantage for street trees, due to less fruit/seed drop.

Actions

- Broaden tree species selection to develop a diverse Urban Forest, focusing on species from warmer and drier environments and including trial species
- Program developed to monitor and record performance of existing and trial urban trees under future changed conditions
- Explore alternative irrigation water supplies, particularly on-site or near site stormwater

4.3.3 Infrastructure Damage and Risk Management

Root growth

Tree roots can cause damage to public and private assets, such as fences, footpaths, kerbs and road pavements. Tree roots have also been used as scapegoats for other causes of infrastructure damage such as poor construction quality. The main issue with tree root infrastructure damage is limited available space for root growth; therefore matching tree size to planting site soil volume is important to avoid infrastructure damage. Root pruning and the installation of root barriers are two approaches for addressing infrastructure damage.

Tree roots that have been implicated in damage to hard structures are often pruned which can reduce the ongoing damage. However, this may only be a short term benefit as in most trees the pruned root will re-shoot generally near the severed end. Over time the root frequently reconstitutes approximately the same sized root as existed prior to pruning. An assessment of the likely impact of root pruning on the health of the tree should be undertaken before the roots are pruned.

Reactive type barriers are installed in response to infrastructure damage, often in conjunction with root pruning. These are used to protect footpaths or fences and are usually linear barriers. Mesh products, made of plastic or copper, can be effective as roots that grow through the mesh are constricted by the small holes.

Actions

- Continue to match species selection to available space to avoid infrastructure and tree conflicts
- Advocate for adequate above and below ground space tree in development areas for tree growth
- Advocate that hard infrastructure is built sufficiently strong to sustain movement associated with soil drying and tree root growth (e.g. reinforced footpaths and driveways)
- Continue to install root barriers where particular circumstances dictate this to be the most effective method of avoiding infrastructure damage.

Tree or Branch Failure

Branch or complete tree failure can cause damage to people or infrastructure assets. In the past, management of hazardous trees has been reactive rather than proactive as risk assessments have not been undertaken on Darebin's tree population. The absence of detailed information on risk potential and works required on trees within Darebin's Urban Forest means that cyclic pruning works are prioritised based on geographical areas rather than targeted risk management.

Action

- Collect data on risk assessment and recommended works for individual trees as part of the inventory
- Increase resource allocation for cyclic pruning programs to manage risk

4.3.4 Formative Pruning

Formative pruning in the first few years after planting is often essential to achieve a well-structured tree and is an effective strategy in reducing long-term tree maintenance costs. This practice involves the selective removal of stems and branches early in a tree's life in order to create a safer, stronger structure. It is an effective risk reduction measure.

Pruning should only remove enough living material so that a tree's growth can be directed and correct structure attained; this is determined by the species. The result of formative pruning over the first 1-10 years of the tree's life (depending on speed of growth) should be a well-structured tree, with few to no faults.

Action

- Develop a Darebin Practice Note to establish formative pruning works to improve tree structure and minimise risk of branch failure
- Review the post planting establishment period of trees and allocate sufficient resources to undertake formative pruning at time of planting, after 2 and 5 years

4.3.5 Electric Line Clearance

The maintenance of trees near power lines is more challenging following the introduction of the *Electricity Safety (Electric Line Clearance) Regulations 2010*.

Periodic pruning of trees near power lines is required to maintain the minimum specification for clear space. To ensure compliance all street trees will require pruning on a 2 year cycle in contrast to Darebin's current 3 year cycle.

These regulations require in some instances severe pruning of the tree to maintain compliance. The clearance ranges from 300mm for aerial bundled cable to 3.5m clearance for 66kV high voltage lines. This has an impact on the aesthetics and amenity of the tree and the entire streetscape.

To reduce the long term requirement for electric line clearance pruning, the City of Darebin is planting smaller sized trees under power lines. In some areas this will result in reduced canopy coverage as large trees will be replaced with small trees.

Action

- Allocate resources to move to a cyclic (2 year) electric line clearance program to achieve and maintain compliance
- Advocate for the review of the specified clear space surrounding power lines to ensure the risk and benefits of trees in the urban environment have been adequately considered
- Advocate for the use of aerial bundled cable (ABC) and preferably underground cabling of electric wires wherever possible
- Continue to plant small sized trees under electric wires whilst acknowledging that these trees will contribute less to Darebin's canopy coverage

5. Implementation

5.1 Planting Opportunities

Opportunities exist to plant trees on public land managed by Council, Public utility managed land and private land. The City of Darebin will advocate for more tree planting to occur on land that it does not manage.

5.1.1 Community Engagement

Success or failure depends on community support for Councils' programs and involvement in community initiatives. Involving the Darebin community in tree planting and maintenance will help to strengthen the view that trees are an important community resource. Planting days provide an opportunity for residents to get involved and foster a greater sense of ownership. Educating the community on the benefits of trees is an important aspect of this Strategy. Australia's Aboriginal concept of 'Caring for Country' is of great relevance as a concept of good stewardship of the land we are living on.

Planting days are often undertaken with the help of community groups in bushland areas. The City of Darebin typically runs about 15 community planting days each year with various school or friends groups.

Opportunities for community involvement should be explored for areas of under-utilised public land. The community can be asked to nominate areas for potential tree planting projects. If the nomination is appropriate the project could be handed over to a community based group under Council supervision to manage. If the areas

designated aren't on Council land, Memoranda of Understanding with public utilities would need to be developed in order to facilitate this.

There is a wide range of community organisations in Darebin who could participate in and take ownership of the expansion of the Urban Forest. These include:

- Creek coordinating committees
- Aboriginal groups
- Ethnic groups
- Schools
- Religious groups
- Service organisations

Actions:

- Continue to consult the community on species selection for streetscape planting
- Continue to facilitate community planting days and investigate opportunities for further community engagement with tree planting projects
- Develop a community tree planting project nomination system
- Encourage the active participation of Darebin community groups in planting projects

5.1.2 Streets and Parks

Tree planting opportunities on Council managed land have been identified for future planting. Vacant planting sites within streetscapes have been plotted using an aerial image and exist as two layers on Council's GIS system. These planting sites have a minimum setback of 10 metres from intersections and 2 metres from vehicle crossovers. Generally one tree is planted in front of each property unless it is double-fronted or there is clearly sufficient space for additional trees. More than 13,000 vacant planting sites have been identified in streetscapes across the municipality. There is also an opportunity to provide habitat links for native animals by planting suitable vegetation.

Actions:

- The planting program will be informed by priorities outlined in section 5.1.5
- Tree species selection will aim to plant as large a tree as possible for each location to achieve the canopy cover targets
- Tree planting opportunities in parks will be identified in Master Plan or site specific plans undertaken as part of park improvement projects

5.1.3 Public Utility Land

Opportunities exist to plant trees and increase the canopy cover in public utility land across the municipality. The City of Darebin will continue to advocate for the Urban Forest and build working relationships with Statutory Authorities, including Vic Track, Vic Roads, Melbourne Water, Department of Education and Early Childhood Development. By working collaboratively with these land managers, opportunities to encourage planting in areas such as redundant road reserves, utility corridors, school grounds, arterial roads and rail corridors will be pursued. There is also an opportunity to provide habitat links for native animals by planting suitable vegetation.

Actions:

- Act as an advocate for Darebin's Urban Forest and encourage the allocation of sufficient spaces for trees

- Engage with authorities that manage public utility land with a view to establishing Memorandums of Understanding in relation to tree planting

5.1.4 Private Land

Private open space can provide an important contribution to the City of Darebin's Urban Forest, both due to the area of this land ownership type and low existing canopy cover. The Canopy Cover Project found that 61% of the area sampled was private land and the average tree canopy cover (residential and commercial) was only 7.6%. Council has an important role to encourage planting and protection of trees within the private realm wherever possible.

Actions:

- Continue to maximise tree planting offsets within the planning permit process to compensate for tree removals undertaken as part of development on private property.
- Educate the community on the importance of canopy trees and increasing the canopy cover.
- Provide incentives for tree planting on private land, e.g. a program of donating trees to property owners.

5.1.5 Prioritise Planting

There are many opportunities within Darebin to plant trees. GreenStreets Streetscape Strategy outlines that Council will not plant more trees than it has the resources and equipment to maintain and that consideration will be given to increasing resources as the Urban Forest grows.

Tree planting needs to be prioritised to assist with achieving the targets set within this strategy. The limited resources available for planting, establishment and maintenance of trees also necessitate that some areas are given precedence for tree planting. While streetscapes will continue to be planted in response to resident requests, other priorities for the Urban Forest will also be considered and prioritised:

- Pedestrian and bicycle priority areas, to increase shade and amenity
- Areas where there is sufficient space for large canopy trees, as large trees deliver more benefits than small trees
- Areas with alternative irrigation water supplies, particularly on-site or near site stormwater that could be utilised for tree irrigation, to maximise tree growth and transpiration cooling benefits and protect waterways
- Hot spots within Darebin, to deliver health benefits from lowering peak summer temperatures
- Areas where shading of buildings will provide an indirect carbon benefit by reducing carbon emissions associated with air conditioning
- Areas that may enhance local natural biodiversity

Actions:

- Identify high priority areas for planting that will achieve multiple benefits for Darebin and maximise the contribution to achieving the canopy coverage target
- Obtain or undertake thermal imaging to identify hot spot areas within Darebin

5.1.6 Climate change minimisation and adaptation

The Urban Forest can reduce carbon dioxide emissions which contribute to climate change. Tree planting programs within Darebin will endeavour to maximise the direct and indirect carbon benefits of street trees.

The effect of a changing climate on the performance of tree species in Darebin is unknown. Monitoring and recording the performance of tree species over time will be central to understanding the impact of climate change on the Urban Forest.

Actions:

- Prioritise tree planting in locations that will encourage people to use public transport, ride or walk rather than drive a car
- Prioritise tree planting in areas that will provide shade and local cooling and reduce the carbon dioxide emissions associated with air conditioning
- Monitor the performance of Darebin's street trees in response to changed climate to inform future species selection
- Plant a diverse range of species to minimise risk
- Trial new tree species, in particular trees that originate from climates that are warmer and drier than Melbourne

5.1.7 Reduce conflicts between trees and infrastructure

Competition for space is often tight to locate the entire infrastructure (including trees) that is required within urban areas. This strategy highlights the importance of trees and advocates for space to be set aside for their establishment. This is particularly important for larger sized trees which provide the greatest benefits. Conflicts between trees and infrastructure is likely to be less of an issue in park and open space areas, than streetscapes, as there is more available space.

To maximise tree related benefits and minimise future maintenance requirements and risk, species selection will be based on the size of the planting site, both below and above ground. Overhead power lines generally prevent the planting of trees that have a mature height of 8m or more. City of Darebin will advocate for the use of underground and aerial bundled cabling of electric wires wherever possible.

Table 3 General below ground space requirements for trees (adapted from Gilman 1997)

Maximum tree size at maturity	Canopy Spread	Planting strip width	Planting area	Minimum distance from trunk to hard infrastructure (pavement or wall)
Small (<6m)	4m	1.0 – 1.3m	<9.5 m2	0.6m
Medium (8m)	6m	1.4m – 2.5m	10 – 18.5 m2	1.2m
Large (>12m)	10m	>2.5m	>18.5 m2	1.5m

Approaches to increase the available root zone volume for tree growth will be encouraged, particularly in capital works funded projects that involve replacing pavements. Some examples include:

- Desirable root growth conditions under pavements (suspended pavements over uncompacted soil, use of structural soils or plastic structural cells)
- Look for opportunities to return full concrete footpaths to grass nature strips and footpath under the Road Reconstruction Program
- Consider reducing road or footpath width
- The addition of kerb outstands in the road

To ensure that trees can be retained in Darebin with minimum damage to hard assets, the following is recommended:

- Footpaths should be constructed that are at least 100mm thick and are reinforced with steel.
- Services are placed as far away from the trees as possible, particularly potable and stormwater pipes. This can be achieved by burying them deep in the soil. The soil on top of the pipe should be compacted as much as possible after the pipe has been installed to reduce potential root growth into the area.
- Engineering requirements for all residential buildings, walls and concrete slabs should be improved to take into consideration the drying effect that trees can have on the soils. Foundations may require higher concrete strength or an increase in installation depth (to stable subsoil).

Actions:

- Continue to plant small trees under electric lines to reduce long term maintenance requirements
- Advocate for hard infrastructure to be designed and built adequately so that it is not affected by trees in the vicinity
- Maximise above and below ground space allocated for tree growth in redevelopment projects

5.2 Maintain and Protect Existing Urban Forest

5.2.1 Data on the existing Urban Forest

To strategically manage the Urban Forest an inventory of publicly owned trees is required. The inventory should contain information on tree species, age, condition, risk assessment and necessary pruning works. This will ensure Council has a detailed understanding of the condition and risk potential of all publicly-owned trees.

Actions:

- Develop and maintain a complete inventory of publicly owned trees that is included in Darebin's GIS system
- Prioritise pruning program based on risk assessments to effectively manage risk
- Review the species diversity, spatial and age distribution of trees within Darebin to inform future tree planting programs

5.2.2 Tree protection

The protection of existing urban trees during development and construction works is important to avoid a decline in Darebin's existing tree population. Effective collaboration and knowledge transfer between the planning, engineering and parks departments within Council is important to ensure trees are protected.

A number of planning schemes exist to protect significant trees within Darebin. Native vegetation is protected under a particular provision. A number of planning overlays exist (Vegetation Protection, Environmental Significance and Heritage Overlays) to protect some of Darebin's significant trees. A brief summary of the trees that are currently protected is provided in each instance. This information is provided as a guide only and a current copy of the planning scheme should always be consulted for the planning provisions affecting a particular location. There is

currently no Darebin-wide tree protection in either local law or Vegetation Protection Overlay form.

Tree protection guidelines outlined in *Australian Standard AS 4970 Protection of Trees on Development Sites* should continue to be enforced. Reinforcing the importance of trees and providing copies of the 'Tree Protection Guidelines' to new planning and engineering staff will assist with protecting the existing Urban Forest.

In relation to buildings and works near trees, in some cases these can be accommodated within the tree protection zones; however the construction method may need to be altered (Where the depth of soil excavation is an issue, reinforced concrete may minimise the excavation depth and achieve the desired outcome).

Table 4 Alternative construction techniques to reduce construction impact on trees

Construction	Alternative construction technique
Structures requiring footings, such as buildings and walls	• pier and beam structures • stumps • screw piles • cantilevered or lightweight walls
Driveways and impervious surfaces	• porous paving, concrete or asphalt • permeable paving • raised boardwalks

Council will develop a register of significant trees located within the City of Darebin. Community members will be asked to nominate individual or groups of trees on private or public land that will be considered for inclusion on the register. The National Trust Significant Trees criteria will be used to assess trees nominated for inclusion on the register. Property owners would be consulted if the significant tree is located on private land. This process of identifying significant trees will encourage community engagement with the Urban Forest. It will also aim to educate the community on the importance of trees and increasing the canopy coverage. The register of trees will also inform future processes for protecting significant trees on private land.

At present, trees on private land are not adequately protected. Council may consider in the future introducing greater control over the protection of trees on private land. Any municipal wide tree protection mechanism will require funding to develop and maintain.

Actions:

- Council will advocate for the protection and proper maintenance of trees within the Urban Forest
- Council will review and update trees protected under the VPO and HO approximately every 10 years
- Council will develop a significant tree register of trees on private land

5.2.3 Water availability for tree health and local transpiration cooling

Maintaining the health and condition of Darebin's mature large canopied trees is important to achieve the goals of this Urban Forest Strategy. Extended periods of drought conditions, like those experienced in Melbourne from 1997-2009, can have a

negative impact on tree health. Tree health decline can result in a reduction in canopy coverage and even tree death.

There are a number of methods to minimise water deficit stress experienced by urban trees. Mulching tree root zones reduces water loss due to evaporation and for trees growing in turfed areas lowers the competition for water between trees and the grass. Supplying supplementary water to the trees will also reduce water deficit stress.

Recharging root zone soil moisture throughout the year is an important tool for maintaining tree health during drier periods and achieving transpiration cooling benefits. As well as reducing water stress in the urban tree population, retaining more runoff water within the landscape will contribute to improving the condition of the local receiving waters, particularly the Darebin and Merri Creeks and Port Phillip Bay.

Actions:

- Council will mulch the root zones of mature trees where appropriate
- Council will explore opportunities to secure access to non-potable water sources (stormwater and treated waste water) for landscape irrigation where possible including stormwater harvesting and storage as well as passive stormwater irrigation systems

5.2.4 Pest and Disease Control

Managing significant pests and disease attacks is important to maintain the canopy coverage of the existing Urban Forest. This will involve monitoring, containment and treatment. Control of Elm Leaf Beetle infestations will continue on an as required basis.

Myrtle Rust, a serious fungus disease, was detected in Victoria in late 2011. It is unclear what effect it will have on the many species within the Myrtle family that are common street tree species. Maintaining a diverse street tree population will help to minimise the potential impact of Myrtle Rust, or any new pest or disease, on Darebin's Urban Forest.

Actions:

- Establish and maintain a diverse tree population so that the Urban Forest is less vulnerable to pest and disease attacks
- The City of Darebin will monitor, contain and treat any significant pest and disease attacks

5.2.5 Tree establishment

Tree establishment planning and implementation is important to Urban Forest renewal. Trees are currently maintained for two years post planting. The item budget allocated for tree planting will be increased to include additional formative pruning at approximately Year 5. Investment in formative pruning of young trees will reduce future costs and potential liability from trees failing.

Actions:

- Provide funding to implement tree establishment program for trees planted in streets and parks

5.3 Monitoring change in canopy cover

The Urban Forest canopy cover will be reported every 4-5 years to monitor change over time and progress towards the target of 25%. A cost effective and efficient method for determining the canopy cover every 4-5 years will be developed. A working group will be established between the GIS TEAM, parks and public realm to develop this methodology.

This Urban Forest Strategy has set a target of increasing the canopy cover percentage within public lands to at least 25% by 15 years. To achieve this target the existing cover on public land (13.8%) will need to be approximately doubled. While it is not applicable to compare targets for different municipalities, the canopy coverage increase set in the 15 year timeframe is quite high relative to other municipalities (Table 5). Canopy coverage change over time in the public realm will depend on the balance between tree removals (in particular large canopied trees), canopy pruning for electric line clearance compliance, tree planting and establishment growth rates. Information needed to attempt to model these changes in the tree population over time is not currently available.

Table 5 Canopy cover targets set by other municipalities

Municipality	Existing Canopy Cover	Target Canopy Cover	Number of trees
City of Sydney	15.5%	23.25% (2030) 27.13% (2050)	42,000 (park and streets)
City of Melbourne (public realm)	22%	40% (2040)	

A number of techniques can be used to measure canopy cover. These techniques vary in the skill level required by staff, time taken to measure canopy cover and the cost for images and software. A cost effective and simple technique is preferred to enable periodic measurements of Darebin's canopy cover. Appendix 7.3 lists the various techniques for measuring canopy coverage.

Actions:

- Develop an internal working group to develop a methodology for monitoring canopy coverage
- Model expected change in canopy cover related to tree removals and planting to assess how achievable the target is

5.4 Measuring the Urban Forest Strategy

These indicators have been set to measure the Urban Forest Strategy (Table 6).

Table 6 Measuring the Urban Forest Strategy

Indicator	Desired Outcome	Timeframe	Target
Data on the Urban Forest	Develop information on the Urban Forest to monitor and strategically manage species diversity, age distribution and risk potential	2 years	Develop a street tree Inventory
Canopy cover	Increase the total tree canopy cover within the City of Darebin	15 years (2028)	Increase the total percentage of canopy cover of public land within Darebin by at least 25% in 15 years
Tree Protection	Reduce the number of trees that are inappropriately removed Ensure that trees are adequately protected from building and construction works	Ongoing	Review significant trees listed under Vegetation Protection Overlay and Heritage Overlay Develop a significant tree register (2013) Explore funding opportunities to establish and maintain a method for protecting trees on private land within Darebin Reinforce collaboration between Darebin's internal departments to ensure trees are protected

Indicator	Desired Outcome	Timeframe	Target
Resilient, healthy and well maintained Urban Forest	Develop and maintain a resilient, diverse and healthy Urban Forest	Ongoing	Set a target for species diversity within the Urban Forest that will inform the tree planting program (after inventory has been completed) Trial at least one new tree species each planting season and monitor performance Monitor, contain and treat any significant pest or disease attack Mulch or irrigate stressed trees to improve health Pruning undertaken according to Australian Standard AS 4373
Tree Establishment	Renewal and expansion of the Urban Forest. Establish an Urban Forest that requires less long term maintenance.	1 year	Include formative pruning of 5 year old trees Best practice tree establishment methods including formative pruning
Planting opportunities	Public authorities cooperate and work collaboratively with Darebin to increase tree planting and canopy cover on public utility land. Increased tree planting and canopy cover on private land	Ongoing	6 monthly meetings with the view to establish MoUs that capture common goals and objectives for increasing canopy cover Conduct a pilot program that offers an incentive (free plants) to plant trees on private land
Climate change minimisation and adaptation	Urban Forest achieves direct and indirect carbon benefits Urban Forest is resilient under changing climate conditions	Ongoing	Tree planting program prioritises areas that will deliver indirect carbon benefits Performance of tree species are rated under changed climate conditions and new species are trialled
Community Involvement	Community understand the value of urban trees and are involved in tree planting	Ongoing	Facilitate community tree planting days

5.5 Action Items

Section	Description	Action	Time Frame	Cost ($)
4.3.1	Lack of detailed data on the existing tree population	develop and maintain an inventory of the Urban Forest	2 years	$2.40 per tree (88,000 trees)
4.3.2	Climate Change	Broaden tree species selection to develop a diverse Urban Forest, focusing on species from warmer and drier environments and including trial species	Ongoing	
		Program developed to monitor and record performance of existing and trial urban trees under future changed condition	2 years	
		Explore alternative irrigation water supplies, particularly on-site or near site stormwater	Ongoing	
4.3.3	Infrastructure Damage and Risk Management (Root Growth)	Continue to match species selection to available space to avoid infrastructure and tree conflicts	Ongoing	
		Advocate for adequate above and below ground space tree in development areas for tree growth	Ongoing	
		Advocate for hard infrastructure, built sufficiently strong to sustain movement associated with soil drying and tree root growth (e.g. reinforced footpaths).	2 years / Ongoing	
	Infrastructure Damage and Risk Management (Tree or Branch Failure)	Collect data on risk assessment and recommended works for individual trees as part of the inventory	2 years	
		Increase funding for cyclic pruning programs to manage	1 year	

		risk		
4.3.4	Formative Pruning	Reinforce the formative pruning works to improve tree structure and minimise risk of branch failure	Ongoing	
		Review the post planting establishment period of trees and allocate sufficient resources to undertake formative pruning at time of planting, after 2 and 5 years	1 year	$50K for first year
4.3.5	Electric Line Clearance	Fund a cyclic (2 year) electric line clearance program to achieve and maintain compliance	Now	$1.2M per year
		Advocate for the review of the specified clear space surrounding power lines to ensure the risk and benefits of trees in the urban environment have been adequately considered	2 years	
		Advocate for the use of aerial bundled cable (ABC) and preferably underground cabling of electric wires wherever possible	Ongoing	
		Continue to plant small sized trees under electric wires whilst acknowledging that these trees will contribute less to Darebin's canopy coverage	Ongoing	
5.1.1	Community Involvement	Continue to consult the community on species selection for streetscape planting	Ongoing	
		Continue to facilitate community planting days and investigate opportunities for further community engagement with tree planting projects	Ongoing / 2 years	
		Develop a community tree planting project nomination system	1 year/Ongoing	
		Encourage the active participation of Darebin community groups in planting projects	Ongoing	
5.1.2	Planting Opportunities – Streets and Parks	The planting program will be informed by priorities outlined in section **5.1.5**	2 years	
		Tree species selection will aim to plant as large a tree as possible for each location to achieve the canopy cover targets	Ongoing	
		Tree planting opportunities in parks will be identified in Master Plan or site specific plans undertaken as part of park improvement projects	Ongoing	
5.1.3	Planting Opportunities – Public Utility Land	Act as an advocate for Darebin's Urban Forest and encourage the allocation of sufficient spaces for trees	Ongoing	
		Engage with authorities that	2 years	

		manage public utility land with a view to establishing Memoranda of Understanding in relation to tree planting		
5.1.4	Planting Opportunities – Private Land	Continue to maximise tree planting offsets within the planning permit process to compensate for tree removals undertaken as part of development on private property	Ongoing	
		Educate the community on the importance of canopy trees and increasing the canopy cover	2 years / Ongoing	
		Provide incentives for tree planting on private land. A program of donating trees to property owners will be considered	1 year / Ongoing	
5.1.5	Planting Opportunities – Prioritise Planting	Identify high priority areas for planting that will achieve multiple benefits for Darebin and maximise the contribution to achieving the canopy coverage target	2 years	
		Obtain or undertake thermal imaging to identify hot spot areas within Darebin	5 years	
5.1.6	Planting Opportunities – Climate Change minimisation and adaption	Prioritise tree planting in locations that will encourage people to use public transport, ride or walk rather than drive a car	1 year	
		Prioritise tree planting in areas that will provide shade and local cooling and reduce the carbon dioxide emissions associated with air conditioning	5 years	
		Monitor the performance of Darebin's street trees in response to changed climate to inform future species selection	Ongoing	
		Plant a diverse range of species to minimise risk	Ongoing	
		Trial new tree species, in particular trees that originate from climates that are warmer and drier than Melbourne	Ongoing	
5.1.7	Planting Opportunities – Reduce conflicts between trees and infrastructure	Advocate that trees are an essential asset within the City of Darebin	Ongoing	
		Continue to plant small trees under electric lines to reduce long term maintenance requirements, while conceding that these trees provide less benefits	Ongoing	
		Ensure hard infrastructure is designed and built adequately so that it is not affected by trees in the vicinity	Ongoing	
		Maximise above and below ground space allocated for tree growth in redevelopment projects	Ongoing	

5.2.1	Data on the existing Urban Forest – see also 4.3.1	Develop and maintain a complete inventory of publicly owned trees that is included in Darebin's GIS system	2 years	see also 4.3.1
		Prioritise pruning program based on risk assessments to effectively manage risk	2 years	
		Review the species diversity, spatial and age distribution of trees within Darebin to inform future tree planting programs	3 years	
5.2.2	Tree Protection	Council will advocate for the protection and proper maintenance of trees within the Urban Forest	Ongoing	
		Council will review and update trees protected under the VPO and HO approximately every 10 years	Ongoing	
		Council will develop a significant tree register for trees on private land	1 year	
5.2.3	Water availability for tree health and local transpiration cooling	The City of Darebin will mulch the root zones of mature trees where appropriate	Ongoing	
		The City of Darebin will explore opportunities to secure access to non-potable water sources (stormwater and treated waste water) for landscape irrigation where possible	3 years	
5.2.4	Pest and Disease Control	Establish and maintain a diverse tree population so that the Urban Forest is less vulnerable to pest and disease attacks	Ongoing	
		The City of Darebin will monitor, contain and treat any significant pest and disease attacks	Ongoing	
5.2.5	Tree establishment	Compile Tree Programs directed by needs derived from a tree inventory and sufficient to meet canopy cover targets	2 years	
		Adequate funding available to implement tree establishment program for all trees planted	1 year	
5.3	Monitoring change in canopy cover	Develop an internal working group to develop a methodology for monitoring canopy coverage	1 year	
		Model expected change in canopy cover related to tree removals to assess how achievable the target is	1 year	

6. Literature

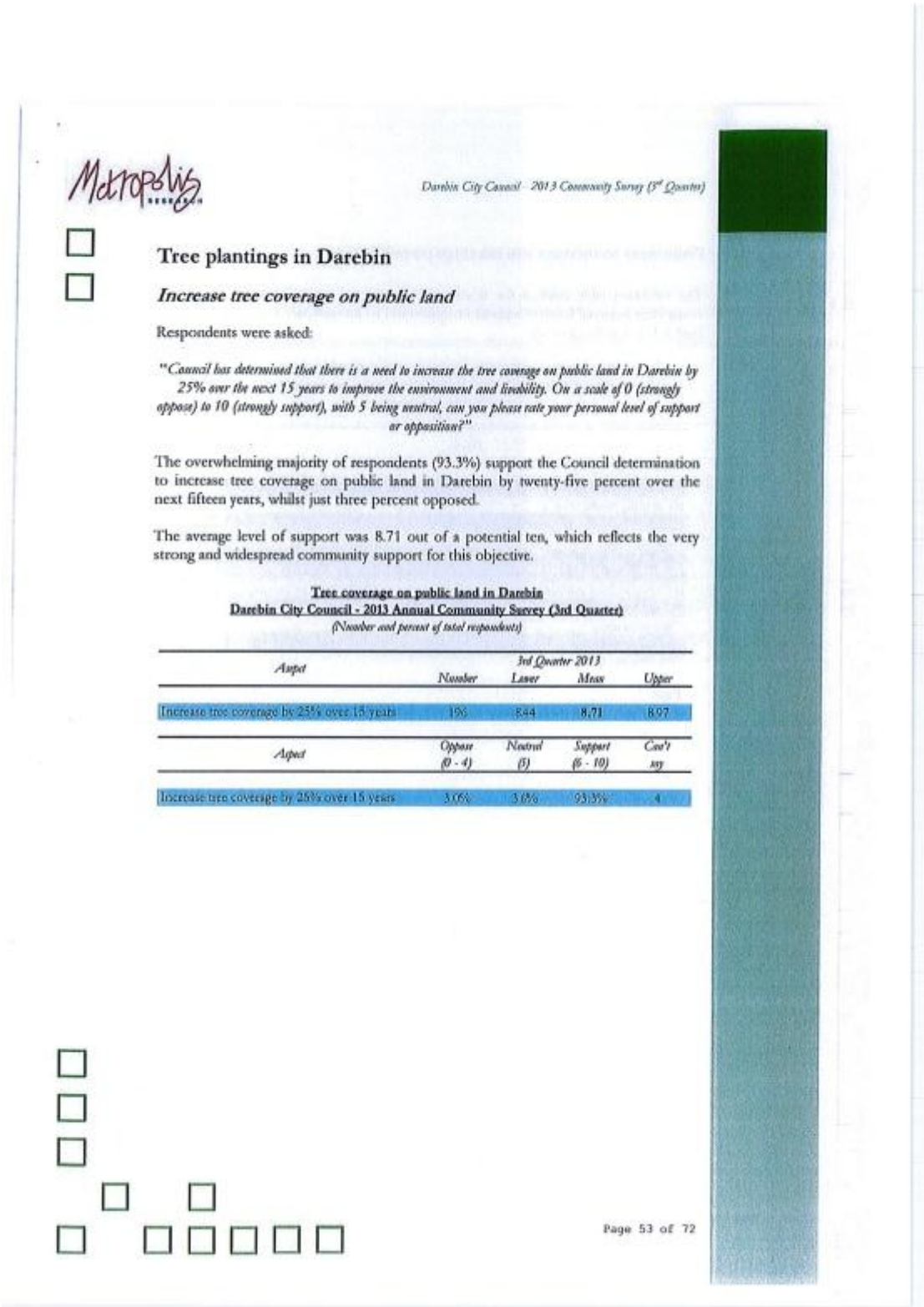
http://www.cityofsydney.nsw.gov.au/__data/assets/pdf_file/0003/132249/Urban-Forest-Strategy-Adopted-Feb-2013.pdf

http://www.portphillip.vic.gov.au/an_urban_forest_approach.pdf

Watson, G.W., 1994, Root development after transplanting, In *The Landscape Below Ground*, Paper presented to *International Workshop on Tree Root Development in Urban Soils*, Edited by G.W. Watson and D. Neely, International Society of Arboriculture, Illinois, pp. 54-68.

7. Appendices

7.1 Community Survey Results



Metropolis

Tree plantings in Darebin

Increase tree coverage on public land

Respondents were asked:

"Council has determined that there is a need to increase the tree coverage on public land in Darebin by 25% over the next 15 years to improve the environment and liveability. On a scale of 0 (strongly oppose) to 10 (strongly support), with 5 being neutral, can you please rate your personal level of support or opposition?"

The overwhelming majority of respondents (93.3%) support the Council determination to increase tree coverage on public land in Darebin by twenty-five percent over the next fifteen years, whilst just three percent opposed.

The average level of support was 8.71 out of a potential ten, which reflects the very strong and widespread community support for this objective.

Tree coverage on public land in Darebin
Darebin City Council - 2013 Annual Community Survey (3rd Quarter)
(Number and percent of total respondents)

Aspect	3rd Quarter 2013 Number	Lower	Mean	Upper
Increase tree coverage by 25% over 15 years	196	8.44	8.71	8.97

Aspect	Oppose (0 - 4)	Neutral (5)	Support (6 - 10)	Can't say
Increase tree coverage by 25% over 15 years	3.06%	3.6%	93.3%	4

Comments on increase tree coverage on public land

The following table displays the open-ended comments received from respondents rating their personal level of support or opposition to increase tree coverage on public land at less than 6 out of 10.

Comments regarding increase tree coverage by 25% over 15 years
Darebin City Council - 2013 Annual Community Survey (3rd Quarter)
(Number of responses)

Reason	Number
I don't know	3
It's ok if the council does it	2
Not that important	2
Waste of money	2
Footpaths and street and trees are too small and they were planted where we didn't want them	1
If you are planting more trees tree maintenance is required. Plant more native trees	1
Not a tree person, enough already which are not maintained properly	1
There is no need	1
Trees grow up and fall down and no one gives support from resulting damage	1
Trees that stay green	1
Total	**14**

Location for additional tree plantings

Respondents were asked:

"What type of locations would you like to see additional tree plantings?"

As is clearly evident in the following table, a large proportion of respondents identified many of the listed locations for additional tree plantings, with parks (65.5%) and streetscapes (64.0%) the most commonly identified.

Locations for additional tree plantings
Darebin City Council - 2013 Annual Community Survey (3rd Quarter)
(Number and percent of total respondents)

Response	3rd Qtr 2013 Number	3rd Qtr 2013 Percent
Parks	131	65.5%
Streetscapes	128	64.0%
Schools	85	42.5%
Along creeks	85	42.5%
Private open space	58	29.0%
Other	9	4.5%
Total responses	**496**	
Total respondents providing a response	*190 (94.7%)*	

Specific locations

Respondents were asked:

"Are there any specific locations within Darebin that you feel would benefit from more trees?"

The following table provides the open-ended list of specific locations identified by respondents as those within Darebin they felt would benefit from more trees.

Specific locations within Darebin that would benefit from more trees
Darebin City Council - 2013 Annual Community Survey (3rd Quarter)
(Number of responses)

Location	Number
Donath reserve	1
Houses	2
Johnston St shops	2
Parks and private opens spaces	2
Public parks and gardens	2
Along all roads	1
Along Bell St and Heidelberg Rd	1
Along Broadhurst Ave, like those around the area	1
Along streets	1
Alphington st	1
Anywhere, but not tall trees	1
Aside main roads as well	1
Basically everywhere	1
Bell St	1
Jessie Street park	1
Gilbert Rd	1
Everywhere because it's good for the environment and people	1
In front of my house - Northcote St. Right trees in the right places for the environment	1
Johnston Park and footpath	1
Leonard St	1
Midway road	1
Most of the streets, particularly the wider ones	1
Need more in Northern areas, like the ones in nice suburbs	1
Plenty Road	1
Residential streets	1
Supermarket carparks - need to stop people vandalising them	1
This street - more trees - Hartley street	1
Train station	1
Total	**34**

Free trees from Council

Respondents were asked:

"If Council was to give away free trees to residents, would you be interested in receiving a free tree to plant on your own property?"

Approximately two-thirds of respondents were either definitely (42.2%) or possibly (25.9%) interested in receiving a free tree from Council to plant on their property.

Receiving free tree from Council for planting on own property
Darebin City Council - 2013 Annual Community Survey (3rd Quarter)
(Number and percent of total respondents)

Response	3rd Qtr 2013 Number	Percent
Yes - definately	78	42.2%
Yes - possibly	48	25.9%
No or unlikely	59	31.9%
Can't say	15	
Total	**200**	**100%**

Local community working group

Respondents were asked:

"Do you think a local community working group to do the tree plantings is a good way to manage the planting of the goal of an additional 25% of trees in Darebin?"

The overwhelming majority of respondents considered community working groups was a good way to do the tree plantings necessary to meet the goal of a twenty-five percent increase in the number of trees.

Community working group is a good way to manage tree plantings
Darebin City Council - 2013 Annual Community Survey (3rd Quarter)
(Number and percent of total respondents)

Response	3rd Qtr 2013 Number	Percent
Yes	148	85.5%
No	25	14.5%
Can't say	27	
Total	**200**	**100%**

Participation in community planting working group

Respondents were asked:

"Would you be interested in participating in a community planting working group in your local neighbourhood if one was to be set-up?"

Almost exactly fifty percent of respondents were either likely or might participate in a local neighborhood community planting working group.

Participation in community planting working group
Darebin City Council - 2013 Annual Community Survey (3rd Quarter)
(Number and percent of total respondents)

Response	3rd Qtr 2013 Number	Percent
Yes - likely to participate	35	20.2%
Yes - might participate	52	30.1%
No - unlikely to participate	86	49.7%
Can't say	27	
Total	**200**	**100%**

7.2 Tree Protection

If development is planned near trees, the best way of protecting them is with the development of Tree Protection Zones (TPZs) introduced at the planning and design stage. Damage to trees during development can be direct and indirect. Direct damage includes mechanical injury to the trunk, the severing of roots, or alterations to the soil environment in the immediate vicinity of tree roots (i.e. compaction or loss of organic matter). Indirect effects of site development are usually related to soil hydrology. This includes alterations to soil moisture content, changes in the level of the water table and drainage patterns (Coder 1995).

TPZs should be calculated according to the AS 4970-2009, Protection of Trees on Development Sites. This method calculates the TPZ as 12 times the trunk diameter at 1.4m above ground level (DBH). The TPZ acts as a physical barrier of protective, chain mesh fencing that is a minimum of 1.8m high. It is erected around retained specimens (at the edge of the TPZ) before site works commence. See Figure 3.

Figure 3: TPZ fencing is erected around retained trees prior to site works.

7.2.1 Considerations when planning development near trees

There is no reason why development that is sensitive and sympathetic cannot proceed with minimal impact to protected trees. The following section outlines considerations when working near trees.

Building under canopies

For ease of application and to ensure the ongoing health of the trees it is recommended that building does not encroach on TPZs. Given the increasing pressure to build within the urban environment this is not always attainable. In some instances building close to trees is inevitable.

When considering the canopy of a protected tree it is important to remember that the TPZ is not a 2 dimensional measurement on the ground, rather a 3 dimensional space for the entire tree. Consideration of building type and height is required to ensure unacceptable amounts of canopy are not pruned.

It should be noted that species that are prone to Sudden Limb Failure are not good candidates for building under the canopy. This includes many eucalypts as well as exotic trees such as elms, oaks, poplars and several different conifer genera (Harris 1983)

Any pruning required to accommodate structures should be completed by qualified arborists and in accordance with AS4373-2007, Pruning Amenity Trees. It is acceptable for branches to overhang a structure; however, clearance of approximately 2m should be maintained.

Tree roots and root sensitive footings

It is important to have a basic understanding of tree root growth in order to minimise potential damage when planning structures near trees. Any tree root will grow where conditions are the most suitable; that is they will always grow through soil in the path of least resistance and they will continue to grow if soil conditions are favourable. If soil conditions are unfavourable root growth will be reduced and may even stop (Raven and Johnson 1992).

The majority of tree roots grow in the upper soil profile (the top 1.0m) and very few trees have large 'tap roots' (Shigo 1991). A tree's root system is wide and spreading rather than an upside down version of the above ground parts of the tree. Tree roots can commonly extend to 2-3 times the drip line of the tree or 1-2 times the height (Hitchmough 1994, Perry 1982, Pirone et al. 1988, Schnelle, Feucht & Klett 1989).

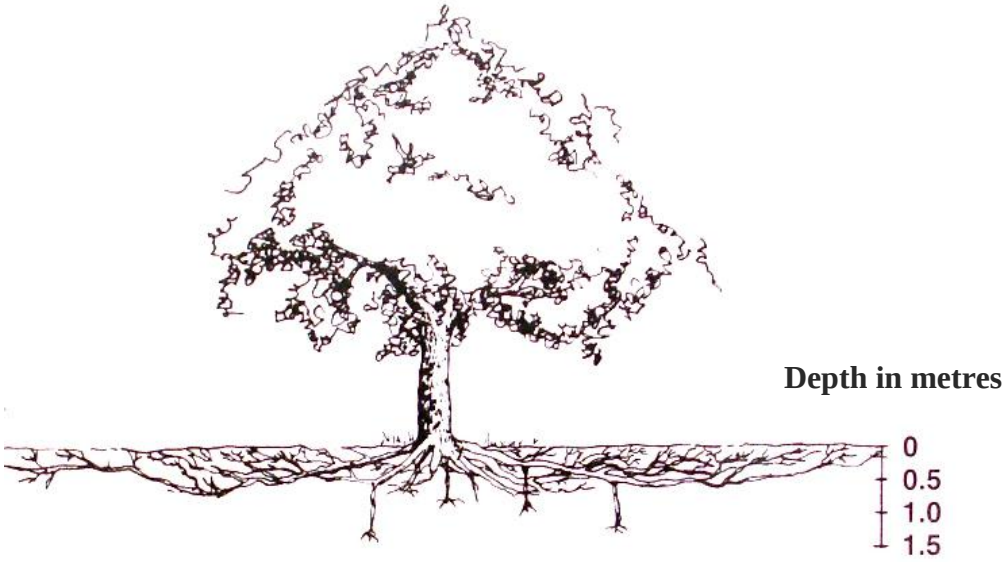


Figure 4: Modern view of a tree root system (Harris, Clark and Matheny 1999)

When constructing within the TPZ of any of the trees, consideration needs to be given to footing design. It needs to ensure sufficient strength such that the influence of the tree's roots won't affect the building and that the construction type and/or excavation required won't have a detrimental effect on the tree. Some root sensitive construction types include:

- Pier and beam designs, the beam must be set at or above grade
- Stumps instead of slabs
- Screw piles
- Cantilevered and/or lightweight wall construction closest to the tree

These types of construction should only be considered when designs changes to move the structure out of the TPZ have been exhausted.

Encroachment into TPZs

Although not desirable, it is possible to encroach slightly into TPZs. Encroachment of less than 10% of the TPZ and outside the SRZ is deemed to be minor encroachment according to AS 4970-2009. Detailed root investigations should not be required but must be compensated with an extension to the TPZ elsewhere. See Figure 5. Variations must be made by the project Arborist considering other relevant factors including tree health, vigour, stability, species sensitivity and soil characteristics.

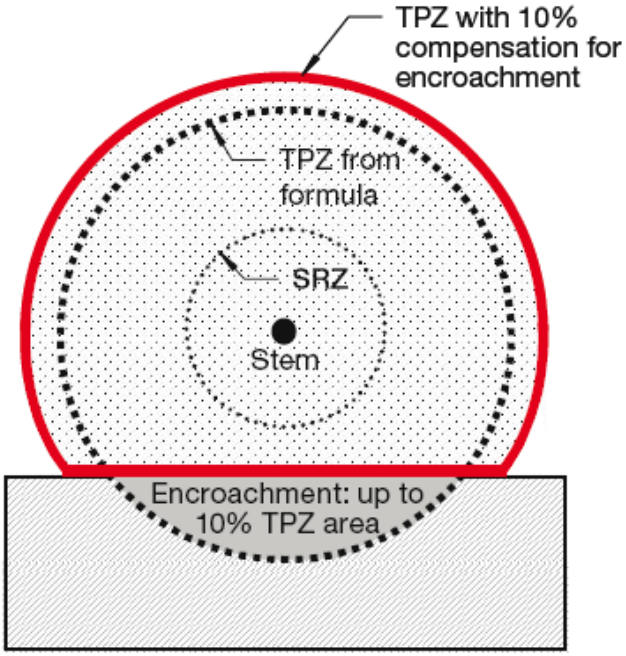


Figure 5: Example of TPZ encroachment and compensatory offset (image from AS 4970-2009)

Encroachment of more than 10% of the TPZ or into the SRZ is deemed to be major encroachment according to AS 4970-2009 and should be avoided as much as possible. The project Arborist must demonstrate that the tree(s) would remain viable with the proposed design and degree of encroachment. The area lost to this encroachment should be compensated for elsewhere and contiguous with the TPZ. This may require root investigation by non-destructive methods and consideration of relevant factors tree health, vigour, stability, species sensitivity and soil characteristics.

Tree care

All of the trees contained within this report are mature specimens and as such can be more susceptible to a decline in health from root damage than a young vigorous specimen. It is important to monitor tree health when changing their environment such as when buildings are constructed within TPZs.
The tree's TPZ should be mulched 75-125mm deep with organic composted mulch. Mulch has many benefits to plants including:

- Soil moisture conservation
- Soil compaction reduction
- Grass and weed suppression
- Reduction in soil erosion
- Soil structure improvements
- An increase in soil fertility

- Moderation of soil temperature on a diurnal and seasonal basis (Harris, Clark & Matheny 1999).

Depending on the time of year and how much rain has fallen, irrigation may also be required. If mulch has been around the root zone of the tree for several months, the infiltration rate should be quite high. The amount of irrigation and frequency to be applied should be calculated on a tree by tree basis. As a guide the irrigation volumes for large mature trees are likely to be 5000-10 000L of water or possibly more.

During any construction, the tree will require periodic monitoring by a qualified Arborist. Changes in the canopy foliage density, accrual of dead wood, general appearance and the emergence of fungal fruiting bodies can all be indicators of construction related decline. If identified early, many factors associated with the decline can be mitigated. If the tree is not managed, further tree decline and death is common (Figure 6).

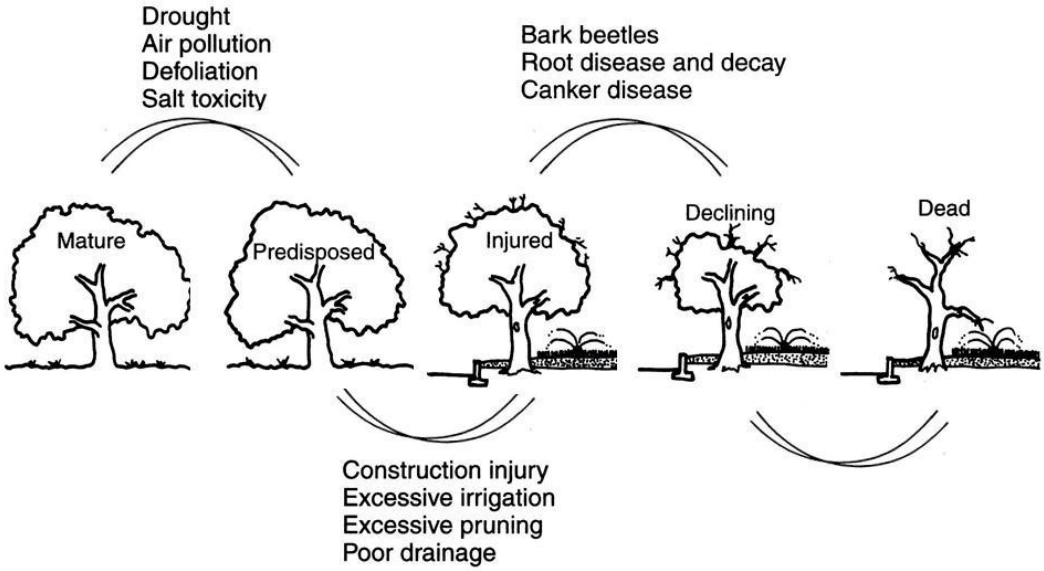


Figure 6: The 'mortality spiral' describes the process of decline from 'vigorous' to 'dead' as a result of specific biological, cultural and environmental factors (Taken from Harris, Clark and Matheny 1999).

Leaf, twig and fruit fall

Trees can shed many small twigs, leaves and fruits from time to time. In the case of deciduous trees, leaf fall in autumn can be significant. This type of 'Litter' is commonplace and any nearby structure should be designed to accommodate it. Cleaning of gutters and sweeping of paths etc. is considered ordinary home maintenance and not a valid reason for excessive tree pruning or removal.

The use of various gutter guarding products in conjunction with regular maintenance will reduce the incidence and severity of litter fall blocking drains etc.

Pruning near trees

All trees listed within VPOs are significant for their link with the heritage of the site and the impact that they have on the surrounding landscape. Pruning may be required from time to time and it is important that the pruning does not change the overall shape and appearance of a tree.

Removal of deadwood, reducing branches that interfere with infrastructure and canopy lifting for vehicular or pedestrian access are all valid pruning operations. Lopping branches at indiscriminate points is not acceptable pruning.

Pruning should only be completed by a qualified Arborist (AQL level 4 Arboriculture) and be in accordance with AS4373-2007, Pruning Amenity Trees.
In several cases, specifically Trees 13, 26, 27 and 45, the canopy extends to ground level. Part of the appeal of these trees is the extent of the canopy and the effect that it creates in the landscape (Figure 7). These trees should not be canopy lifted, rather the branches allowed to touch the ground and continue to grow. Structures, dwellings or foot paths should not be planned within the canopies of trees where the canopy comes to ground level.

Figure 7: Trees such as this English Oak have wide canopies that extend to the ground

7.2.2 Tree Protection Zone Guidelines:

Careful adherence to the following exclusions and inclusions will maintain the health and longevity of retained tree specimens.
Exclude the following from taking place within any TPZ (adapted from AS 4970-2009):

- built structures or hard landscape features (i.e. paving, retaining walls)
- materials storage (i.e. equipment, fuel, building waste or rubble)
- soil disturbance (i.e. stripping or grade changes)
- excavation works including soil cultivation(specifically surface-dug trenches for underground utilities)
- placement of fill
- lighting of fires
- preparation of chemicals, including preparation of cement products
- pedestrian or vehicular access (i.e. pathways).

Include the following procedures in setting up and maintaining any TPZ (adapted from AS 4970-2009):

- erect warning signs at regular intervals along the entire length of any protective TPZ fencing (Figure 8)
- construct TPZ fencing to prevent pedestrian access into the protected area.
- mulch the TPZ area to a depth of 150mm with woodchips (if available, use woodchips generated from on-site tree clearing).
- Irrigate TPZs periodically, as determined by the consulting Arborist.

TPZ guidelines need to adhere to all stages of the design and construction process and are relevant to all on-site utilities.

Figure 8: Examples of TPZ warning signs to display along TPZ fencing

7.2.3 Tree Protection under the Darebin Planning Scheme

Vegetation Protection Overlays

Tree protection in Darebin exists in the form of Vegetation Protection Overlays in the Former Kingsbury Centre, Mt Cooper, Spring Thorpe and Lancaster Gate Estates. A permit is required to remove, destroy or lop any vegetation specified in a schedule to this overlay.

This does not apply:

- If the table to Clause 42.02-3 specifically states that a permit is not required.
- To the removal, destruction or lopping of native vegetation in accordance with a native vegetation precinct plan specified in the Schedule to Clause 52.16.

Schedule 2 – Former Kingsbury Centre (Latrobe University)
Schedule 3 – Mount Cooper
Schedule 4 – Springthorpe
Schedule 5 – Lancaster Gate

Environmental Significance Overlays

Along the creek lines there are Environmental Significance Overlays. A permit is required to:

- Remove, destroy or lop any vegetation, including dead vegetation. This does not apply:
  - If a schedule to this overlay specifically states that a permit is not required.
  - If the table to Clause 42.01-3 specifically states that a permit is not required.
  - To the removal, destruction or lopping of native vegetation in accordance with a native vegetation precinct plan specified in the schedule to Clause 52.16.

Schedule 1 – Merri Creek and Environs

Schedule 2 – Darebin Creek and Environs

The requirement for a permit to remove, destroy or lop any vegetation does not apply to:

- A tree on residential zoned land with a single trunk circumference of less than 0.35 metre and 1 metre above the ground and which is less than 6 metres high or has a branch spread of less than 4 metres.
- A non-indigenous tree that has the capacity to adversely affect stream flow.
- The control or removal of non-indigenous plants is preparation for revegetation works.
- Pruning of plants to maintain access or maintain a plant's horticultural health.

Heritage Overlays

A number of properties within Darebin have tree protection included within the Heritage Overlays. A current list of these properties is provided in Table 7.

Those properties on the Victorian Heritage Register that currently include tree controls are listed as follows:

H019 (Yes Ref No H1774)
H0312 (Yes Ref No H2287)
H045 (Yes Ref No H2129)
H0144 (Yes Ref No H2031)
H059 (Yes Ref No H1872)
H074 (Yes Ref No H1091)
H0175 (Yes Ref No H1950

Table 7 Heritage properties which currently include tree controls

PS Map Ref	Heritage Place	Tree details provided in Schedule
H075	2 Rowe Street, Fairfield	Canary Island Palm (Phoenix canariensis)
H0188	Preston General Cemetery 900 Plenty Road Bundoora	
H0189	Fairfield Primary School, No. 2711 1-5 & 176-206 Langridge Street & Wingrove Street, Fairfield	Moreton Bay Fig and Pepper Trees
H0191	Reserve – Johnson Park 12 Palmer Street, Northcote	
H0194	Northcote Cemetery 143 Separation Street, Northcote	Italian Cypress
H0195	Northcote High School 19-29 St Georges Road, Northcote	
H0197*	Reserve – Oldis Gardens and Northcote Cricket Ground Westgarth Street Northcote	
H0205	House 664 Bell Street Preston	Canary Island Palm (Phoenix canariensis)
H0208	Sandland Family houses 36 & 40 Cooper Street Preston	
H0210	Preston City Oval & Band Hall 11-21 Cramer Street Preston	
H0225	All Saints Anglican Church complex 400 High Street Preston & 239 Murray Road Preston	Bhutan Cypresses
H0231	Preston South Primary School No. 824 56B Hotham Street Preston	
H0232	House (Rainhamville) 4 Hurlstone Avenue, Preston	Canary Island Palm
H0239	Preston West Primary School No. 3885 383 Murray Road Preston	
H0248	House and Canary Island Palms 30 Regent Street, Preston	Canary Island Palms
H0263	Reserve – Edwardes Lake and Park 200A Edwardes Street Reservoir	
H0265	Clydebank Dairy Trees 679 Gilbert Road Reservoir	Bhutan Cypresses
H0268	House 40 Gloucester Street Reservoir	Canary Island Palm
H0272	MMBW Preston Reservoir Complex 832-834 High Street Reservoir 885-897 High Street Reservoir	
H0276	Reserve – F.G Pike Reserve 26 Mason Street Reservoir	
H0277	House 34 Mason Street Reservoir	Canary Island Palm
H0284	Reserve – The Steps	Canary Island

PS Map Ref	Heritage Place	Tree details provided in Schedule
	1 Clarendon St, 12 & 19 Gooch St, 26 Flinders, 29 Rossmoyne St and 2A Raleigh St Thornbury	Palms
H0287	Thornbury Primary School No. 3889 16-24 Hutton Street Thornbury	Italian Cypresses
H0290	Reserve – Penders Park 48A Pender Street Thornbury	
H0297	Broomfield Avenue Precinct 2-52 and 3-45 and 495 (Park); 509 and 515 Broomfield Avenue; Heidelberg Road Alphington	Street trees and Bloomfield Park

Native Vegetation

Native vegetation within Darebin may be protected under Clause 52.17 of the Victorian Planning Provisions.

A permit is required to remove, destroy or lop native vegetation, including dead native vegetation. This does not apply:

- If the table to Clause 52.17-6 specifically states that a permit is not required.
- To the removal, destruction of lopping of native vegetation species in the schedule to this clause
- To an area specified in the schedule to this clause

7.3 Managing Trees

7.3.1 Managing trees during Climate Change

Simplified decision matrix for managing trees in the Urban Forest during climate change (Moore G M - The Impact of Climate Change on Climate Zones and Urban Forests 2011)

Species Characteristics	Tolerance of Higher Temperature	Tolerance of Drought or Lower Rainfall	Likely Impact of Climate Change	Management Implications
Widely dispersed over a broad range	High	High	Low	Select propagation material from appropriate provenance
Restricted range	Low	Low	High	Monitor performance and consider related species with tolerance of warmer, drier conditions
Drought prone	High	Low	High	May only survive if irrigated. Not recommended.
Drought resistance	Low	High	Moderate	Grow in shaded, cooler parts of cities
Seed set	Low	Moderate	Moderate	May be an advantage when fruits or seeds are problematic in cities
Photosynthetic rate	Moderate	Moderate	Low	May be an advantage with higher establishment and growth rates. Could be enhanced with irrigation

Species Characteristics	Tolerance of Higher Temperature	Tolerance of Drought or Lower Rainfall	Likely Impact of Climate Change	Management Implications
Respiratory rate	High	Moderate	Moderate	Enhanced tree establishment and growth through efficient irrigation
Transpiration rate	High	Low	High	May only survive if irrigated
Frost sensitive when young	Moderate-High	Moderate	Low	Small, young trees may be grown without protection from frost

7.3.2 Tree and Infrastructure Conflicts

There are two main ways that trees cause damage to structures; subsidence and heave from soil moisture changes, and intrusion followed by expansion of tree roots.

Pavements, Footpaths and Kerbs

One of the biggest problems for municipalities is the damage that tree roots cause to footpaths, kerbs and pavements. Construction techniques used for footpaths can create favourable conditions for root growth. Concrete footpaths tend to warm the soil more than the surrounds during the day. At night the slab cools faster than the soil creating a temperature differential resulting in condensation (Barker 1994, Randrup, McPherson & Costello 2001). The slab also acts as a barrier to moisture loss through evaporation from the soil surface. When footpaths and kerbs are created, often the soil used for backfill does not get compacted. This medium, which has a lower bulk density than surrounding soil, can be ideal for tree root growth (Coder 1998).

Often roots growing under footpaths are found to have few laterals (Kopinga 1994). Upon discovering resources in soil, possibly a residential garden on the other side of the pavement, the roots often fan out (Coder 1998, Kopinga 1994). The result is a transport root that runs under the footpath. Basic biology suggests that secondary growth of the root will cause it to enlarge (Harris, Clark & Matheny 1999, Kozlowski 1962), eventually applying upward pressure on the slab and causing it to lift over time up to seven metres away (Randrup, McPherson & Costello 2001). In order for the tree to cause damage, the weight of the slab or structure must be less than the expansion pressure of the root. As a result, structures that are relatively light are most susceptible to this sort of damage (i.e. slabs, small walls and asphalt) (Biddle 1998a). If the structure is heavier than the expanding pressure of the root, the root will distort. Distorted roots are common near many built structures and large rocks.

Research has shown that trees usually cause little damage to footpaths until they are at least semi-mature (Kopinga 1994, Randrup, McPherson & Costello 2001). Wagar and Barker (1983) found that in general large trees caused more damage than small trees, and that the narrowest planting strip combined with the largest tree diameter seemed to result in the highest chance for footpath failure.

The work of Sydnor et al. (2000) however found that footpath damage was similar with or without trees. This would suggest that faults may be due to insufficient engineering (D'Amato et al. 2002, Sydnor et al. 2000). Environmental factors are not usually taken into account when designing footpaths, and so, in some soil types footpath design may be inappropriate. The work of D'Amato et al (2002) showed that where a cracked joint existed in a footpath near a tree it was more likely to contain a root than an intact joint. They surmised that in many situations the tree root exploited

the existing crack. Age is also a factor with some footpaths damaged through old age. In USA, the useful life expectancy of the footpaths is 20-25 years. Damage after this date would seem to be irrelevant as the footpath is due for replacement.

Damage to Underground Utilities
Pipe damage and blockage is a problem for utility companies. Incursion of roots into pipes occurs most commonly through the following connection joints:

- Two different types of pipe
- Manhole covers and frames
- Two identical pipes and
- Inspection chambers (Ståhl & Rolf 1998).

Trees do not seek out these services for water or resources, but should a root be near a leaking sewer, it will proliferate and eventually enter and block the pipe (Hitchmough 1994). The most common problems have been associated with concrete and terracotta pipes with rubber seals, whilst it appears that PVC piping has reduced problems (Hitchmough 1994, Ståhl & Rolf 1998).

Damage caused by Subsidence and Heave
Subsidence and heave are the result of soil moisture changes over time. Subsidence can be defined as:
'The downward movement of a structure caused by loss of support beneath the foundations'. It usually involves volumetric change of the subsoil and must be caused by a factor external to the structure' (Biddle 1998a, p105)
As soil dries out, depending upon its composition, its volume can shrink. Clay soils with a high smectite or vermiculite content will show potential for considerable shrinkage (Craul 1992). Soils with a high illite or mica content will shrink as a result of cracking and the incursion of air into the soil (Biddle 1998a). Although it is recognised that trees can cause subsidence (O'Callaghan & Lawson 1995), it is not necessarily the tree that is completely responsible. Seasonal water volume changes in high clay content soils can still cause the ground to shrink and a building to subside; trees usually just exacerbate a natural process (Hitchmough 1994). It is often thought trees that have a high water requirement or have little stomata control at low water potential will have more potential for building damage than trees that require little water (McCombie 1995, Stewart & Sands 1996). This is due to the continual transpiration of water as the soil dries.

The work of Cutler (1995) showed that when subsidence is blamed on trees, all too often the soil type is overlooked. In a study of 12 000 cases of the 18 most common genera of tree that resulted in damage to buildings, 96 – 100% of them were located on shrinkable soils. Indeed, McCombie (1995) states that there will not be damage caused to a foundation if it is located on soil that is not shrinkable. To add to many cases of building subsidence on shrinkable clays, a number of other considerations have been omitted. Soil drying due to increased surface runoff, water interception and evaporation and total runoff can increase the soil moisture deficit in the soil and exacerbate the shrinking process (Lawson & O'Callaghan 1995).

In general, subsidence damage caused by tree roots affects smaller structures with shallow footings as it is the soil under the footing that must be dried (Stewart & Sands 1996). If foundations are built deeper than can roots extract moisture, damage is unlikely. Builders have a primary duty to investigate the risk posed either by trees on site or by movement resulting from tree removal during site clearance (Stead & Lavers 1999).

7.4 Techniques for Measuring Canopy Coverage

Source data	Processing method	Expertise level required	Advantages / Disadvantages
Field data collection	Manual calculation based on average canopy width	Low	Data collection is relatively expensive, although an inventory provides useful data for tree management. Processing method is simple and low cost. An accurate method for measuring canopy cover.
Aerial or satellite imagery	Manual tracing of tree canopies	Low	Council has access to aerial images. Processing method is very time consuming. An accurate method for measuring canopy cover.
	Automated using GIS software application	Moderate	Higher resolution images, for example Landsat, can be purchased. Moderately accurate method that depends on the quality (extent of shadows) and resolution of the image.
	Random point-plot scheme (for example I-tree canopy)	Low	Fast and easy to use. The method can be easily repeated by different users over time. The level of accuracy can be increased by processing a greater number of points or plots. Council may have access to imagery and free software.
Skyward-oriented hemispherical (fish-eye) photography	Software application (for example Gap Light Analyser)	High	Relatively untested technique that uses photographs taken looking upward through an extreme wide-angle lens. Requires specialist equipment (hemispheric photography) and assessment areas are limited to publicly accessible areas. Free software is available
Light detection and ranging (Lid AR)	GIS software application (for example Lid AR Analyst)	High	A complex processing method that requires a high level of expertise. Accurate and potentially a very powerful tool if expertise is available. Lid AR data can be sourced from the Victorian Government or directly via private companies. A software licence is also required to model the tree canopy cover.