Knox City Council

Street Tree Asset Management Plan

May 2016

Executive Summary

Knox City Council is responsible for managing approximately 70,000 trees in the municipality's road reserves. Street trees are regarded as one of Council's greatest assets and contribute to the green leafy image of Knox. They provide a wealth of social, economic and environmental benefits.

The Knox *City Plan* recognises the importance of retention and planting of canopy trees across the overall urban forest. Street trees are one element of the urban forest and there are existing policies and procedures to guide the processes of street tree management. However, this Asset Management Plan provides a practical framework for those policies, as well as centralising street tree management practices.

Specifically, the *Street Tree Asset Management Plan*:

- Presents the recent history of street tree management practices within Knox.
- Describes the current situation of street tree management.
- Provides a transparent picture of Council's procedures and practices in managing street trees.
- Identifies opportunities to improve street tree management.

Key recommendations resulting from this Plan are themed as follows:

1 Tree management systems – e.g. undertake data collection of all street trees, with key data fields to be updated at five-year intervals.
2 Canopy cover – e.g. commit to progressively increasing the percentage of tree canopy cover within Knox.
3 Tree diversity – e.g. consider improved diversity of street trees by species and family, within the constraints of Council's existing policies.
4 Plantings – e.g. consider various planting layouts in streets and specify and utilise high-quality tree stock.
5 Inspection data capture – e.g. create and maintain thorough records of all tree management processes.
6 Budgets – e.g. review and restructure street tree budgets.

Figure 1 Taylors Lane, Rowville

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Chapter 1: Introduction

1. 1 Knox's Urban Forest

Knox City Council defines its *urban forest* as being the trees and vegetation on both public and private land, from indigenous bushland to planted native and exotic trees in streets, residential gardens, parks and road reserves.

The composition of Knox's urban forest is quite unique as the municipality is situated at the foothills of the Dandenong Ranges, providing an extraordinary backdrop for both the community and visitors to Knox. The backdrop of the Dandenong Ranges, in conjunction with the trees and vegetation on both private and public land, are the essence of Knox's green leafy image. The community has continually reiterated the importance of this "green and leafy" image, and as such, it is often referred to in Council planning documents to describe the community's aspiration for the future character of the City. In addition, this strong theme was validated in the community engagement program undertaken as part of Knox@50 – a celebration of the first 50 years of the City of Knox. As such, it is recognised that a "green and leafy municipality" is one of the key community aspirations for the future Knox.

There are three key units within Council which contribute to the growth, enhancement and maintenance of the public realm of the urban forest – Active Open Space, Biodiversity and Open Space & Landscape Design. Each unit has an important role in their respective contributions to the urban forest. The Active Open Space unit is responsible for creating and maintaining the green leafy image within the streets and road reserves. Active Open Space is responsible for ensuring the successful integration of these living organisms into the urban environment through appropriate tree selection, tree inspections and maintenance programs. The Biodiversity unit is the guardian of Knox's remnant vegetation, of which there is less than 4% remaining in the City of Knox. In addition, Biodiversity is tasked with protecting the existing indigenous habitats for the flora and fauna within Knox and the enhancement of these habitats by improving the biodiversity and health of the ecosystems. The Open Space & Landscape Design unit enhances and protects the vegetation in reserves during upgrade and master planning works.

All of these units contribute to maintaining the green leafy image of Knox; however, the benefits of trees within Knox extend far past providing a green leafy image. Trees also contribute greatly to community wellbeing by:

- Shading and cooling
- Reducing energy needs
- Carbon sequestration
- Removing pollutants from the air
- Intercepting rainfall and reducing stormwater run-off
- Erosion control
- Increasing amenity
- Increasing property values

- Decreasing crime rates
- Providing habitat
- Contributing to a positive effect on people's wellbeing
  (Dwyer, Schroeder & Gobster 1991; Kurn et al, 1994; McPherson et al, 2005; Sander et al, 2010; Wolf, 1998)

While all trees will provide these benefits to varying degrees, it is important to note that trees also have specialised attributes whether it be in the form of environmental tolerance, such as wet ground, or the degree to which they provide a specific benefits such as the extent of shade. For example, the Lemon Scented Gum (*Corymbia citriodora*) provides many benefits such as providing shade and intercepting rainfall, but it also has a specialised benefit of atmospheric pollution removal. Another example, is the Yellow Box (*Eucalyptus melliodora*), a locally indigenous tree to Knox. Again while the tree provides a host of benefits, its specialised benefit is being an excellent source of food and habitat for indigenous fauna of Knox. It is the role of tree managers to utilise their knowledge of tree species and "plant the right tree in the right place" to achieve the maximum benefits of that tree.

1. 1. 1 The role of Street Trees in the Urban Forest

Street trees encounter unique challenges when compared to parkland and bushland trees. They have to withstand limited growing space, urbanised compacted soils (i.e. soils without distinct horizons), radiant heat from asphalt and continual pruning to maintain clearance regulations set out in Council's *Road Management Plan* and the *Electricity Safety (Electric Line Clearance) Regulations*. In order to provide benefits to the overall urban forest, street trees must remain healthy in a hostile growing environment.

Street trees are also required to meet a wide variety of community expectations such as conservation, providing habitat for wildlife and enhancing the appearance of streetscapes. In addition, street trees by the nature of their location (i.e. adjacent to properties and roads) are in prime position to mitigate the urban heat island effect. The urban heat island effect is attributed to the high concentration of built structures and hard surfacing in cities, often with little shading (when compared to the surrounding landscape). This results in the structures and surfaces, and then the surrounding atmosphere, becoming hotter than the surrounding land, creating a heat island effect. The urban heat island effect causes greater use of energy (through attempts to offset its impacts), health issues for human populations and impacts to biodiversity. Increasing urban tree canopy cover can mitigate these effects (Coutts et al, 2007).

1.2 Purpose of this Plan

This *Street Tree Asset Management Plan* aims to maximise the benefits of trees along streets and roads for the best environmental, social and economic outcomes. The purpose of this Plan is to provide the framework for managing street trees by linking the various related policies thus providing a central reference point. In addition, this Plan aims to complete any gaps within existing policies and documents.

The Plan will also provide Council officers with a clear framework that guides their routine activities and provide members of the public and other stakeholders with a transparent means to understand the procedures that Council follows when managing street trees.

PURPOSE OF THIS ASSET MANAGEMENT PLAN

- To recognise Knox City Council's commitment to best-practice management of its urban forest.
- To provide a central framework for daily and long-term management and decision making.
- To identify existing challenges facing street tree managers.
- To formulate future solutions to address these challenges.
- To meet expectations outlined in Council's Vision, policies and strategies.

This Plan aims to maintain existing levels of management of Council's street trees, as well as identifying opportunities for improvements. The main areas of recommendations aim to achieve:

- Improved street tree management systems and data
- Increased canopy cover
- Improved street tree species diversity
- Improved street tree planting practices
- Improved inspection data capture
- Improved operational funding

It is important to note that trees are living dynamic organisms, and as such it would be unrealistic to have the same expectations regarding the mitigating effect of proactive works that is associated with other assets such as footpaths (i.e. Council will always receive reactive tree requests due to the dynamic nature of trees and climate).

Knox City Council acknowledges the contribution of Tree Dimensions Pty Ltd in the development of this Plan.

1.3 Framework

Knox City Council has a detailed framework within which street trees are managed. The following figure, from Council's *Green Streets Policy*, provides a suitable overview. This Plan forms a critical (and practical) component of that framework.

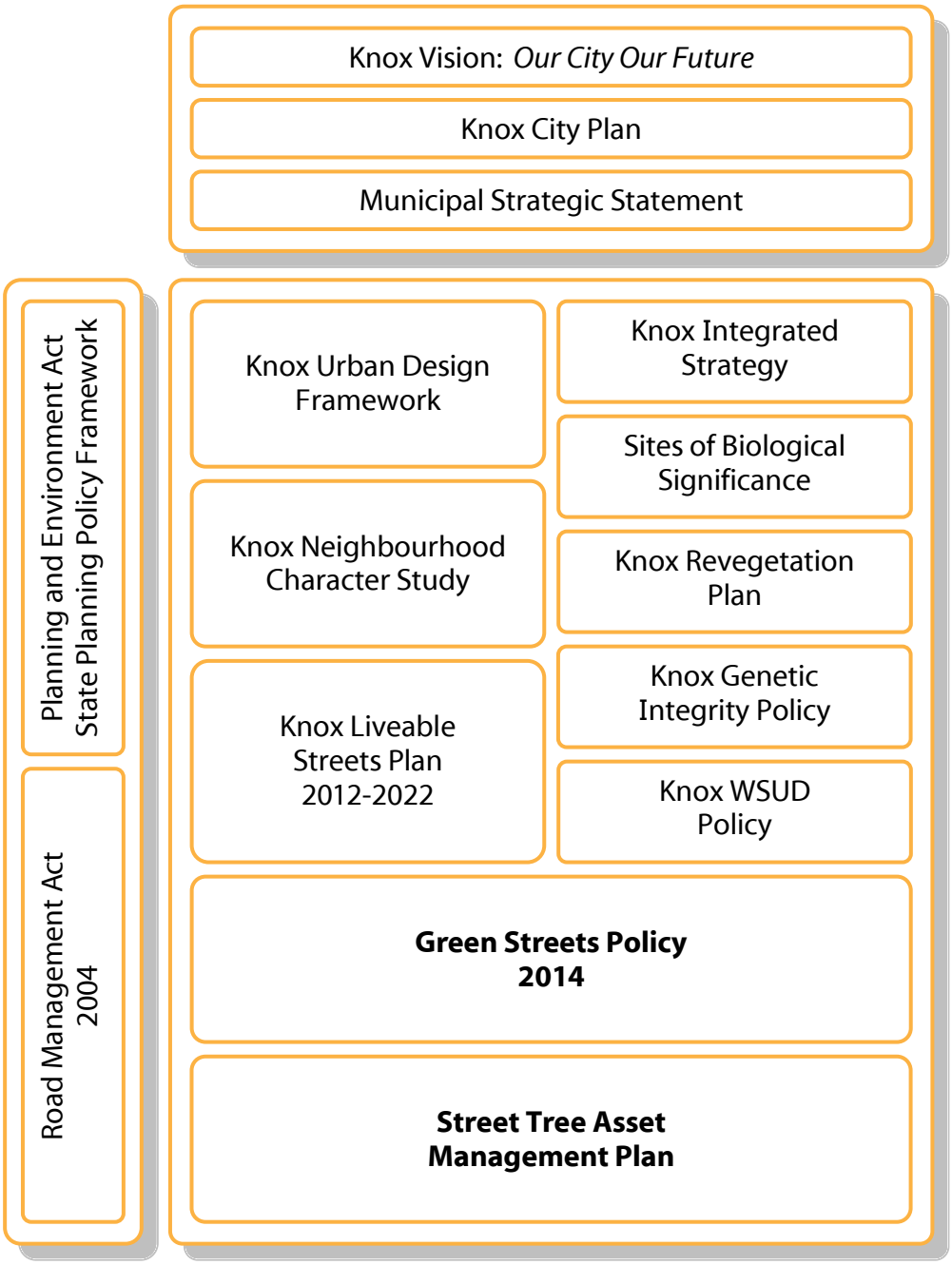


Figure 2 Existing framework (adapted from Knox *Green Streets Policy*)

Figure 3 Silkwood Way, Rowville

Related documents are listed below.

- **Knox Vision**
  - Knox City Council's far-reaching vision is for a thriving community and environment.
- **Knox City Plan (incorporating Council Plan)**
  - Includes overarching objectives for the City that are relevant to street trees.
- **Road Management Plan 2015**
  - Documents some of the key inspection frequencies, intervention levels and maintenance service levels for trees within road reserves.
- **Liveable Streets Plan 2012-2022**
  - Highlights valuable opportunities to improve the entire streetscape (including trees).
- **Green Streets Policy 2014**
  - Overarching policy to guide future implementation of street tree planting.
- **Revegetation Plan 2013**
  - Strategic approach to revegetation across the municipality, including a commitment to no net loss of street trees.
- **Neighbourhood Character Study**
  - Identifies a range of precincts across the City of Knox based on character types that include vegetation cover, topography and the character of existing street trees.
- **The Municipal Strategic Statement (MSS)**
  - The Municipal Strategic Statement (MSS) sets out the long term directions and outcomes to be achieved through the Planning Scheme.
- **The Planning and Environment Act**
  - The Planning and Environment Act establishes the objectives of planning in Victoria
- **Sites of Biological Significance in Knox – 2010**
  - Outlines significant remnant vegetation within the municipality.

1.4 Scope

This *Street Tree Asset Management Plan* guides the management of all **street trees** for which Council is responsible, including those in:

- Council's municipal roads – where Knox is the coordinating and responsible road authority
- VicRoads arterial roads – where Knox is the responsible road authority

The following diagrams demonstrate the location of street trees relative to typical road reserves.

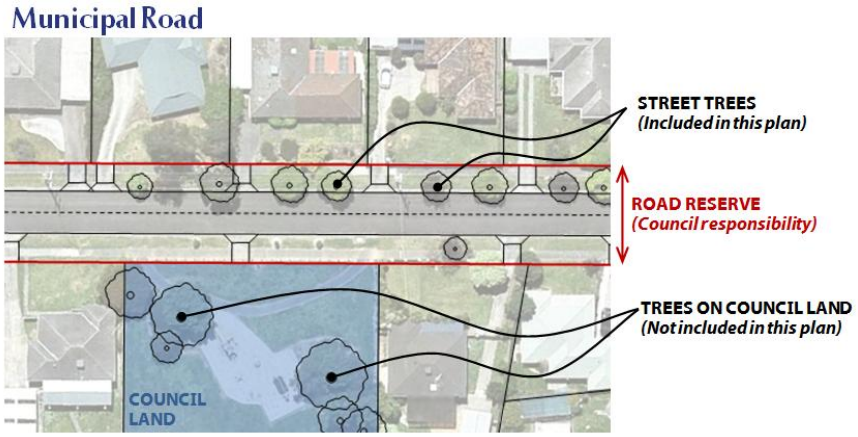


Figure 4 Street trees in Municipal Roads

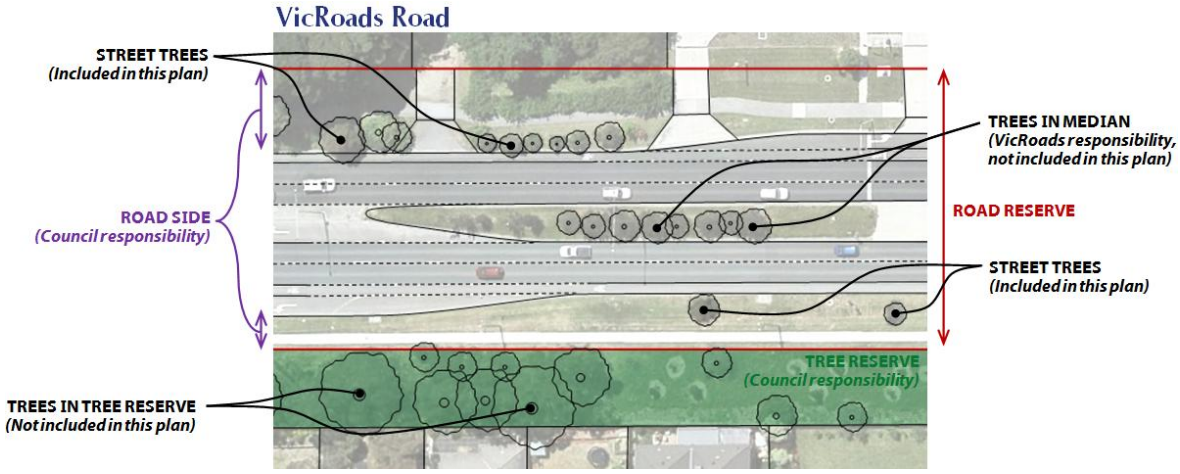


Figure 5 Street trees in Arterial Roads

Tree reserves are parcels of Council land which typically run parallel to road reserves and contain trees that may be perceived to be street trees. While the management of these trees is similar to that of street trees, they are considered to be reserve trees and therefore not covered by this Plan. The management of trees on other Council land or reserves is also not covered by this Plan. It is worth noting that according to the *Knox Revegetation Plan*, "street trees represent less than 1% of the total number of plants installed" in the 2011/12 year.

1.5 Regulatory Requirements

There are a number of regulatory requirements which impact on Council's management of its street trees – the principal ones being the *Road Management Act* and the *Electricity Safety (Electric Line Clearance) Regulations*.

Council is required to submit an annual Electrical Line Clearance Plan to Energy Safe Victoria. This report outlines how Council intends to maintain its trees in accordance with the regulations set out by Energy Safe Victoria. The regulations advise Council of clearances of vegetation around power lines and how Council inspects its tree population around power lines, including the processes in making decisions.

The following are identified as the key objectives of this Plan in fulfilling Council's duties set out in the *Electricity Safety (Electric Line Clearance) Regulations 2015*.

- Public Safety; in relation to supply of electricity
- Compliance with the *Electricity Safety (Electric Line Clearance) Regulations 2015*
- Protection of areas of important vegetation which may be deemed as such on the basis of those areas containing botanically, historically or culturally important vegetation or vegetation of outstanding aesthetic or ecological significance, and/or the habitat of rare or endangered species;
- Management of vegetation to maximise the environment, biodiversity and amenity value of the Council's trees;
- Provision of a safe working place for employees and contractors;
- Provide continuity of supply.
- Minimise fire starts.
- Community satisfaction with the manner in which the necessary works area carried out.

The *Road Management Act* outlines statutory requirements for Council (as a road authority) to inspect, maintain and repair its public roads. As street trees are located within the road reserve, and pose potential risks to road and pathway users, Council has historically included street trees in its *Road Management Plan*.

Refer also to sections 4.5 and 4.6 for further information on how Council undertakes its proactive inspections and maintenance activities to meet these regulatory requirements.

1.6 Stakeholders

Knox City Council considers the key stakeholders to be the community – residents and businesses of Knox, who live, work in, and commute along the streets and roads lined with street trees. Consultation with residents, business and visitors to Knox provides the necessary feedback that guides Council's management of street trees.

Internally, the stakeholders at Knox City Council include:

- **Active Open Space**
  - Maintenance, renewal/replacement, inspections, contract management of street trees.
- **Open Space & Landscape Design**
  - Development of policy and strategic objectives (e.g. *Green Streets Policy* and *Liveable Streets Plan*).
- **Biodiversity**
  - Interface between streets and sites of biological significance, protection of habitat corridors (e.g. *Revegetation Plan*).
- **Works Services/Project Delivery/Construction**
  - Infrastructure issues in relation to street trees.
- **Urban Planning**
  - Administration of *Municipal Strategic Statement* and *Urban Design Framework*, along with development assessments and Planning Scheme overlays.
- **Sustainable Futures**
  - Holistic view of street trees with respect to heat island effect etc.; research, liaison with Eastern Alliance for Greenhouse Action.
- **Asset Strategy**
  - Coordination of strategies and data management with other infrastructure assets.

Chapter 2:
Asset Knowledge

2. 1 Introduction

Knowledge of Council's street tree assets is based on data collected in 2002/03, limiting the picture of the current situation. It has been historically difficult to quantify the exact street tree inventory.

However, the technology of street tree management is constantly developing. Knox City Council is seeking to improve the way in which it collects and manages street tree information. Innovative methods such as canopy cover analysis via satellite imagery have been used recently (2013).

2. 2 Street Tree Population

Council last undertook a municipal wide street tree audit in 2002/03, and at last count there were some 70,000 street trees.

Since that audit, many trees have been removed due to poor health and/or structure for risk management reasons. New trees have been planted, either individually in existing vacant sites or when whole streets have been planted. Despite Council's replanting efforts, it was reported in 2011 (findings presented at the Ordinary Council Meeting 22 February 2011) Knox had an estimated deficit of 11,350 street trees. In response, Council further increased the street tree planting budget. In the past three years, tree planting is now out-numbering tree removal, so that the street tree population is steadily increasing.

In terms of a breakdown by species of street trees, this information is presented in section 3.4.

2. 3 Street Tree Value

Historically it has been difficult to value trees, as they have not been considered in the same way as other assets. Trees are not currently valued from an accounting perspective hence why valuation data is not periodically updated. Unlike other infrastructure assets, trees typically appreciate in value as they age, meaning they are difficult to assess from an accounting viewpoint. As tree benefits are better understood, and tools for deriving their value are improving, street trees can be valued at regular intervals. Knowledge of the value of street tree assets can assist Council allocate appropriate budgets for their management.

At the last audit, the amenity value of Knox's street tree population was estimated at more than $70 million (Knox *Green Streets Policy*, page 3). This valuation considers amenity value only. It does not include economic and ecological values that can now be measured using tools such as i-Tree (software suite from the USDA Forest Service that provides urban forestry analysis and benefits assessment tools). A current valuation of Knox's street trees that considers all of their benefits is likely to be considerably higher.

If the street tree population was re-evaluated taking economic and ecological benefits into account, the ratio of expenditure to value is likely to be considerably lower for street trees than it is for other Council assets –indicating the management of street trees has been historically underfunded.

In 2014 Council acknowledged the change in street tree evaluation methodology by endorsing section 7.1.1.2 of the *Green Streets Policy*. Section 7.1.1.2 outlined that during the planning application stage, street trees affected by developments will be given a monetary value using the valuation method developed by the City of Melbourne. The method has been developed for local conditions and is well suited to Council's street trees (see Appendix H).

2. 4 Inventory and Systems

Knox City Council's street tree data is mostly contained within Council's Asset Register (Lifecycle) and represented spatially within a GIS system (IntraMaps). Although, there are two systems, in general, the systems are in alignment. Street trees are recorded as a spatial attribute with an X and Y location and a unique key (Tree Number). Relevant information about each tree and surrounding infrastructure is also recorded.

2. 4. 1 Asset Register

Street Tree data is recorded in the Lifecycle Asset Register (AREG). The fields and their descriptions are provided in Appendix A of this Plan. Most tree data in the Asset Register was collected some years ago and now requires updating for accuracy. Only minimal updates and amendments have been applied.

Future data collection will allow for the possibility of further fields such as "Impacts to infrastructure" and "Life Expectancy (LE)".

2. 4. 2 Work Order System

In general, Knox City Council's Work Order System (in Lifecycle) allows recording and tracking of Council's assets and all work requests and actions applying to those assets.

From a tree perspective, work orders relating to street trees are generally categorised under the category 'Roadside Vegetation'. Street trees are not recognised as individual assets within the Work Order System, so work orders for trees are currently tagged to a road segment asset, while the location of the work order will be the closest street address to the tree(s). This system works well when there is only one street tree outside an address. The system has the potential to be improved if street trees are recorded as individual assets.

Figure 6 Koolamara Boulevard, Ferntree Gully

2. 5 Recent Expenditure

The following table presents actual expenditure on managing Knox's street trees for the last five years.

Table 1 Actual expenditure of street tree programs from 2009

YEAR	CAPITAL	OPERATIONAL		
	Renewal Expenditure Program 1013	Maintenance Expenditure Street Tree Pruning 34520	Maintenance Expenditure Residential Street Planting (Infill) 34527	Maintenance Expenditure Reactive Tree Maintenance* 34505
2009/10	$ 399,851	$ 591,406	$ 26,591	$ 1,008,667
2010/11	$ 401,336	$ 751,121	$ 161,082	$ 1,039,223
2011/12	$ 609,563	$ 798,200	$ 152,001	$ 1,222,594
2012/13	$ 486,873	$ 801,500	$ 167,274	$ 1,203,653
2013/14	$ 711,844	$ 853,482	$ 88,642	$ 1,533,514

* The Reactive Tree Maintenance program includes ALL Council trees in streets and reserves, and covers all reactive tree maintenance, stump removal, chemicals and all tree staff costs and overheads. Street trees account for approximately 90% of this expenditure.

The above table presents actual expenditure only, however, further analysis of Council's financial data identifies two patterns: an underspend in the residential street planting program (34527) to offset the over expenditure in street tree water maintenance program (34505) and a continual overspend in reactive tree maintenance (34505).

Based on the information and identified patterns, there is a clear need to reassess the absolute and relative requirements of these two maintenance programs in future budgetary planning (see section 4.9).

It is recommended that funds are redistributed between the street tree planting budget and the tree watering budget to accurately reflect the over and under spend, and the reactive tree maintenance budget is increased to reflect the continual historic over spend.

Other sections of this Plan highlight the need to increase canopy cover throughout Knox. Considering this, tree programs (in particular operational expenditure) could be considered under-funded. This can only be determined through further detailed analysis.

As can be seen from the following charts, street tree maintenance accounts for a significant proportion of overall street tree funding.

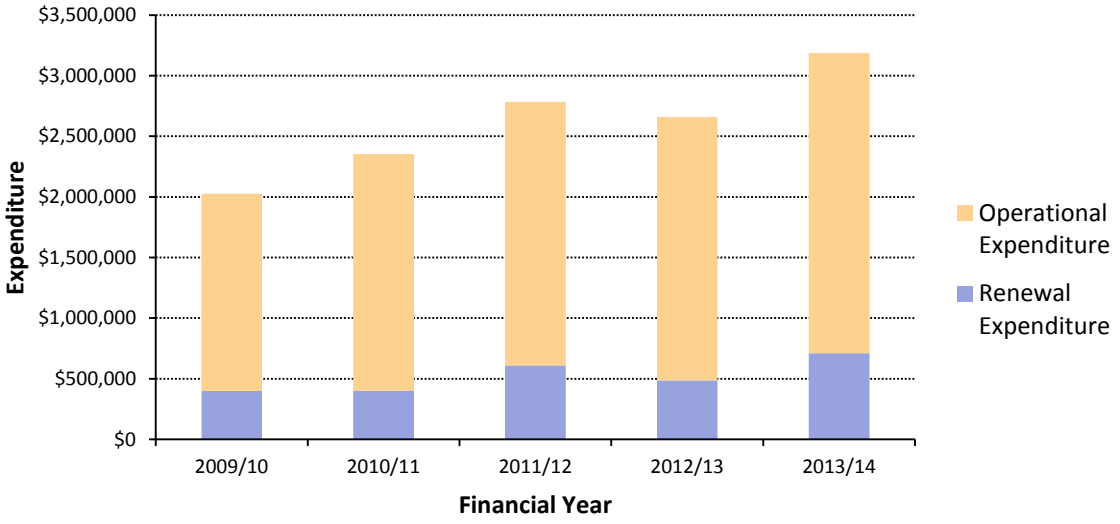


Figure 7 Recent annual expenditure on street tree programs (2009/10 to 2013/14)

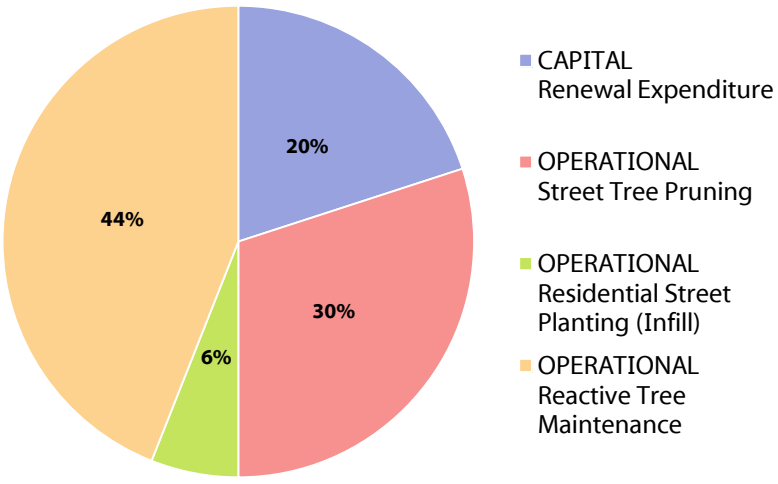


Figure 8 Breakdown of annual average expenditure over last five years (2009/10 to 2013/14)

Compared to other assets for which Council has responsibility (such as civil infrastructure, plant and equipment), it is interesting to note that street trees represent approximately 4% of Council's capital renewal expenditure, yet they represent approximately 16% of maintenance expenditure.

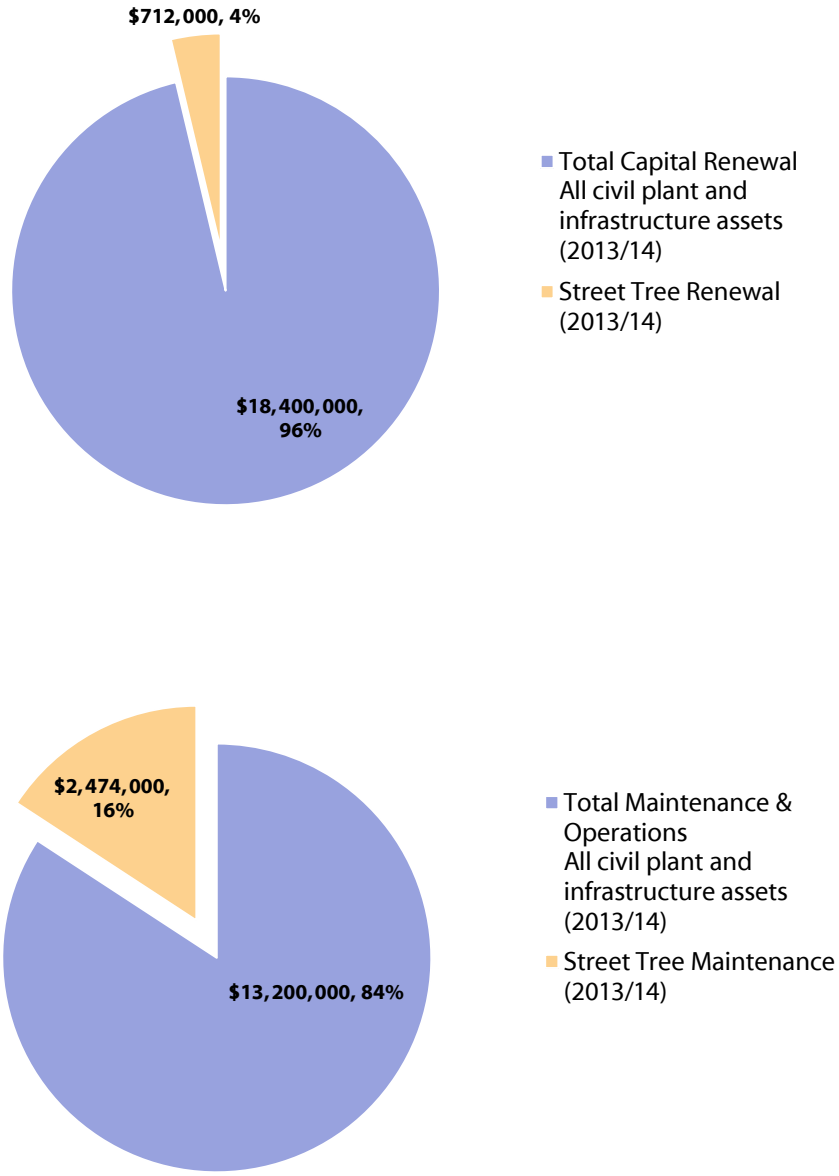


Figure 9 Proportion of street tree expenditure compared to other Council assets (2013/14)

Chapter 3:
Asset Performance

3. 1 Street Tree Condition

The results of the existing data (2002/2003) collection demonstrate the following condition of Knox's street trees. As the data dates from some time ago, it is likely that many of the hazardous and dead trees, and trees in poor condition, have been removed and replaced with new trees.

Table 2 Condition of street trees (2003)

Health			Structure		
Condition	**Quantity**	**Proportion**	**Condition**	**Quantity**	**Proportion**
Dead	636	0.9%	Hazardous	451	0.7%
Poor	3898	5.7%	Poor	17035	24.8%
Fair	40183	58.5%	Fair	37765	55.0%
Good	23953	34.9%	Good	13417	19.5%
			Unknown	2	0.0%
	68670	**100%**		**68670**	**100%**

Original data was the genesis for many of the ongoing programs today and although Council is confident of making significant inroads into improving the treescape of Knox streets, this can only truly be confirmed by another full survey. It has only been in the last 3-4 years that data has been consistently captured in the tree removal/replacement/planting aspect.

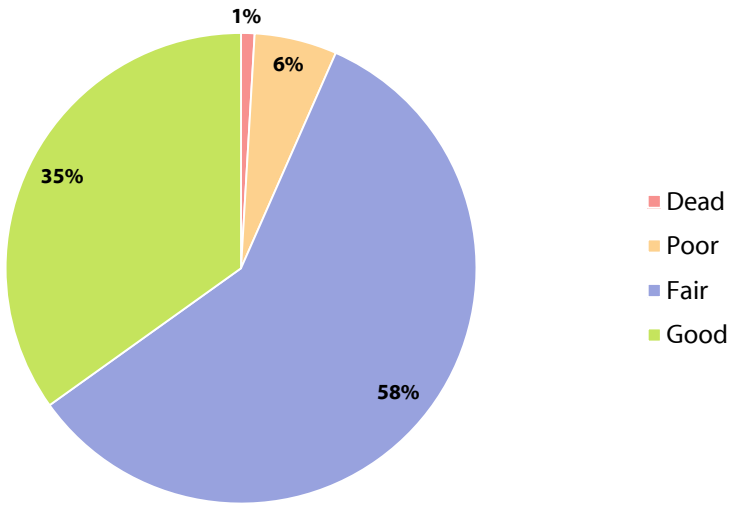


Figure 10 Health condition of the Knox street tree population (2003)

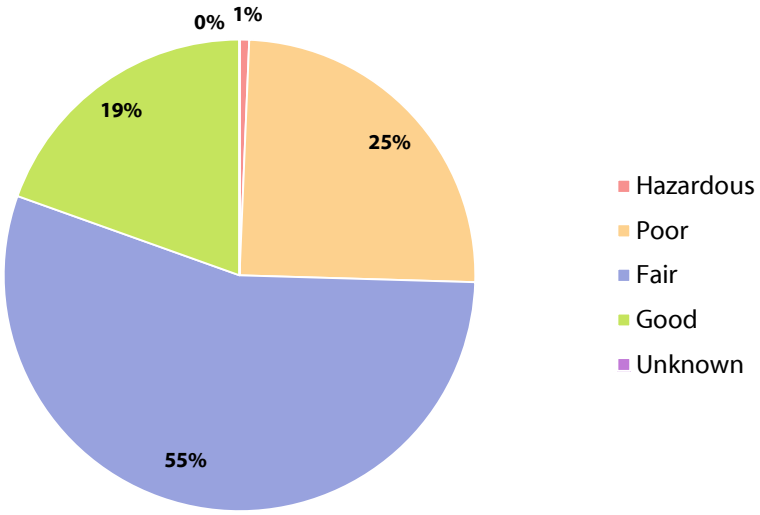


Figure 11 Structural condition of the Knox street tree population (2003)

3.2 Canopy Cover

In 2011, Knox City Council identified a potential deficit of 11,350 in its street tree population. In response, Council increased the street tree planting budget and was also aware of the importance of identifying the location in need of street trees. In 2013 Council identified streets requiring tree planting through satellite imagery analysis, an innovative cost effective technology that identified the percentage of street tree canopy on an individual street basis (see section 4.3.1. for a detailed breakdown).

This analysis revealed Knox to have an overall street tree canopy percentage coverage of 22%. The coverage related solely to street tree canopy within the streets and roads of Knox, and was measured against defined road polygons. Parkland reserves and private vegetation were not included.

The figure below shows an example of a typical residential street. In this particular street, the canopy coverage was measured at 22%.

Figure 12 Leah Court, Rowville – Canopy cover 22%

3.3 Maintenance History

The Work Order System allows historical requests to be analysed to assess maintenance performance and volumes.

The first table below shows work orders by activity and by risk classification over a five year period. It is worth noting that over a third of work orders are deemed to be 'no hazard', where Council's officers have responded to an issue logged by a customer and found it either did not meet the intervention level for maintenance to be undertaken, or it was deemed to be a duplicate request.

The second table shows the source of the work orders over the same five year period. 'Ad hoc' and 'after hours' are work orders that are raised by Council officers through the course of their normal activities. 'Condition audit' is usually from an external contractor. 'CRS' is the Customer Request System, where issues are raised by the general public and called through to the general Knox customer service number. A 'Routine Hazard Inspection' is a work order created as a result of Council officers undertaking their routine proactive inspections. Despite the proactive nature of much of Council's work, this data shows that the vast majority of issues continue to be raised reactively by the general public (although as in the point above, many of these are later determined to be of no issue). As noted earlier, trees are living dynamic organisms, and as such it would be unrealistic to have the same expectations regarding the mitigating effect of proactive works that is associated with other assets (such as footpaths).

Table 3 Records of reactive street tree maintenance (2009/10 to 2013/14)

Maintenance Activity	Total Work Orders	Risk Rating of Hazard				
		Extreme	High	Low	Medium	No Hazard
Fallen Limb or Fallen Tree Removal	6,037	128	675	1,674	1,250	**2,310**
Line Clearance	477	1	1	76	291	**108**
Pest and/or Vegetation Disease Control	612	6	47	72	87	**400**
Pruning - Street Trees & Shrubs	3,890	1	30	520	1,935	**1,404**
Stump Removal	3,999		4	3,326	365	**304**
Tree Removal	5,600	2	45	851	2,521	**2,181**
TOTALS	**20,615**	**138**	**802**	**6,519**	**6,449**	**6,707**

Maintenance Activity	Total Work Orders	Source of Hazard				
		Ad hoc Hazard Inspection	After Hours	Condition Audit	CRS	Routine Hazard Inspection
Fallen Limb or Fallen Tree Removal	6,037	227	504		**5285**	21
Line Clearance	477	17	1		**214**	245
Pest and/or Vegetation Disease Control	612	11	40		**557**	4
Pruning - Street Trees & Shrubs	3,890	201	6	1	**3594**	88
Stump Removal	3,999	3321	6		**537**	135
Tree Removal	5,600	267	5	3	**4550**	775
TOTALS	**20,615**	**4,044**	**562**	**4**	**14,737**	**1,268**

3. 4 Species Diversity

Species diversity in regard to trees refers to the use of different tree species in the urban forest. For the purpose of urban tree management, the tree classification groups of interest are: Family, Genus, and Species. The 'Golden Wattle' for example is classified as follows;

Family: Fabaceae
Genus: *Acacia*
Species: *pycnantha*

The importance and necessity for species diversity within a tree population has been realised through a number of catastrophic events (Raupp, Cumming & Raupp 2009). In the early 1900s, nursery stock infected with the chestnut blight fungus from Asia was imported into New York, the American chestnut tree had little resistance to the blight and by 1940 over 3.5 billion chestnuts had been killed (Raupp, Cumming & Raupp 2009). In 1920, Dutch Elm Disease (DED) was reported to have killed millions of elm trees in Europe and by 1930 DED had been introduced into the United States resulting in the death of millions of more elm trees (Raupp, Cumming & Raupp 2009). Due to the popularity of the elm tree and subsequent heavy use of elm tree in cities, many city streets were left barren (Raupp, Cumming & Raupp 2009). More recently, in Australia, the discovery of Myrtle Rust has given cause for concern, as it has the potential to impact at a Family level, although at this stage only a small proportion of species have shown ill effects. Furthermore, Cypress canker (fungus) has recently led to the death of many cypress trees within Knox.

In addition to existing known threats, future impacts to the street tree population include both the foreseeable and the unforeseeable, for example:

- climate change and the resulting changes in rainfall patterns and temperatures, which can significantly alter the trees growing conditions
- entry of new pest and disease populations.

It is evident from past and current events that an urban forest lacking diversity is vulnerable to climatic changes and the effect of pests and diseases. In simplistic terms, in order to reduce risk of large scale tree loss – tree managers should not put 'all their eggs in one basket'. However, in terms of tree management, this raises the question of how many eggs should be put in one basket and how many baskets are needed?

In the 1970s, such thinking led to development of the concept of setting species diversity targets. Species diversity targets refer to the percentage division of tree species across the following classifications; Family, Genus and Species. In terms of limiting the effects of pest outbreaks, a widely used and accepted (nationally and internationally) target recommendation is: no more than 10% of one species, 20% of a single genus or 30% of a single family of plants are to comprise the overall urban tree population (Santamour 1990). This target is commonly referred to as the 30: 20: 10 rule. In addition to limiting the effects of pest outbreaks, diversity targets also offer

protection against climate change i.e. there is a greater likelihood that more tree species would adapt and/or survive extreme weather events.

Data collected several years ago shows the following breakdown of Knox street trees at their botanical family level.

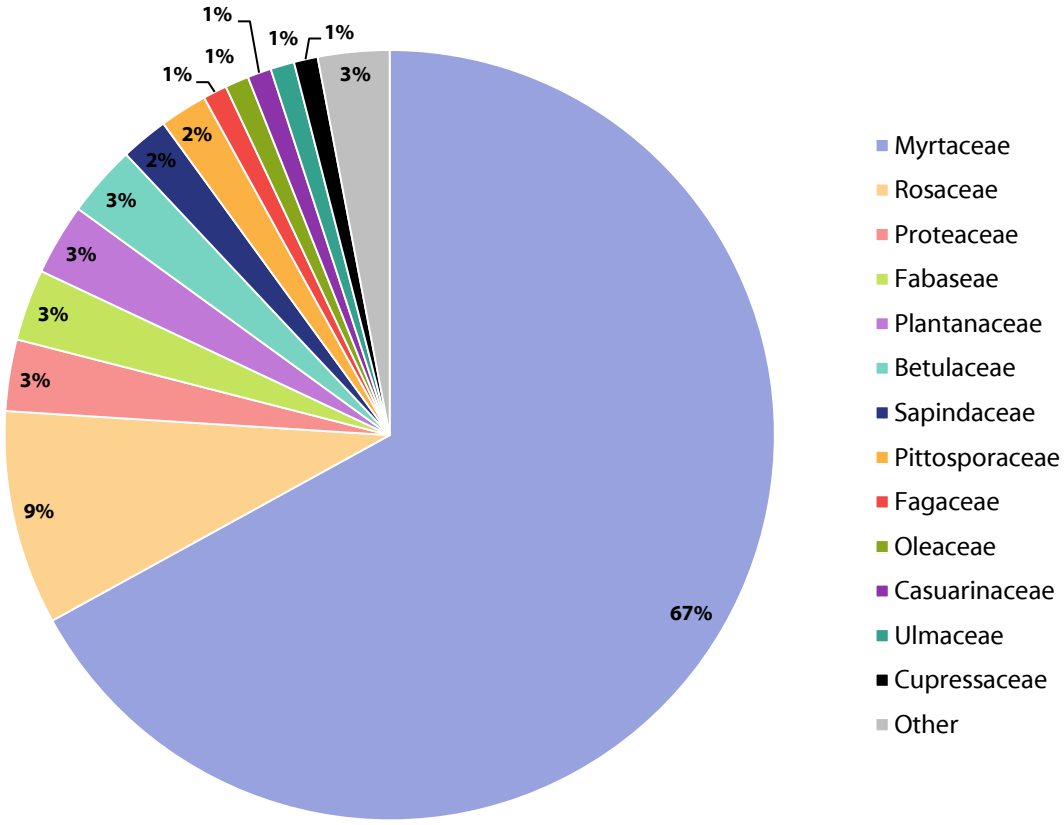


Figure 13 Overall breakdown of street trees by botanical family (2003)

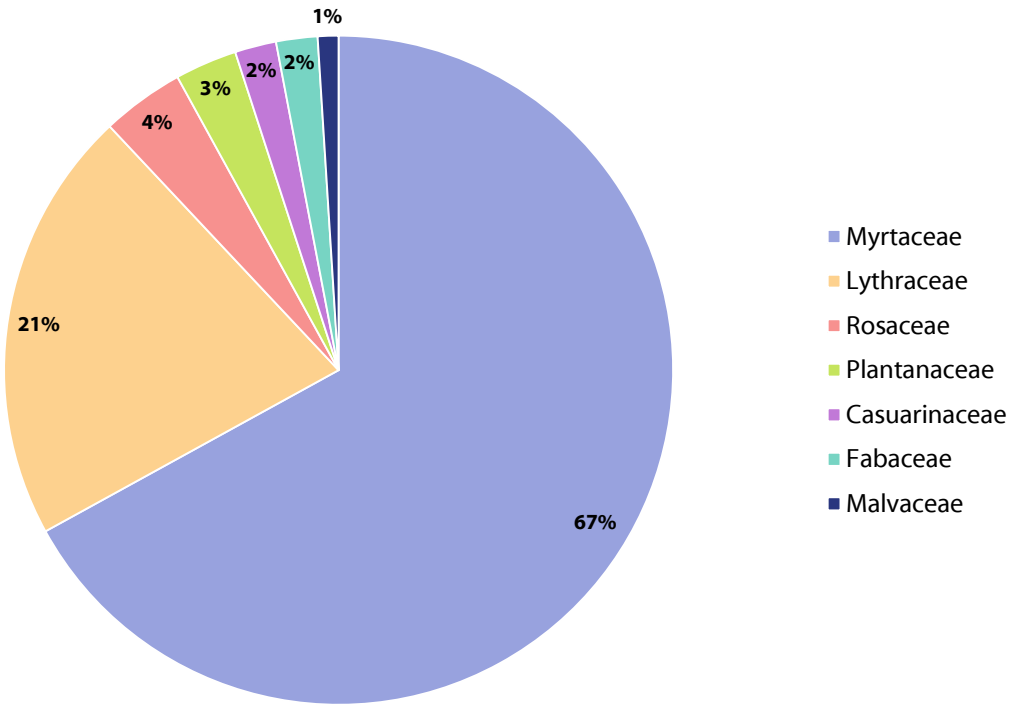


Figure 14 Breakdown of recent bulk street tree planting by plant families (2013/14)

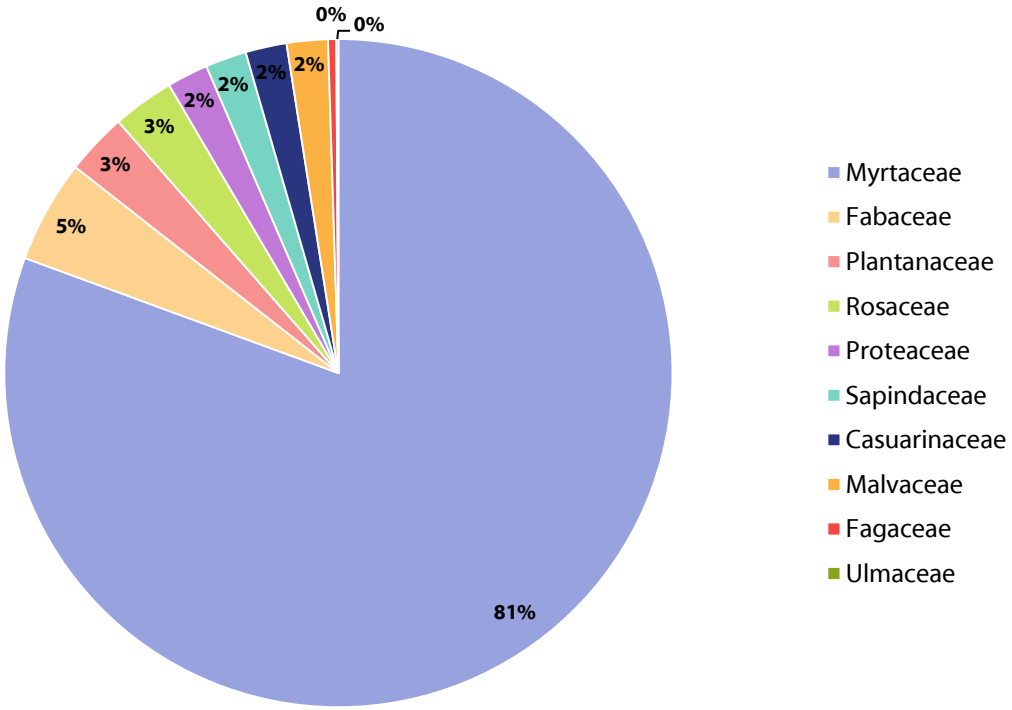


Figure 15 Breakdown of recent infill street tree planting by plant families (2013/14)

These charts show that, while the proportion of some plant families has been increased with new plantings, trees in Myrtaceae continue to be the majority of new plantings. This is in part due to planting guidelines within the *Neighbourhood Character Study*, and objectives of the Planning Scheme under Environmental Significance, Vegetation Protection and Significant Landscape Overlays (refer to Appendix K).

While Council acknowledges the importance of species diversity in maintaining a healthy street tree population, the planting guidelines within the *Neighbourhood Character Study* and the planning overlays are governing documents which determine where particular types of street trees can be planted. Given that Knox is uniquely situated at the foothills of the Dandenong Ranges, there are a number of areas where only indigenous and/or native street trees are permitted – particularly along the 'foothills' (eastern) side of the municipality. This rationale is further supported in the *Council Plan*, the *Revegetation Plan,* the *Green Streets Policy* and the *Sites of Biological Significance in Knox,* all of which highlight the value placed on biodiversity, places of natural significance and the ability to sustain native fauna within the municipality through increased habitat corridors. Furthermore, a 2013 study identified that more than 30% Eucalyptus street trees are actually required to support a diverse urban native bird population (Ikin 2013).

When considering targets for species diversity, it is therefore important to recognise the feasibility of achieving such targets in the context of species selection restrictions outlined above, which can ultimately constrain the ability to diversify. It is also important that any species diversity objectives do not openly contradict the objectives of already adopted policies, plans, guidelines and studies, nor significantly impact the urban character of Knox. Although there may be a limited opportunity to diversify in certain locations (particularly at a Family level, as a large portion of native and indigenous trees are in the Myrtaceae family), there is still an opportunity to diversify at a genus and species level. For example, the Myrtaceae family includes an estimated 900 Eucalyptus species and there is far more diversity within it than between some pairs of families. Furthermore, given that street trees are not subject to Council's *Genetic Integrity Policy*, where indigenous trees are the appropriate selection for particular sites, Council has the opportunity to also source stock from further afield to ensure a degree of genetic diversity.

It is important to note that any species diversity changes should not impact Council's existing street tree population – given the benefits that street trees provide, it would be misguided to remove and replace healthy trees solely for the purpose of species diversity. Nor does species diversity infer that street tree selection should solely be based on species origin. As noted in section 1.1.1, street trees grow in a difficult environment, and as such, street tree selection should continue to be based on the principle of planting the 'right tree in the right place'. This means that Council arborists should continue to select trees based on wide variety of factors including but not limited to; soil conditions, site exposure, overhead powerlines, underground services, tree size, specialised tree benefits and policy documents/guidelines.

3. 5 Recent Tree Planting (and Removal)

The following table shows Knox's recent street tree planting history. Overall, street tree numbers have been increasing since 2010 as more trees have been planted than removed. This data has only been captured consistently for the last 3-4 years.

Table 4 Annual street tree planting since 2010

Year	Total Street Trees Planted	Total Street Trees Removed
2010/11	1490	687
2011/12	2103	1139
2012/13	1822	1187
2013/14	2255	1422

3. 6 Risk Management

Risk management is an integral part of good asset management. The application of sound risk management allows for continual improvement in decision making and processes and is an essential consideration in the appropriate levels of service.

Trees are living organisms and as such come with a level of inherent risk. However, statistics in Australia and abroad show that urban trees do not pose a significant threat to the community (Norris 2010).

It is not possible for Council to address all defects and eliminate all risks, however they are being mitigated, for example, by undertaking inspections to identify risks. The levels of service for maintenance and inspection (outlined in Chapter 5) have been adopted as a result of the risk assessment process undertaken in developing Council's *Road Management Plan* (refer to Attachment 5 of that Plan).

Knox City Council's Risk Register Report specifically identifies tree damage to property and infrastructure as an Asset Management risk for Council. Overall inherent and residual risk ratings in regard to the tree damage risk are however currently classified as 'Low'. Council officers are regularly required to re-assess this risk rating and comment on how the risk is being mitigated. Examples of mitigating actions include:

- Proactive tree inspections undertaken on foot
- Funding for prioritised street tree replacement
- Funding for street tree maintenance programs.
- Development of a Street Tree Infrastructure Risk Assessment Matrix

3. 6. 1 Insurance Claims – Above excess

In the five years 2009/10 to 2013/14, Council received 12 tree-related insurance claims above its $10,000 excess (note: Council's excess has since increased to $20,000). The total payout relating to these claims is shown in the following table. Over-excess claims are managed by MAV Insurance on behalf of Council.

Table 5 Cost of insurance claims involving trees (2009/10 to 2013/14)

Status	Gross
Paid	$106,000
Pending	$221,000

From the 12 claims, the total paid out was $106,000 (including both insurer payments and Council's excess). Four claims were denied; eight were paid or are still pending.

3. 6. 2 Insurance Claims – Under excess

Under excess claims are managed by Echelon on behalf of Council. Over the five-year period (2009/10 to 2013/14) Council paid out $70,459 resulting from 208 claims totalling $508,195. Of the 208 claims, 162 have been finalised, 120 of which were denied with justification. 46 claims remain outstanding.

When both under and over excess claims are considered, the total payout from Council was less than $200,000 over a five year period.

Figure 16 Kingston Park Court, Knoxfield

Chapter 4:
Asset Lifecycle Management

4.1 Introduction

Trees require management through their lifecycle, from planning to planting, establishment, maintenance and finally removal. These lifecycle phases generally fall within the three key tree management programs undertaken by Council:

1 Capital works: includes planting, establishment and removal
2 Proactive inspections: to identify maintenance needs and mitigate risks
3 Maintenance program: to ensure street trees perform to their potential

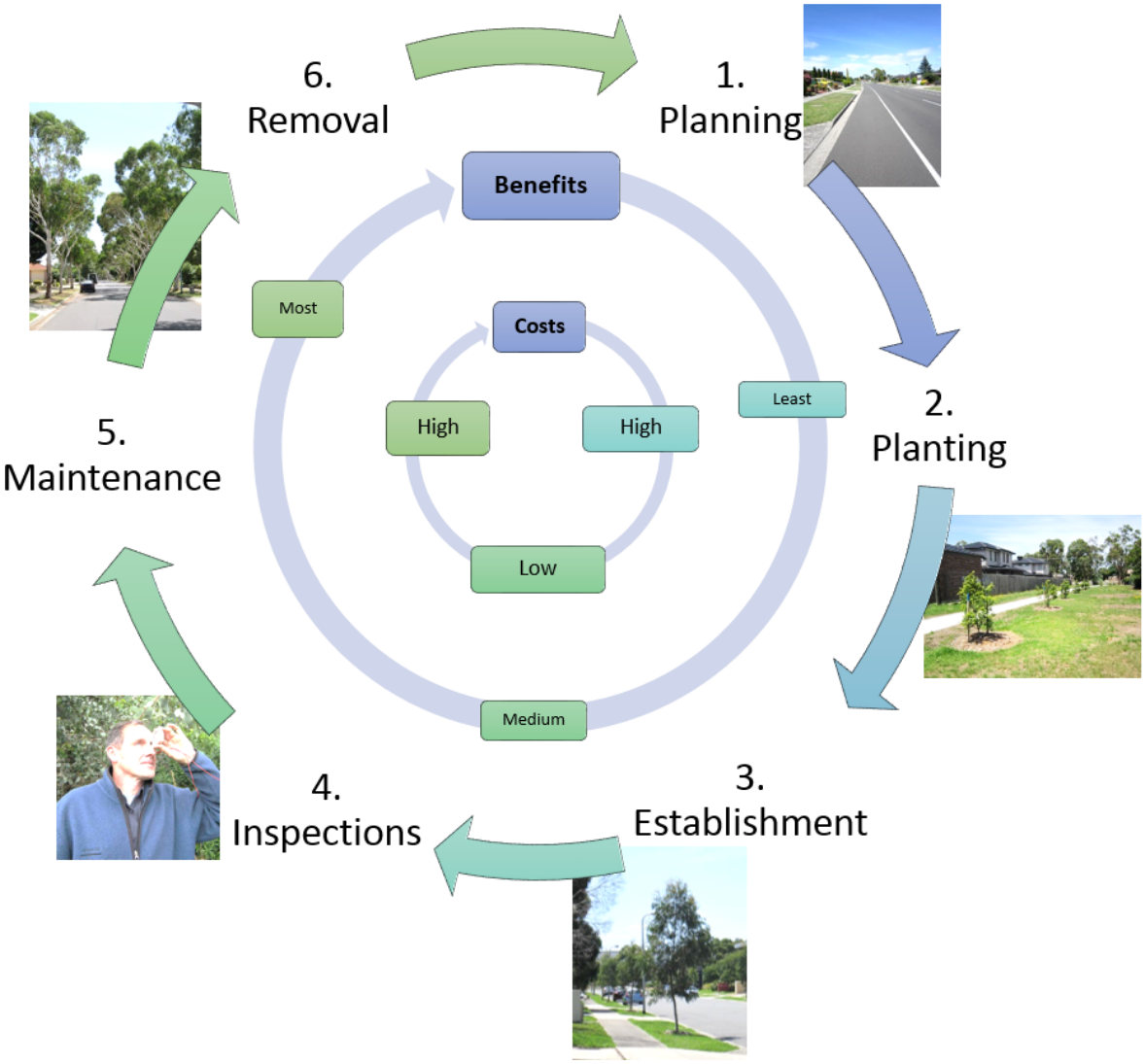


Figure 17 Lifecycle management of street tree assets

4. 2 Roles and Responsibilities

The main roles associated with street tree management at Council, and their relevant responsibilities, are outlined in the following diagram.

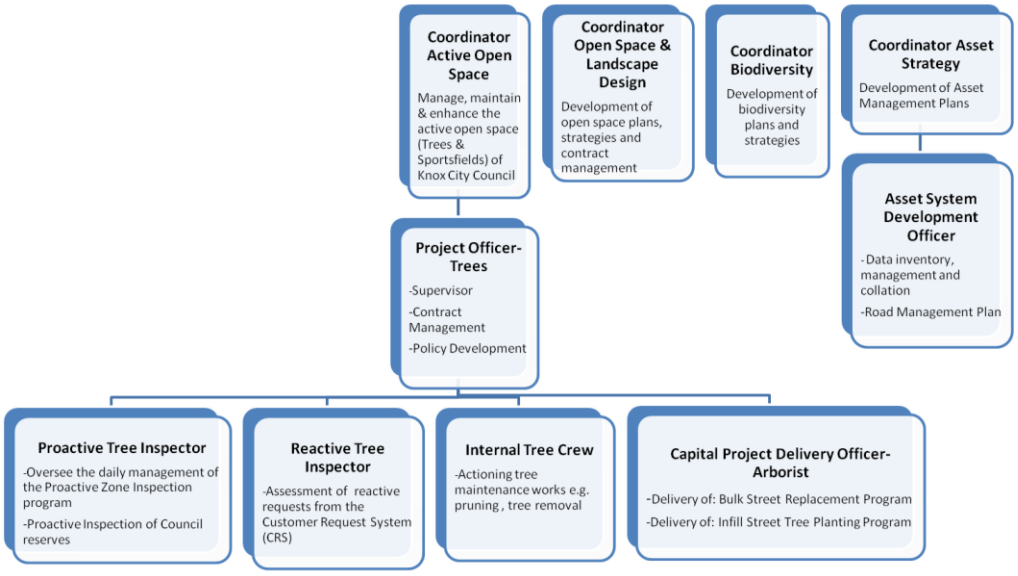


Figure 18 Council roles relating to street tree management

4. 3 Planning

Planning for street tree lifecycle management includes the following important considerations:

- Environmental benefits (and where possible supporting ecological outcomes and sites of biological significance)
- Social benefits
- Risks arising during tree lifecycle
- Financial costs of tree lifecycle management

The principal document outlining Knox's planning process regarding street trees is the Knox *Green Streets Policy*.

Total tree lifecycle management considers the inputs required to manage trees from planting, through their growth into maturity and on to their removal. This requires planning, before trees are planted, to achieve important outcomes:

- Identify locations in Knox that can support and will benefit from street trees.
- Design and engineer suitable planting locations that can support trees
- Choose appropriate species for the site
- Develop a planting program that maximises diversity of the tree population
- Manage the trees during their lifecycle to maximise the period during which they provide maximum benefits requiring the least input
- Have systems in place to respond to identified risks and issues
- Remove and replace trees at optimal times

4. 3. 1 Identify Locations for Planting

Council strategically allocates resources for street tree planting to maximise benefits, by identifying and prioritising streets with the lowest percentage of existing canopy cover. Recent analysis of satellite imagery has enabled each street in Knox to be assessed for canopy cover. This analysis has in turn identified streets lacking canopy cover. Upcoming planting programs will focus on those streets. Further analysis of satellite imagery will be undertaken to continue this program.

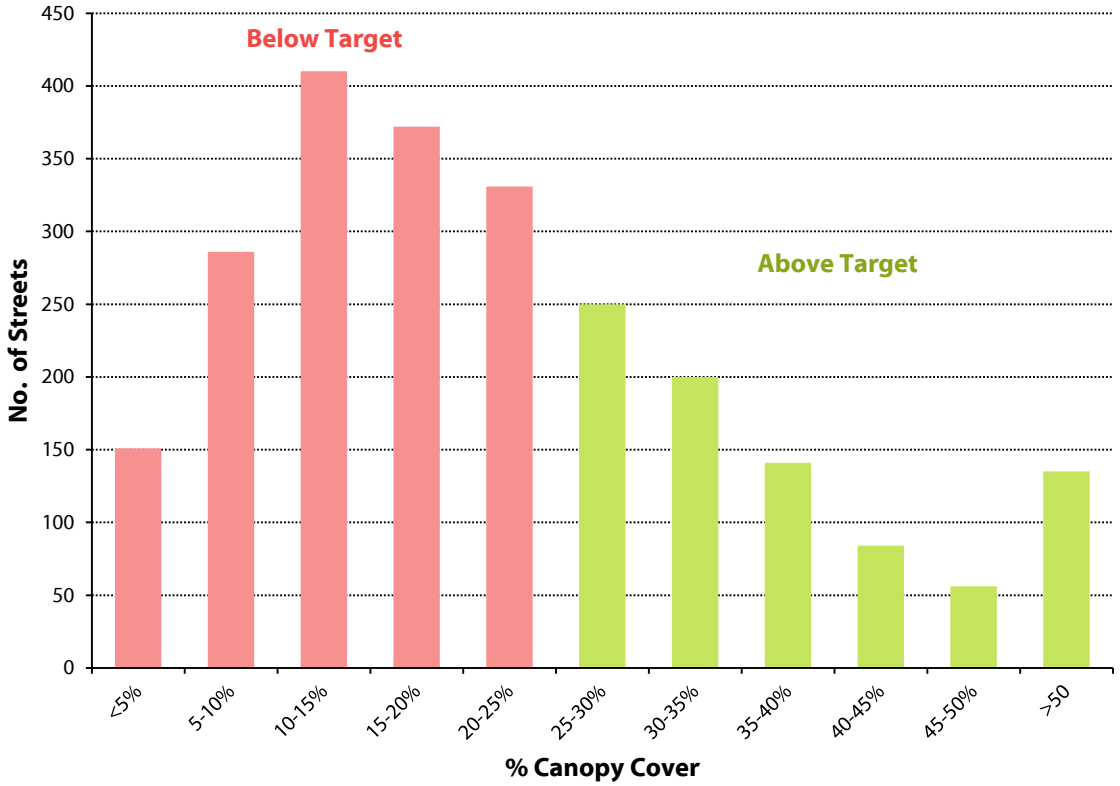


Figure 19 Number of streets with different amounts of canopy cover

For example, if 25% canopy cover is used as a target, the above graph shows that approximately 64% of streets (1,554) are below 25% canopy cover.

4. 3. 2 Design and Engineer Suitable Planting Locations

Well-designed planting sites minimise the likelihood of trees affecting surrounding infrastructure. Improving design of footpaths, roadways, water sensitive urban design (WSUD), services and other infrastructure can also assist to accommodate and support the health of street trees. However, it is acknowledged that redesigning infrastructure is a costly and timing process, therefore, in the interim, Council's arborists will utilise their knowledge of tree species growth rates in order to lessen the likelihood of trees affecting surrounding infrastructure.

4. 3. 3 Species Selection

To date, Council's street tree planting list has been updated through visual observations (tree performance) in addition to factors such as; site exposure, soil condition, available growing space, habitat value and underground services. The list includes evergreen and deciduous species which are categorised by Neighbourhood Character Area and sub categorised by size – small, medium or large trees. The current species selection list is contained in Council's *Green Streets Policy*.

Given that street trees grow in a complex and continually changing environment, it is beneficial widen the scope of evaluation criteria. Criteria such as: climate adaptation, vulnerability to pest and disease, ability to tolerate excessive pruning and specialised benefits (e.g. atmospheric pollution removal) would greatly aid in appropriate species selection. Ultimately, the greater the range of information available will ensure that the right tree is selected for the right place.

For further information on **PLANNING**, refer also to:

- *Green Streets Policy*

4. 4 Planting

Knox's program for tree planting is outlined in the Knox *Green Streets Policy*. Street tree planting is made up of bulk (or renewal) planting, and infill planting. In both of these programs, Council aims to improve canopy cover and to create quality avenues of street trees for the community by selecting high quality and appropriate stock.

Bulk Tree Replacement provides new trees along a street where there are few trees or where the majority of trees require replacement (healthy trees are retained to minimise social and environmental impacts). Replacement tree species are chosen by a Council arborist in accordance with Council's street tree selection guidelines and community consultation process. Bulk Tree Replacement streets are a part of Council's Capital Works Program; as such, streets are prioritised based on specific ranking criteria (refer Appendix B).

Infill planting provides trees in streets where vacant planting sites are identified in existing avenues of street trees. In general, if the existing tree species is considered appropriate and is successfully growing, then the new trees will usually match the existing species in the street. Due to stock availability and quality, it is preferential that tree planting requests be lodged no later than April of that planting year. The procedure for infill planting requests is outlined in Appendix J.

Planting programs are governed by budgets, tree availability at nurseries, and seasonal planting times.

- The timeline for the tree planting process is typically:
- Location identification (August–December)
- Inspect Nursery Stock (December–January)
- Purchase Stock (February)
- Plant (May–July)

Newly planted trees are maintained by Council's planting contractors for two years, after which time they are handed over to Council for ongoing maintenance. Typical maintenance during the first two years includes: watering, mulching, weed control and formative pruning.

For further information on **PLANTING**, refer also to:

- *Green Streets Policy*

4. 5 Inspections

4. 5. 1 Proactive Inspections

The Knox *Road Management Plan* (RMP) prescribes inspection requirements for all assets within the road reserve, including street trees. The main focus is on proactive (routine hazard) inspections which address both typical tree hazards as well as electricity line clearance issues.

Council's street trees are therefore inspected proactively in accordance with the following table. Inspections are programmed by zones and scheduled so as to comply with nominated frequencies.

Table 6 Roadside Vegetation inspection frequencies for identified risk levels and road hierarchy

Residual Risk Level	Road Hierarchy	Hazard Inspection Frequency for Roadside Vegetation
Extreme	Link VicRoads arterial	1 year cycle
High	Collector Industrial	1 year cycle
Medium	Access	1 year cycle (with power lines) 2 year cycle (without power lines)

Approximately 20 possible hazards are listed (with photographic examples) in the hazards list within the RMP (refer Attachment 4 of Council's RMP) with corresponding maintenance activities.

During the Proactive Zone Inspection program described above, any hazards are identified and recorded. For those that require action, the relevant maintenance activity is identified. Each maintenance activity is described in detail in the RMP; potential risks are identified; and target times are specified for the initial response and for completion of rectification works.

The Proactive Zone Inspection program ensures that street trees breaching the intervention levels defined in the Knox *Road Management Plan*, and in the *Electricity Safety (Electric Line Clearance) Regulations 2015* are rectified. In addition, the Proactive Zone Inspection program identifies street trees that have a 'poor' Tree Retention Value, such trees are removed and replacement trees planted.

To meet these inspections standards and frequencies, Council's current practice is as follows:

- EVEN (2016, 2018, 2020 etc) YEAR
  - Contractor inspects and then prunes all the Roads/Trees on the East side of Knox.
  - Council arborist (proactive inspector) inspects all roads (except Access Roads without powerlines) on the East side of Knox and actions as required.
- ODD (2015, 2017, 2019 etc) YEAR
  - Contractor swaps to the West side of Knox and the inspector to the East side.

Furthermore, between zone inspections, trees are reactively assessed when Council arborists are made aware of concern about a tree; see section 4.5.2 for further information.

4.5.2 Reactive Inspections

Apart from the proactive inspection process described in section 4.5.1, Council, also provides residents with a reactive tree inspections service. In general it is members of the public that utilise this service, however, occasionally internal work crews and other Council officers will also lodge reactive customer requests.

Typical customer requests involve limb failure, limbs overhanging private property, shedding of leaf and litter, and claims of damage caused by tree roots (that are identified outside scheduled inspections). Risk of injury or damage from limb or tree failure, are assessed by a Council arborist using the Visual Tree Assessment method (see 4.5.3 for further information) and a step-by-step process (Appendix E). The risk of tree root damage is assessed by a Council arborist using a series of matrices (see Appendix G).

Shedding of leaves, twigs, fruit and other small debris is not considered a reason for tree removal; however Council may respond with increased street sweeping to help alleviate the problem if the issues are assessed as severe.

As mentioned, Council's arborists use the Visual Tree Assessment method when assessing trees. A brief checklist form will be developed for Council's arborists to record details (see Appendix C). These forms can be filed in paper format; however there is an opportunity to develop an electronic recording system for ease of storage and access.

4. 5. 3 Visual Tree Assessment

The Visual Tree Assessment (VTA) method of determining tree health and structural condition is used widely by the Australian arboricultural industry, and it is the method applied by Council's arboricultural staff when assessing trees.

The VTA method enables arborists to determine tree condition by inspecting biological and mechanical aspects of a tree to identify structural weakness indications of roots, stem, limbs and branches, and the health of foliage.

VTA as a method focuses on external features of trees to identify defects and hazards. The nature of a defect or hazard identified by VTA may lead to a recommendation for a more intensive examination of a tree.

For further information on **INSPECTIONS**, refer also to:

- *Road Management Plan – Attachment 4*
- *Procedural Document Roadside Vegetation Audits*

4. 6 Maintenance

Council undertakes programmed (routine) maintenance, as well as reactive maintenance arising from both reactive and proactive inspections.

4. 6. 1 Street Tree Maintenance Service Levels

The *Road Management Plan (RMP)* outlines: timeframes and intervention levels for the initial response, temporary works and rectification works relating to a street tree maintenance activity. The timeframe in which pruning or other maintenance works are to be completed depends on: the reason for the works, the type of works, and the risk level. If rectification is not possible within the specified timeframe, Council will provide appropriate temporary protection works until permanent repair can be completed.

It is likely that during emergency situations, including storm events and large accidents, Council may only be able to provide temporary protection works within the designated timeframes. Response and rectification timeframes for other activities with lower risk levels may also be unachievable while Council responds to these higher risk level

events. In such cases a return to the specified timeframes will occur as soon as practicable following an emergency event. Council's approach to dealing with emergency situations is detailed in the RMP.

Aside from the service levels outlined in the RMP, maintenance practices such as tree branch pruning, tree root pruning, possum guards, and other practical treatments for trees, is performed in accordance with stipulations of appropriate Australian Standards, such as AS4373 *Pruning of Amenity Trees*. The table in Appendix F outlines current street tree maintenance service levels. Appendix J outlines the procedure for a customer initiated maintenance request.

4. 6. 2 Tree Pruning

Trees are regularly pruned (biennial) as part of Council Proactive Zone Inspection program. Pruning works may also arise from reactive inspections resulting from a customer request. The procedure for tree pruning requests is outlined in Appendix J. Broad principles regarding tree pruning are included in Council's *Green Streets Policy*.

Trees are pruned to:

- remove identified hazards;
- reduce risk;
- to improve tree health, structure and form; and
- to comply with current power line clearance regulations.

All tree pruning is in accordance with Australian Standard 4373 *Pruning of Amenity Trees* and is to current best practice.

Trees are *not* pruned:

- to preserve, create or enhance view,
- for the reduction of shade or leaf litter, tree debris,
- to deter roosting birds or other animals;
- outside the guidelines of AS4373 (e.g. lopping, excessive pruning).

4. 6. 3 Root Pruning

Roots are required for tree health and stability; roots cannot be removed without expertise and due care. In some cases Council will prune or remove roots (cut cleanly with clean, sharp tools) that are found to be causing damage, *or* are likely in the foreseeable future to cause damage. However, it is simply not always possible to cut or remove roots without seriously compromising the stability and health of the tree.

When Council identifies a risk of roots causing damage to infrastructure in the foreseeable future, a root barrier may be installed. The suitability of this response depends on: site conditions, soil type and other factors. The most common cause of root barrier failure is when roots grow over the top of the root barrier. This can be easily identified through visual inspections. Therefore Council should develop a program for inspecting root barriers on an annual basis.

In instances of current or potential future infrastructure damage due to street trees, tree removal will only be considered if a root barrier and/or root pruning is not possible or feasible.

4. 6. 4 Protecting Root Zones

Development and/ or working near trees can adversely affect tree health, and in some cases irreversibly. Above ground, machinery can damage tree stems and branches. Below ground, roots can be damaged by excavation and trenching. In addition, roots can be damaged in the long term by compaction of the soil within the root zone. Council relies on Australian Standard 4970 *Protection of trees on development sites* for guidelines for working near trees. The standard provides methods for protecting stems, branches and root zones.

Successful tree protection begins with an assessment of trees near development. A suitably qualified arborist can determine the suitability of each tree for retention, and their protection requirements during development.

The principal method of protecting trees is the *Tree Protection Zone* (TPZ- a specified area above and below ground and at a given distance from the trunk set aside for the protection of a tree's roots and crown to provide for the viability and stability for a tree to be retained where it is potentially subject to damage by development). The radius of the TPZ is calculated as: **TPZ = DBH x 12,** where DBH is the diameter of the stem at 1.4 metres above ground. The minimum TPZ radius is 2 metres and the maximum is 15 metres. Palms have a TPZ of crown projection plus one metre. The TPZ should be adjusted to protect the crown where necessary. Encroachment into the TPZ may be allowed under the guidance of an arborist.

Within the TPZ is the *Structural Root Zone* (SRZ- the area around the base of a tree required for the tree's stability in the ground, the woody root growth and soil cohesion in this area is necessary to hold the tree upright). Many factors can affect the actual location of structural roots, but AS4970 provides a model for calculating the radius of the zone where these roots are likely to be found. If works are proposed close to a tree, an arborist is required to assess the extent of the SRZ and provide guidance.

Minor encroachment (less than 10% TPZ area and outside the SRZ) is acceptable when the remaining TPZ can be adjusted to compensate for area lost to works. Major encroachment (greater than 10% TPZ area or inside the SRZ) requires an arborist to demonstrate that the tree will remain viable and the lost area should be compensated elsewhere and be contiguous with the TPZ.

Impacts on trees can be minimised during development by various methods, including alternative footing designs, using permeable surfaces, and using boring techniques or directional drilling when installing services and utilities.

For further information on **MAINTENANCE** (including pruning and root pruning), refer also to:

- *Road Management Plan – Attachment 4*
- *Green Streets Policy*

4.7 Removal

Street trees like all assets have a lifecycle and will eventually require removal and replacement. Trees that are found to have *Poor* Retention Value during Visual Tree Assessment (see section 4.5.3) will be removed through the following programs:

- Proactive zone inspections (see Appendix J)
- Reactive customer requests (see Appendix E)
- Bulk Street Replacement (as part of Capital Works renewal program)

Street tree removal undertaken as part of Council's renewal program (bulk tree replacement) is combined with replanting (refer section 4.4). The current ranking criteria for the bulk tree replacement program is described in Appendix B, however this is due to be reviewed in 2016.

When street tree removal is required, it will be done with as little environmental and social impact as possible, through community consultation, wildlife relocation and permit application (where appropriate).

4.7.1 Allergies

Allergies are complex. Many members of the community have allergies which are often heightened in spring; studies have shown that this is often associated with airborne pollen and particles from grasses and other plants, often found some distance away. In Council's experience street trees are rarely a significant cause, most street trees have limited flowering seasons during which they are likely to cause any problems. When this coincides with more widespread causes, such as grass pollen, it can be perceived as the cause.

As a general rule, street trees will not be removed on the grounds of allergic reactions. Any residents concerned about allergies should undertake allergy testing with a qualified medical practitioner to identify its cause. Council requires a medical certificate identifying the cause of the allergy before any further consideration will be given.

4. 7. 2 Wildlife Relocation

Before street trees are removed, they will be assessed for the presence of any native wildlife. If wildlife is found, it/they will be relocated by qualified personnel before the tree is removed. Council will delay removal or pruning of street trees in which birds are nesting or possums have dependent young.

For further information on **TREE REMOVAL**, refer also to:

- *Green Streets Policy (risk evaluation matrix and retention value)*

4. 8 Street Trees and Developments

New developments benefit from the presence of street trees, whether they are retained during development or newly planted. Planning applications which impact street trees are assessed by a Council arborist. Where development works may adversely affect the health and or structure of the existing street tree, Council's arborist will recommended mitigation measures. The *Green Streets Policy* provides guidance on assessing applications for tree removal. The flow chart showing this process is included in Appendix E.

For further information on **STREET TREES AND DEVELOPMENTS**, refer also to:

- *Green Streets Policy*

4. 9 Financial Forecasts

Future budgets (as currently documented in Council's Long Term Financial Forecast) to manage the phases outlined in this Chapter are shown in the following table.

Table 7 Forecast expenditure on street tree programs

YEAR	CAPITAL	OPERATIONAL		
	Renewal Expenditure Program 1013	Maintenance Expenditure Street Tree Pruning 34520	Maintenance Expenditure Residential Street Planting (Infill) 34527	Maintenance Expenditure Reactive Tree Maintenance* 34505
2015/16	$ 620,000	$ 905,931	$ 243,124	$ 1,038,635
2016/17	$ 779,000	$ 932,203	$ 250,175	$ 1,073,839
2017/18	$ 755,000	$ 956,440	$ 256,679	$ 1,107,457
2018/19	$ 620,000	$ 981,308	$ 263,353	$ 1,142,180
2019/20	$ 800,000	$ 1,006,821	$ 270,200	$ 1,178,043
2020/21	$ 800,000	$ 1,032,999	$ 277,224	$ 1,213,219
2021/22	$ 697,000	$ 1,059,857	$ 284,432	$ 1,249,479
2022/23	$ 674,000	$ 1,087,413	$ 291,828	$ 1,286,847
2023/24	$ 900,000	$ 1,115,686	$ 299,415	$ 1,325,362

* The Reactive Tree Maintenance program includes ALL Council trees in streets and reserves, and covers all reactive tree maintenance, stump removal, chemicals and all tree staff costs and overheads. Street trees account for approximately 90% of this expenditure.

Opportunities to review future budgets are discussed in Chapter 5.

Chapter 5:
Opportunities for Improvement

5.1 Introduction

Knox City Council has an effective and evolving system for managing street trees. Effective planning is a key component of this system. Recent developments have made significant gains in line with industry standards. To achieve best practice in managing street trees, the next steps involve a shift to obtaining and managing data that provide overview of the strengths and weaknesses of the urban forest. This enables opportunities for consolidation and improvement to be implemented.

5.2 Tree Management Systems

Successful day-to-day tree management relies on having strong policies and procedures, access to information and good communication between Council departments.

Council's ability to analyse existing conditions is limited by the age of the current tree data (2002/2003). Updated tree data would allow improved decision-making and budget forecasting (see 5.7 for further information) by Council. Canopy cover analysis has been done more recently (2013), however this too needs to be updated at frequent intervals if it is to be a useful tool to Council staff.

Current best practice of urban forest management at the local government level demands an up-to-date database of tree assets. Although the financial outlay for this database can be in the range of $120,000 to $400,000, depending on the number of data fields collected, these costs are offset by the long-term advantages the database gives to tree managers. For instance, such a database allows for sophisticated analysis of the tree population, which in turn provides the knowledge for identifying risks that can be minimised, developing diversity of the tree population, and selecting tree species.

The steps of developing and maintaining a tree database are typically:

- Data collection
  - Collect individual tree data including:
    - GPS location
    - Species
    - Information
    - Age
    - Condition (health)
    - Structure
    - Life Expectancy (LE)
    - Other relevant information such as impacts to infrastructure, and information that facilitates valuation of the trees' amenity and environmental benefits.

- Database management
  - Ongoing updating of the database with plantings, removals, work orders. This requires less resources as the information can be provided as a result of other programs such as planting, proactive assessments, reactive assessments and work orders.
- Analysis of the database to improve strategic planning for the urban forest.

As the technology around data collection is constantly developing, it is possible that the initial audit, and regular updates, could be a combination of on-ground individual data collection by arborists with data from satellite imagery including LIDAR, photogrammetry and other tools allowing tree canopies to be identified. This is useful well beyond street tree management – it assists with analysis of the entire urban forest including trees in Council reserves as well as trees on private land. It can be used to monitor tree health, changes in canopy cover, and more.

5. 2. 1 Recommendations

- Undertake data collection of all street trees within two years.
- Data collection of all street trees should be repeated, with fewer data fields required, at regular intervals, for instance every five years.
- Refine the street tree database management system so that once the data is collected, it can be updated on an ongoing basis (e.g. monthly) by Council officers and contractors supervising tree planting, maintenance and removals.

5. 3 Increasing Canopy Cover

As detailed in section 3.2, canopy cover analysis of Knox's street has found the average canopy coverage to be 22%. As this analysis identified the percentage of canopy cover to a street level, Council can identify areas where the street tree planting will have the greatest impact on the urban heat island effect as described in section 1.1. The dead, dying or hazardous street trees that are removed typically have large canopies compared to their immediate replacements. Based on preliminary assessments using a 30 year model, and acknowledging more plantings than removals, it still does take time to accumulate a noticeable net gain in canopy cover.

5. 3. 1 Recommendations

- Aim to increase the overall percentage of canopy cover within Knox's road reserves to a *minimum* of 25% in the next 30 years.
- Monitor progress using methods outlined in the previous section.

5. 4 Increasing Diversity of Street Tree Population

The street planting program can be improved by analysing the street tree database recommended above. Diversity for a resilient tree population should ideally include a mix of exotic, native and indigenous species, diversity of family groups with upper limits set for any one family, and diversity of age classes across the municipality.

The existing situation at Knox is highlighted in Chapter 3. Research on diversity principles and limitations specific to Knox are also documented in Chapter 3. Recent plantings have increased overall canopy cover, but have not significantly increased diversity of plant families.

The 30: 20: 10 rule (no more than 30% of street trees from any one plant family; no more than 20% from any one genus; no more than 10% from any one species) described in Chapter 3 is a commonly accepted diversity target for an urban tree population, adopted by a number of other urban Councils. However, given the various constraints outlined in this document in relation to neighbourhood character, Planning Scheme and overlays, the extent of the Myrtaceae family, and a strong community desire to maintain a connection to the Dandenong Ranges foothills and remnant indigenous vegetation, it is accepted that such a target is not likely to be achievable in Knox. In saying that however, there is still an obligation for Council's street tree managers to consider and improve species/family diversity across the municipality where the opportunity arises, provided that the right tree for the right place continues to be selected when all matters are taken into consideration.

5. 4. 1 Recommendations

- Improve the diversity of the Knox street tree population by giving detailed consideration to family, genus and species when street trees are selected for planting.
- Street tree species selection is to adhere to planting guidelines within the Neighbourhood Character Study, and objectives of the Planning Scheme under Environmental Significance, Vegetation Protection and Significant Landscape Overlays.
- Chosen street trees are to be well suited to the stressful conditions found in urban ecosystems, and sourced from a good quality gene pool.

5. 5 Planting

Performance of street trees is highly dependent on the quality of the tree stock at the time of planting. Opportunities for street tree planting will increase with greater use of different planting solutions.

5. 5. 1 Recommendations

- Update the existing tree procurement policy to include and elaborate on topics such as: specifications of tree stock to be supplied by nurseries, a process for auditing tree stock, and a process for dealing with any stock that does not meet specifications.
- Develop, and implement where appropriate, a greater range of planting designs and engineering solutions, for instance; greater use of engineered planting pits; incorporation of WSUD solutions to support tree health; using in-road cut-outs or pits for planting where nature strip conditions limit planting.
- Review and revise the current street tree selection list (as an amendment to the *Green Streets Policy*) against a greater range of evaluation criteria to reflect the dynamic growing environment of a street tree.

5. 6 Data Capture – Reactive Tree Inspections

Council's existing tree data was collected some years ago. There is an opportunity to improve all aspects of tree management through improved knowledge of the existing street tree assets.

5. 6. 1 Recommendations

- In the short term, for reactive tree assessments, record data on a brief checklist form to begin on paper (for an example of this form see Appendix C).
- Develop a system for recording root barrier installations and a program for annual inspections of all root barriers.

5.7 Review Budget Structure

Operational street tree management budgets have been historically over spent (see section 2.5), particularly in the area of reactive tree maintenance. Future budgets (see section 4.9) indicate this pattern will continue into the future. It is recommended that Council reassess its operational budget and allocate appropriate funding to reflect current expenditure. In terms of capital budgets, in the absence of updated street tree inventory data, it is difficult to assess the adequacy of existing capital budgets related to street trees. As new data becomes available (in accordance with section 5.2), there is an opportunity to review the future capital budget currently documented within Council's Long Term Financial Forecast.

5.7.1 Recommendations

- In the short term, look to re-distribute funds between existing operational budgets to reflect the true nature of over and under spending, for example, redistribute funds between the tree watering budget (increase) and the infill tree planting budget (decrease).
- In the long term, use existing Council data to identify potential spending patterns such as response to storms events; utilise this data during future budgetary planning.
- Use updated street tree inventory data to review the adequacy of future capital budgets.

Action ID	Recommended Action	Target Timeframe	Priority	Key Responsibility	Support from	Indicative Cost
STAMP 1	**Tree Management Systems**					
	a) Undertake data collection of all street trees within two years. Data collection of all street trees should be repeated, with fewer data fields required, at regular intervals, for instance every five years.	2017	Medium	Active Open Space	Asset Strategy	$120k (able to fund through existing audit/consultant operational budget)
	b) Refine the street tree database management system so that once the data is collected, it can be updated on an ongoing basis (e.g. monthly) by Council officers and contractors supervising tree planting, maintenance and removals.	2017	Low	Asset Strategy	Active Open Space	Existing operational
STAMP 2	**Increasing Canopy Cover**					
	a) Increase the overall percentage of canopy cover within Knox's road reserves. Aim for a *minimum* 25% canopy cover within 30 years. Monitor progress.	2045	High	Active Open Space	Biodiversity Open Space & Landscape Design	Existing operational (infill planting)
STAMP 3	**Increasing Diversity of Street Tree Population**					
	a) Improve the diversity of the Knox street tree population by giving detailed consideration to family, genus and species when street trees are selected for planting.	Ongoing	High	Active Open Space	Biodiversity Open Space & Landscape Design	Existing operational
	b) Street tree species selection is to adhere to planting guidelines within the Neighbourhood Character Study, and objectives of the Planning Scheme under Environmental Significance, Vegetation Protection and Significant Landscape Overlays.	Ongoing	High	Active Open Space	Biodiversity Open Space & Landscape Design	Existing operational
	c) Chosen street trees are to be well suited to the stressful conditions found in urban ecosystems, and sourced from a good quality gene pool.	Ongoing	High	Active Open Space	Biodiversity Open Space & Landscape Design	Existing operational

Action ID	Recommended Action	Target Timeframe	Priority	Key Responsibility	Support from	Indicative Cost
STAMP 4	**Planting**					
	a) Update the existing tree procurement policy to include and elaborate on topics such as: specifications of tree stock to be supplied by nurseries, a process for auditing tree stock, and a process for dealing with any stock that does not meet specifications.	2017	Medium	Active Open Space	Open Space & Landscape Design	Existing operational
	b) Develop, and implement where appropriate, a greater range of planting designs and engineering solutions, for instance; greater use of engineered planting pits; incorporation of WSUD solutions to support tree health; using in-road cut-outs or pits for planting where nature strip conditions limit planting.	2018	Low	Active Open Space	Project Delivery Open Space & Landscape Design Construction Place Management	Existing operational
	c) Review and revise the current street tree selection list (as an amendment to the *Green Streets Policy*) against a greater range of evaluation criteria to reflect the dynamic growing environment of a street tree.	2016	High	Active Open Space	Open Space & Landscape Design Biodiversity	Existing operational
STAMP 5	**Data Capture – Reactive Tree Inspections**					
	a) In the short term, for reactive tree assessments, record data on a brief checklist form to begin on paper (for an example of this form see Appendix C).	2016	High	Active Open Space	N/A	Existing operational
	b) Develop a system for recording root barrier installations and a program for annual inspections of all root barriers.	2017	Medium	Active Open Space	N/A	Existing operational

Action ID	Recommended Action	Target Timeframe	Priority	Key Responsibility	Support from	Indicative Cost
STAMP 6	**Budget Structure/Distribution**					
	a) In the short term, look to re-distribute funds between operational budgets to reflect the true nature of over and under spending, for example, redistribute funds between the tree watering budget (increase) and the infill tree planting budget (decrease).	2017	Medium	Active Open Space	N/A	Existing operational
	b) In the long term, use existing Council data to identify potential spending patterns such as response to storms events; utilise this data during future budgetary planning	2017	Medium	Active Open Space	N/A	Existing operational
	c) Use updated street tree inventory data to review the adequacy of future capital budgets.	2017	Medium	Active Open Space	N/A	Existing operational

Appendices

Figure 20 Segarta Circuit, Ferntree Gully

Appendix A: Tree data stored in Council's Asset Register

(This Appendix is current as at May 2016)

FIELDS	EXAMPLE	DESCRIPTION, POSSIBLE VALUES	In AREG table or AREG_History?	Fieldname
AssetID	284072	Lifecycle Asset Id number	AREG	ID_COUNTER
Tree Number	AR371	Unique tree number	AREG	GISLINK
Common Name	Weeping Bottlebrush	Common Name of Tree	AREG	ASSET_NAME
House No.	3	House	AREG	ADDRESS_1
Street Name	BEN ST	Street Name	AREG	ADDRESS_2
Frontage	Front	Adjacent, Cmedn (Central Median), Front, Osep (outside Separator), Opposite	AREG	ADDRESS_3
Vacant Site?	No	Yes or No	AREG	TEXT_1
Inspection Date	08-Jun-01	Inspection Date	AREG_History	HDATE_1
Removed?		Has the tree been removed (Y or N)	AREG_History	HTEXT_18
Genus	Callistemon	Genus of tree	AREG	TEXT_2
Species	viminalis	Species of tree	AREG	TEXT_3
Height	<3	<3, 3 to 6, 6 to 10, 10 to 15, >15	AREG_History	HTEXT_2
Diameter	100 to 300	<100, 100-300, 3-500, 5-700, 7-900, >900	AREG_History	HTEXT_3
Health	Good	Dead, Poor, Fair, Good,	AREG_History	HTEXT_4
Structure	Good	Hazardous, Poor, Fair, Good,	AREG_History	HTEXT_5
Overhead Wire	Other	None, LV, Other, LV & Other, LV & HV, HV	AREG_History	HTEXT_6
Pruning Required	Clearance	None, Clearance, Formative, Structural	AREG_History	HTEXT_7
Pruning Urg	Low	None, Low, Medium, High	AREG_History	HTEXT_8
Action Prob	None	None, Remove, Disease, Pest, Root Barrier	AREG_History	HTEXT_9
Action Urg	None	None, Medium, Low, High	AREG_History	HTEXT_10
Infrastructure	None	Road Pavement, Property, None, Kerb, Footpath	AREG_History	HTEXT_11
Infrastruc Urg	None	None, Low, High	AREG_History	HTEXT_12
Comments		Miscellaneous comments…	AREG_History	HTEXT_13
Property No.	296439	Geac TPKLPAPROP number	AREG	Num_5

Appendix B: Street Tree Replacement Program

(This Appendix is current as at May 2016)

This list of ranking criteria is current but is due to be reviewed in 2016.

The assessment process incorporates a triple bottom line evaluation which considers an assessment of the social, environmental and economic impacts of the project.

	Assessment Criteria Street Tree Replacement	**Score**
1	Treescape Value	
	Low	15
	Medium	7
	High	0
2	Overall Tree Health in the Treescape	
	Dead	10
	Poor	7.5
	Stressed	5.0
	Good	2.5
	Excellent	0
3	Overall Tree Structure in the Treescape	
	Extremely Defective	10
	Moderately Defective	7
	Minimally Defective	3
	Non- Defective	0
4	Potential Planting Opportunities	
	Vacant Sites	15
	Weed Species	10
	Trees in an Unsuitable Location	10
5	Renewal Works occurs in conjunction with other capital works	
	Yes	10
	No	0
6	Trees & Infrastructure with the Following criteria	
	Suspected of causing public & private infrastructure damage	10
	Suspected of causing kerb/road damage	5
	Suspected of causing footpath damage	5
	Maximum Possible Score	**100**

Appendix C: Reactive Tree Assessment Form – Proposed

(This Appendix is current as at May 2016)

Knox City Council – Reactive Tree Assessment Form

CRS Location

Asset id Species

Health	Crown	Scaffold limbs	Stem	Root buttress	Root zone	Defects
☐ Good	☐ Good	☐ Good	☐ Good	☐ Good	☐ Good	☐ Fungal decay
☐ Fair	☐ Fair	☐ Fair	☐ Fair	☐ Fair	☐ Fair	☐ Cavities
☐ Poor	☐ Poor	☐ Poor	☐ Poor	☐ Poor	☐ Poor	☐ Poor forks
☐ Action req'd	☐ Action req'd	☐ Action req'd	☐ Action req'd	☐ Action req'd	☐ Action req'd	☐ Root damage
Hazard codes			Maintenance codes			☐ Action req'd

Action

Inspected by Date

Appendix D: Tree Descriptors

(This Appendix is current as at May 2016)

The following descriptors are used during tree assessments.

Amenity	Describes the contribution that the tree makes to the subject site and surrounding properties with regard to aesthetic contribution, privacy, shading and so on. Amenity is classified according to the following categories: Very High High Medium Low	
Health	Summarises observations of tree health made in the field.	
	Good	No significant pest or disease problems, expected growth rates, dense canopy, and good leaf colour.
	Fair	Minor pest or disease problems, average growth rates, canopy perhaps sparse in places, or some chlorosis.
	Poor	Serious pest or disease problems, poor growth rates, sparse canopy, or major leaf discolouration.
	Dead	The tree is dead.
Comments	Summarise observations made in the field.	
Dimensions	are measured with laser equipment and tape measures where possible, otherwise estimated.	
	DBH	Diameter at Breast Height is measured at 1.4m above ground level, or calculated from the total stem area if the tree was multi-stemmed at that height. If measured elsewhere, such as below a swelling or fork, this is described in the report.
	Height	Measured with laser equipment where possible, otherwise it is estimated.
	Spread	Distance across the crown.
Maturity	Summarises the age class of the tree.	
	I	Immature: young tree with mostly dynamic mass.
	S	Semi-mature: actively growing tree that has not yet reached 70% of its mature size.
	M	Mature: tree has reached around 70% of its full size and growth has slowed.
	O	Overmature: tree has reached full size, is shedding large sections and is vulnerable to pests and disease.
Origin	Describes the source of the species:	
	I	Native trees that are indigenous to Knox.
	V	Native trees from elsewhere in Victoria.
	A	Native trees from elsewhere in Australia
	E	Exotic trees from outside Australia.

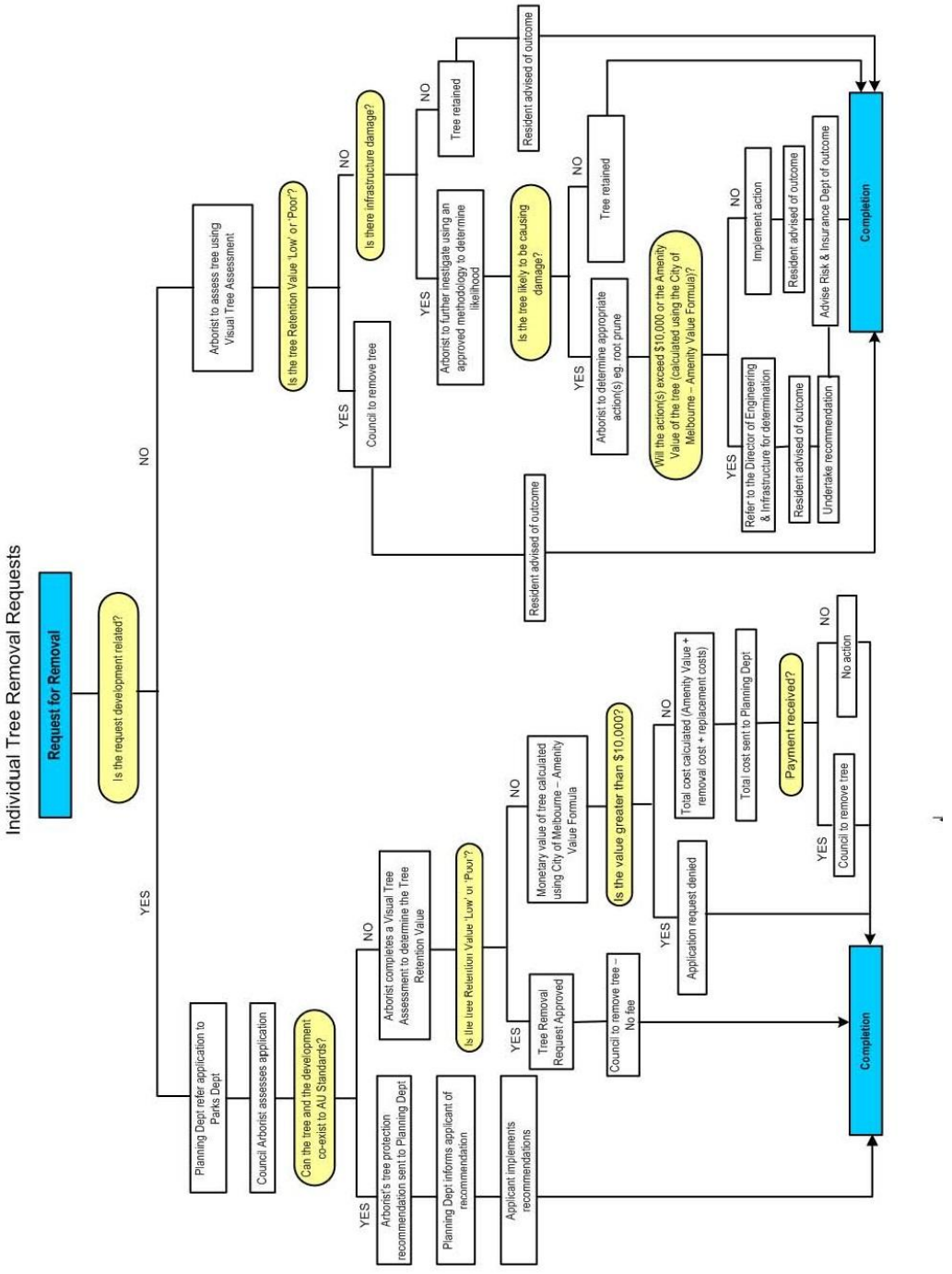
Retention Value	Considers several factors.	
	High Retention Value (Tree should be retained)	• Tree has the potential to be a long term component of the landscape i.e. long life expectancy; • Tree offers or exhibits cultural values; • Tree poses minimal risk to person or property; • Tree may have a trunk diameter greater than 400mm; • Tree is in very good condition has good form, health and structure; • Tree is of high amenity value; • Tree is worthy of auxiliary works to accommodate its retention; • Tree may be Heritage listed or of similar significance; • Tree (living or dead) is located in an Environmentally Significant Overlay (ESO), Vegetation Protection Overlay (VPO) or bush corridor and has high biodiversity value; • Tree has established hollows important for nesting and homes; and/or, • Tree may have minimal long term maintenance required.
	Medium Retention Value (Tree that is desirable to retain)	• Tree has the potential to be a medium to long term component of the landscape i.e. medium to long life expectancy. • Tree is in good condition, has reasonable form, health and structure. • Tree is of medium to high amenity value. • Tree could be retained with some auxiliary works. • Tree is 3 years old or more; • Tree is a remnant tree and adjacent to ESOs, VPOs or bush corridors; or, • Tree could be accommodated with appropriate levels of line clearance.
	Low Retention Value (Tree not desirable to retain)	• Tree is in average condition with a Life Expectancy (LE) of 2 years or less; • Tree has an untreatable pest or disease which cannot be practically cured or controlled and will send the tree into decline; • Tree is an identified, environmental weed or pest plant that Council is actively controlling as part of its maintenance program; • Tree has been planted by a third party and does not accord with Council's approved planting list; or • Tree is not in a good location and requires above average maintenance works.
	Poor Retention Value (Tree should be removed in the short term)	• Tree is in decline and has a LE of 1 Year or less; • Tree is in poor condition and structure with possible major dead wood; • Tree is causing safety issues for the travelling public that cannot be resolved by other means; • Tree is an identified, environmental weed or pest plant that Council is actively controlling as part of its maintenance program; • Tree has been planted by a third party and does not accord with Council's approved planting list; • Tree species may be on a proactive tree removal program; or, • Tree is dead and has no habitat value.

Significance	Summarises the significance of the tree in the landscape. This combines other attributes such as amenity, habitat value, origin, size, species, and cultural or historic value. Significance is classified according to the following categories: Very High High Medium Low
Structural Root Zone (SRZ)	Indicates the likely radial spread of the tree's structural roots, required for stability. This is calculated according to AS 4970 – 2009 *Protection of trees on development sites*.
Structure	Summarises observations of tree structure made in the field: Good – All forks sound, no major decay in limbs or trunk. Fair – Some poor forks developing, or decay developing in limbs or trunk. Major failure unlikely. Poor – Serious defects present, either poor forks, or decayed limbs or trunk; failure likely.
Suitability	Summarises the tree's suitability to the site based on health, structure, species and potential longevity. Good – Good health and structure, with potential longevity at the site. Moderate – Fair health and/or structure, requiring some treatment; may have shorter lifespan than "good" trees. Poor – Poor health and/or serious structural defects, unlikely to be repaired by treatment; unsuitable to site.
Tree Protection Zone (TPZ)	Indicates the recommended minimum distance (radius) from the trunk for protection of the tree's root zone during construction. This is calculated according to AS 4970 – 2009 *Protection of trees on development sites*: TPZ = 12 x DBH.
Life Expectancy (LE)	Indicates the anticipated remaining lifespan of the tree in its existing surroundings. Its lifespan is the time that it will continue to provide amenity value without undue risk or hazard and with a reasonable amount of maintenance. ULE is grouped into the following categories:
	0 (dead) 1-5 years 5-10 years 10-20 years 20-30 years 30-40 years 40-50 years >50 years

Appendix E: Street Tree Assessment Workflow

(This Appendix is current as at May 2016)

This tree assessment workflow outlines the process followed by Council's arborists in the administration of its tree management programs. This includes proactive and reactive tree programs. This workflow diagram is from the Knox *Green Streets Policy*.



Appendix F: Current Street Tree Maintenance Levels

(This Appendix is current as at May 2016)

These tables are reproduced from Council's Road Management Plan

PROACTIVE HAZARD INSPECTIONS

ASSET CATEGORY	HAZARD INSPECTION FREQUENCIES			
	ROAD HIERARCHY			
	LINK	COLLECTOR	INDUSTRIAL	ACCESS
ROADSIDE VEGETATION	1 year cycle	1 year cycle	1 year cycle	2 year cycle
ROADSIDE VEGETATION IN VICINITY OF OVERHEAD CABLES	1 year cycle	1 year cycle	1 year cycle	1 year cycle
VICROADS ARTERIAL ROADS	Roadside Vegetation for arterials listed in Table 5 of Knox Public Road Register – 1 year cycle			

Reference: Knox City Council Road Management Plan, Attachment 4, Part 2

ROUTINE MAINTENANCE

Maintenance Code	Maintenance Activity	Description	Current Service Level	Frequency
RV-ROU-038	Line Clearance	Prune street trees to provide adequate clearance around overhead cables. (This activity includes pruning within Arterial and Municipal Road Reserves, Nature Strips, Tree Reserves and Bushland Areas). Prune street trees to provide adequate clearance around overhead cables. (This activity includes pruning within Arterial and Municipal Road Reserves, Nature Strips, Tree Reserves and Bushland Areas).	Line Clearance in accordance with Electricity Safety (Electric Line Clearance) Regulations 2005.	2 year cycle
RV-ROU-039	Pruning - Street Trees & Shrubs	Street tree and/or shrub shaping to control future growth, provide for long-term stability/health and maintain desired height, lateral and sight clearances. Pruning to address dead/diseased and/or damaged limbs.	a) Prune Street Trees and Shrubs (where no overhead powerlines exist) to comply with the following clearance limits: Height Clearance: Footpaths and Shared paths: 2.5 m Roadway: 5m for Link and Industrial Roads, 3.5m for all other Roads Lateral Clearance (excluding groundcover vegetation not exceeding 500mm in height which does not encroach on path or road): Footpaths and Shared paths: 500mm Roadways: 1m from back of kerb, edge of shoulder or table drain. b) Prune/ remove vegetation (where no overhead powerlines exist) within clearance sight triangles as per Austroads Guidelines Part 5 - Intersections at Grade (Table 5.3). Trees/shrubs within identified significant vegetation areas are referred for impact assessment by Sustainability department prior to works.	3 year cycle (within road reserves)
RV-ROU-040	Tree Watering	Seasonal watering of selected trees & shrubs in centre medians, shopping centres, Local Area Traffic Management Treatments (LATMs) and selected deciduous trees in Road Reserves.	Water trees & shrubs in centre medians, selected shopping centres, LATMs and deciduous trees in Road Reserves as required based on weather conditions.	Seasonal (max. 3 week cycle during summer months)
RV-ROU-043	Pest and/or Vegetation Disease Control	Treatment to control spread of pests affecting the health of roadside vegetation and/or creating a public health risk.	Ground injection of all Municipal Elm trees to remove Beetles.	2 year cycle
RV-ROU-044	Bushland Management	Maintenance activities designed to retain, and where possible improve significant vegetation environments at selected sites.	a) Practice sensitive management of siginificant vegetation habitats within Road and Tree Reserves. b) Maintain habitats using appropriate management techniques such as weed control, exotic grass species removal, roadside burning, pruning, limb removal, pest/rodent control, signage maintenance and litter control. c) Annual inspection of reserves prior to Declared Fire Danger Period to ensure appropriate treatments are in place to reduce the risk of fire ignitions occurring in these reserves impacting on adjoining assets d) Maintain remnant native grass to 300mm height. e) Prune Street Trees and Shrubs (where no overhead powerlines exist) to comply with the following clearance limits: Height Clearance: Footpaths and Shared paths: 2.5 m Roadway: 5m for Link and Industrial Roads, 3.5m for all other Roads Lateral Clearance (excluding groundcover vegetation not exceeding 500mm in height which does not encroach on path or road): Footpaths and Shared paths: 500mm Roadways: 1m from back of kerb, edge of shoulder or table drain. f) Prune/ remove vegetation (where no overhead powerlines exist) within clearance sight triangles as per Austroads Guidelines Part 5 - Intersections at Grade (Table 5.3).	2 month cycle

Reference: Knox City Council Road Management Plan, Attachment 4, Part 3

REACTIVE MAINTENANCE

Maintenance Code	Maintenance Activity	Description	Current Service Level	Target Time for Initial Response	Target Time for Rectification Works
RV-REA-038	Line Clearance	Prune street trees to provide adequate clearance around overhead cables. (This activity includes pruning within Arterial and Municipal Road Reserves, Nature Strips, Tree Reserves and Bushland Areas). Prune street trees to provide adequate clearance around overhead cables. (This activity includes pruning within Arterial and Municipal Road Reserves, Nature Strips, Tree Reserves and Bushland Areas).	Line Clearance in accordance with Electricity Safety (Electric Line Clearance) Regulations 2005.	2 days	45 days
RV-REA-039	Pruning - Street Trees & Shrubs	Street tree and/or shrub shaping to control future growth, provide for long-term stability/health and maintain desired height, lateral and sight clearances. Pruning to address dead/diseased and/or damaged limbs.	a) Prune Street Trees and Shrubs (where no overhead powerlines exist) to comply with the following clearance limits: Height Clearance: Footpaths and Shared paths: 2.5 m Roadway: 5m for Link and Industrial Roads, 3.5m for all other Roads Lateral Clearance (excluding groundcover vegetation not exceeding 500mm in height which does not encroach on path or road): Footpaths and Shared paths: 500mm Roadways: 1m from back of kerb, edge of shoulder or table drain. b) Prune/ remove vegetation (where no overhead powerlines exist) within clearance sight triangles as per Austroads Guidelines Part 5 - Intersections at Grade (Table 5.3). Trees/shrubs within identified significant vegetation areas are referred for impact assessment by Sustainability department prior to works.	3 days	64 days
RV-REA-034	Tree Removal	Removal of dangerous street trees, and/or limbs within Road and Tree Reserves.	Provide temporary protection works and/or remove dangerous street trees and/or limbs posing a potential hazard to road users/ pedestrians or property. Trees/shrubs within identified significant vegetation areas are referred for impact assessment by Sustainability department prior to works.	3 days	92 days
RV-REA-034A	Stump Removal	Removal of dangerous stumps within Road and Tree Reserves.	Provide temporary protection works and/or remove dangerous street tree stumps posing a potential hazard to road users/ pedestrians or property. Trees/shrubs within identified significant vegetation areas are referred for impact assessment by Sustainability department prior to works.	3 days	92 days
RV-REA-035	Fallen Limb or Fallen Tree Removal	Removal of broken and/or fallen limbs and/or trees.	Remove broken and/or fallen limb and/or tree obstructing pedestrian/ cyclist or vehicular traffic movements.	2 days	32 days
RV-REA-043	Pest and/or Vegetation Disease Control	Treatment to control spread of pests affecting the health of roadside vegetation and/or creating a public health risk.	Temporary and/or permanent treatment to control pests and/or vegetation diseases based on Council Officer assessment of risk to both public and vegetative species (Beetles, spitfires, bees, wasps and white ants only).	3 days	96 days

Reference: Knox City Council Road Management Plan, Attachment 4, Part 3

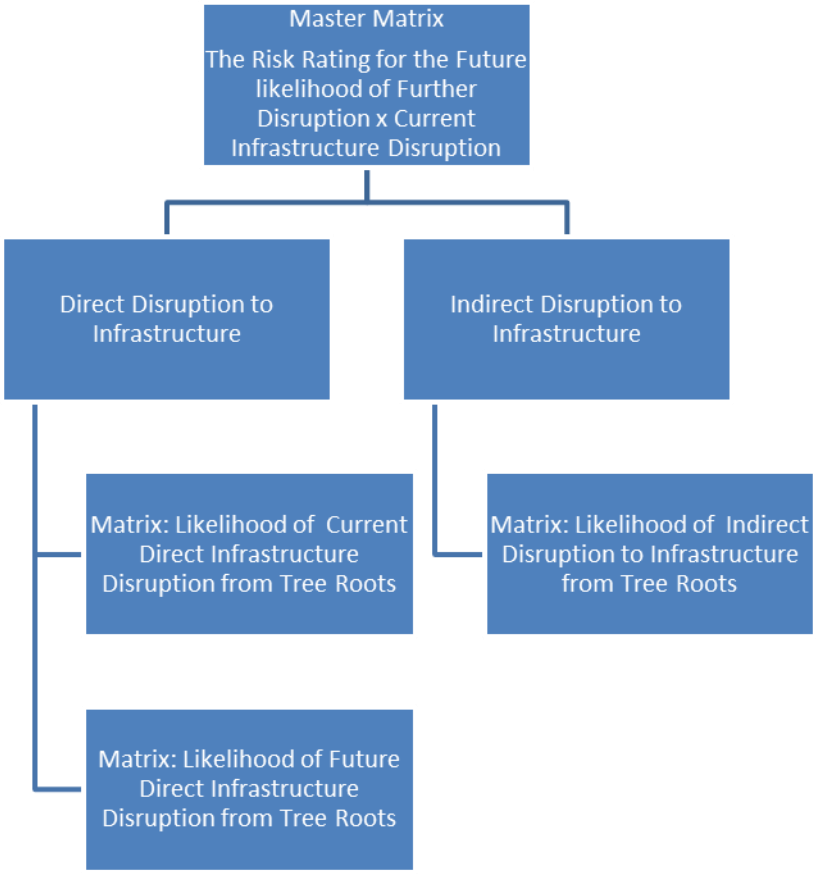
Appendix G: Street Tree Infrastructure Risk Assessment Matrix

(This Appendix is current as at May 2016)

This Appendix has been reproduced from Council's *Green Streets Policy*.

Note: The following matrix and series of supporting matrices have been developed to assist Council in the assessment of possible potential disruptive effects on public and private infrastructure. These matrices are intended to be applied as an indicator of potential and are not to be relied upon as providing definitive answers to questions of tree and infrastructure conflict (from *Green Streets Policy*).

Street Tree Infrastructure Risk Assessment Matrix Structure Diagram



Note: Where applicable a matrix or matrices are fed through the Master Matrix. The matrix which rates the highest in the Master Matrix will determine the overall risk rating.

Master Matrix

Infrastructure Risk Rating equals Future Likelihood of Further Direct or Indirect Disruption and Existing Infrastructure Disruption

This master matrix is the primary tool to establish the rating of risk and the associated actions to be applied. The master matrix is informed by an assessment of the existing levels of infrastructure disruption, and the results of assessments of the likelihood of indirect and direct infrastructure disruption as determined using the following three matrices. Of note, the matrix that reflects the highest level of risk will be used to determine the overall rating.

Existing Level of Infrastructure Disruption	Rare	Unlikely	Possible	Likely	Almost Certain
Severe					
Significant					
Moderate					
Minor					
Negligible					

Future Likelihood of Further Direct or Indirect Disruption

Risk Rating Results/Action Glossary	
Term	*Definition*
Critical	Immediate action required. Action may include removal of trees.
Major	Short term action required. Action may include targeted removal of tree or trees or mitigation works such as root barriers.
Moderate	Medium term action required. Action may include mitigation works such as root barriers. Continue to monitor the street for further issues through the Proactive Zone Inspection Program and re-evaluate as necessary.
Minor	The tree/treescape will be monitored for signs of further infrastructure disruption as a part of Proactive Zone Inspection Program.
Negligible	No action required.

Existing Level of Infrastructure Disruption Glossary	
Term	*Definition*
Severe	Major disruption to five (5) or more cases of private infrastructure (e.g. residential housing) within the same street and/ or claims with a cumulative value in excess of $100,000.
Significant	Major disruption to one to five (1-5) cases of private infrastructure and/or claims with a cumulative value not exceeding $100,000.
Moderate	Moderate disruption to private supporting infrastructure (e.g. residential garage) and/or claims not exceeding $20,000 or moderate disruption to Council infrastructure.
Minor	Minor infrastructure disruption to private property (e.g. boundary fence) or Council infrastructure (e.g. footpaths lifting over 20mm).
Negligible	Disruption to Council infrastructure that does not exceed intervention level (e.g. footpath lifting below 20mm).

Likelihood of Future Indirect Infrastructure Disruption

		Stage in Tree Lifecycle			
		Juvenile	Semi Mature	Mature	Over Mature
Soil Reactivity (AS2870 Classification)					
	S Class – Slightly Reactive	Rare	Rare	Rare	Rare
	M Class – Moderately Reactive	Rare	Rare	Rare	Rare
	M Class & Abnormal Moisture Conditions	Likely	Possible	Unlikely	Rare

Note: This matrix estimates the likelihood of indirect root disruption to infrastructure by evaluating the current stage in the lifecycle and the susceptibility of the soil to shrinkage.

Stages in Lifecycle Glossary	
Term	*Definition*
Juvenile	A recently planted tree that has begun to establish. In general, the tree is of good vigour but is not yet significant to the landscape.
Semi-Mature	A tree that is established, actively growing and is significant to the landscape.
Mature	A tree that has reached its expected size in its environment and is significant to the landscape. The tree is approximately in the middle stage of its life expectancy and in general is of good vigour.
Over- Mature	A tree that is fully established, moderately vigorous but slowing in growth.

Shrinkage Rating Glossary	
Classification	*Knox Soils (see following Soil Type Definition Table for more information)*
S	Qc4, Nc1,Djf, Djk, Dje & Djc
M	Qc1, Qa1, G241, Dxh, Sxm & Sxa
M Class & Abnormal Moisture Conditions	Where a residential dwelling lies within the zone of influence of a tree (where the height of the tree is greater than the horizontal distance from the base of that tree to the residential dwelling) on the following soil types: Qc1, Qa1, G241, Dxh, Sxm & Sxa. Interpreted from AS 2870- 2011 Residential slabs and footings.

Soil Type Definition Table	
Knox Council GIS KEY	**DESCRIPTION**
Qa1	Low level alluvium, beach sands
Dxh	Massive to thin bedded siltstones, interbedded near base (Humevale formation)
Qc1	Fan and slump deposits, hillwash
H	Metamorphic phase: Hornfels (Humevale formation)
G241	Granodiorite; minor hornblende granodiorite (Lysterfield Granodiorite)
Sxg	Laminated and current bedded sandstones, interbedded with massive siltstones and shales (Dargile formation)
Nb	Fine to coarse sands, with minor poorly sorted gravels, poorly consolidated (Red bluff sands)
Sxa	Massive siltstones. Interbedded with the sandstones. Occasional bunches of massive, laminated and current bedded greywackes, conglomerates, and clast beds
Djc	Several flows of dense rhyolite, often finely flow-banded, interbedded fragmental rhyolite at north
Dje	Numerous flows of rhyolites and rhyodacites, with interbedded fragmental flows and tuff beds
Djk	Single flow of rhyodacite flow banded at base (Kalorama Rhyodacite)
Djf	Single flow of biotite-hypersthene rhyodacites. Chilled glassy base schistose phase: highly schistose biotite-hypersthene rhyodacites (Ferny creek Rhyodacites)

Likelihood of Current Direct Infrastructure Disruption[1]

		Structural Root Zone			
		1.5m	2.25m	3.0m	3.5m
		(D=0.15m)	(D=0.4m)	(D=0.8m)	(D=1.2m)
Set- back Distance	0-2m	Possible	Almost Certain	Almost Certain	Almost Certain
	2-4m	Unlikely	Possible	Likely	Almost Certain
	4-6m	Rare	Unlikely	Possible	Likely
	6-9m	Rare	Rare	Unlikely	Possible
	9m+	Rare	Rare	Rare	Unlikely

Note: This matrix estimates the likelihood of current direct infrastructure disruption from tree roots. The matrix works on the premise that the structural root zone contains the roots that anchor the tree and will therefore contain the largest roots with the greatest potential to cause disruption. The structural root zone is not definitive and can change due to an impediment and/or soil conditions. When using this matrix Council's arborists will also take into account species specific root characteristics outside of the SRZ.

Glossary	
Term	*Definition*
Set-back distance	The distance from the base of the tree (at ground level) to the structure (e.g. house or footpath).
Structural Root Zone (SRZ)	The SRZ is the area around the base of the tree required for stability, the area to maintain a viable tree is much larger than this. An indicative SRZ radius is calculated by measuring the trunk diameter immediately above the root buttress and then putting the value into the follow formula: SRZ radius= (D x 50) 0.042 x 0.64. This calculation does not apply to trees with asymmetrical root zones. (AS 4970- 2009 Protection of Trees on Development Sites).

[1] The likelihood of current direct damage is required in order to determine the likelihood of future direct damage

Likelihood of Future Direct Infrastructure Disruption

		Current Stage in Life Cycle			
		Juvenile	**Semi-mature**	**Mature**	**Over-mature**
Likelihood of Current Direct Infrastructure Disruption	**Almost Certain**	Almost Certain	Likely	Unlikely	Rare
	Likely	Likely	Possible	Unlikely	Rare
	Possible	Possible	Possible	Unlikely	Rare
	Unlikely	Unlikely	Unlikely	Rare	Rare
	Rare	Rare	Rare	Rare	Rare

Note: This matrix predicts the likelihood of future direct disruption by evaluating the 'Current Likelihood of Direct Disruption' (determined from the Likelihood of Current Direct Infrastructure matrix) and the current stage in the life cycle.

Stages in Lifecycle Glossary	
Term	*Definition*
Juvenile	A recently planted tree that has begun to establish. In general, the tree is of good vigour but is not yet significant to the landscape.
Semi-Mature	A tree that is established, actively growing and is significant to the landscape
Mature	A tree that has reached its expected size in its environment and is significant to the landscape. The tree is approximately in the middle stage of its life expectancy and in general is of good vigour.
Over-Mature	A tree that is fully established, moderately vigorous but slowing in growth.

Appendix H: Tree Removal, Tree Valuation Method and Glossary

(This Appendix is current as at May 2016)

Council will use the following factors when calculating the charges for removing and replacing a tree.

Removal Costs

Applicants will be charged for:

1. The removal of the tree
2. The grinding of the stump and the surface roots

Amenity Costs[2]: City of Melbourne method

The City of Melbourne uses the following formula for calculating a tree's amenity value.

Value = Basic value ($) x S x A x L x C

Basic Value ($)

Knox Council will utilise the most up-to-date City of Melbourne Monetary Value table to determine the Base Value for a tree. Basic Value is a result of the tree's stem diameter at 1.4 metres (DBH).

In cases where the DBH does not correspond to an increment, Council's arborists will either round up or round down depending on the value. For example, a DBH of 42 will be rounded down to 40 and a DBH of 43 will be rounded up to 45.

Species Factor (S)

A qualified Council arborist will determine the species factor using their knowledge of the behavior of tree species in Knox and recognized industry publications regarding tree species longevity in an urban environment.

[2] Applications that involve tree species that are considered a 'weed species' by Knox City Council (as stated in Knox City Council- General Provisions Local Laws 2010, Administrative Guidelines) will not be charged an Amenity Value. However, the applicant will be charged for: the removal of the tree, the reinstatement of a new tree and two years establishment maintenance.

Aesthetics (A)

Aesthetic Factor	Knox Descriptor
Contributes little to the landscape	A tree that obviously does not fit with the existing treescape. For example, one evergreen tree in a street of deciduous trees.
One of a group of close planting	Trees in tree reserves, road reserves and, bush boulevards that are within 10 meters of each other.
Wide plantings	Trees in tree reserves, road reserves and, bush boulevards that are more than 10 meters from each other.
Irregular spacing between trees; regular spacing one side	Incomplete treescape- a treescape with numerous vacant lots that are scattered throughout the street.
Street or pathway planting, regular spacing both sides	Complete treescape- tree avenues with minimal vacant sites.
Solitary feature specimen trees	These trees are predominantly found in Council parks/ reserves, shopping centers and car parks.

Locality (L)

Locality Factor	Descriptor
In undeveloped bushland or open forest	Trees in tree and road reserves that are 10m+ from a property boundary. As illustrated below. 
In country areas and country roads	N/A in Knox
In outer suburbs areas and residential streets	Trees in: residential streets, industrial streets, tree reserves and roads reserves than are within 10m of a property boundary. As illustrated below. 
In inner city suburbs	N/A in Knox
In City Park or Reserve; significant street near City Centre	All trees in Council parks and reserves.
In City Garden, City Square, Mall or City Centre secondary street	All trees in Council car parks and shopping centers
City Centre Main Street, Principal Boulevard	N/A in Knox

Tree Condition (C)

A qualified Council arborist will use Visual Tree Assessment to assess the tree and determine the appropriate score for each assessment criteria.

Ecological Service Value

At present Knox Council will not be charging applicants for the 'Ecological Service Value' as Council is currently not using the i-Tree valuation tool and therefore cannot calculate a value.

Reinstatement Costs

Applicant will be charged for:

1. The purchase of a 30cm pot tree (species to be determined by Council's arborist).
2. The planting, staking and mulching of the tree
3. Two years maintenance for the tree, including watering, weed control and fertilising.

It is preferable that the replacement tree will be planted in front of the applicant's property. However, where this is not possible, the tree will be planted in an appropriate alternative location chosen by Council's arborists.

Appendix I: Overview of Council's Integrated Risk Management Process

(This Appendix is current as at May 2016)

Step 1: Identify Sources of Risk

Step 2A: Analyse Risk Consequences

Consequence	People	Environment	Financial	Safety	Technology	Operational Performance	Regulatory	Asset Management
Critical	Essential service failure that poses a critical safety risk to service users	Irreversible damage	Above $1,000,000	Death			Major breach where organisation faces criminal conviction	Condition of the asset poses a critical risk to users
Major	Essential service failure for more than 1 day Service or provider needs to be replaced Widespread negative coverage in media including televisionand papers	Harm requiring restorative work	Up to $1,000,000	Extensive injuries	Major corruption or loss of data that can't be recovered or failure of core systems for more than 2 days	Process is so inefficient or ineffective that it must be ceased immediately	Major breach where organisation faces heavy penalties	Condition of the asset causes a significant damage to property
Moderate	Temporary, recoverable service failure up to 1 day Issue raised in local community newspapers	Residual pollution requiringclean up work	Up to $250,000	Medical Treatment	Failure of core systems up to 2 days or noncore system up to 5 days	Process failure impacts service up to 1 day or requires significant injection of resources to maintain	Breach of legislation where the organisation is put under notice to remedy by external body	Inability of the asset to perform its function (service risk)
Minor	Brief service interruption up to half a day Customer complaints are escalated	Temporary pollution, e.g burn off outside of Knox causes smoke to drift into Knox area for short period and dissipates	Up to $50,000	First Aid Treatment	Failure of core systems for up to half a day or non core system up to 2 days	Process failure impacts service up to half a day	Systemic non compliance with legislation that is identified and remedied in house	Failure to preserve the ongoing value of the asset (investment risk)
Negligible	Negligible impact, brief reduction/loss of service Customer complaints resolved in dayto-day management	Brief, non hazardous, transient pollution	Up to $5,000	No Injuries	Failure of non core system up to a day	Brief interruption to process that has negligible impact on service	Non systemic incidents which are recognised and rectified during normal operations	Minor impact to the value of an asset at the end of its life cycle (investment risks)

Step 2B: Analyse Risk Likelihood

Likelihood	*Description*
Almost Certain	The event is expected to occur in most circumstances
Likely	The event will probably occur in most circumstances possible
Possible	The event should occur at some time
Unlikely	The event could occur at some time
Rare	The event may occur only in exceptional circumstances

Step 3: Evaluate the Risk

Consequence	*Negligible*	*Minor*	*Moderate*	*Major*	*Critical*
Likelihood					
Almost Certain	Medium	Medium	High	High	Extreme
Likely	Low	Medium	Medium	High	Extreme
Possible	Low	Low	Medium	High	High
Unlikely	Low	Low	Medium	Medium	High
Rare	Low	Low	Low	Medium	Medium

Step 4: Treat the Risk

Extreme Risks	Must be eliminated/mitigated immediately
High Risks	Need urgent action within one month
Medium Risks	Need action within six months
Low Risks	May not require immediate action but will be reviewed annually

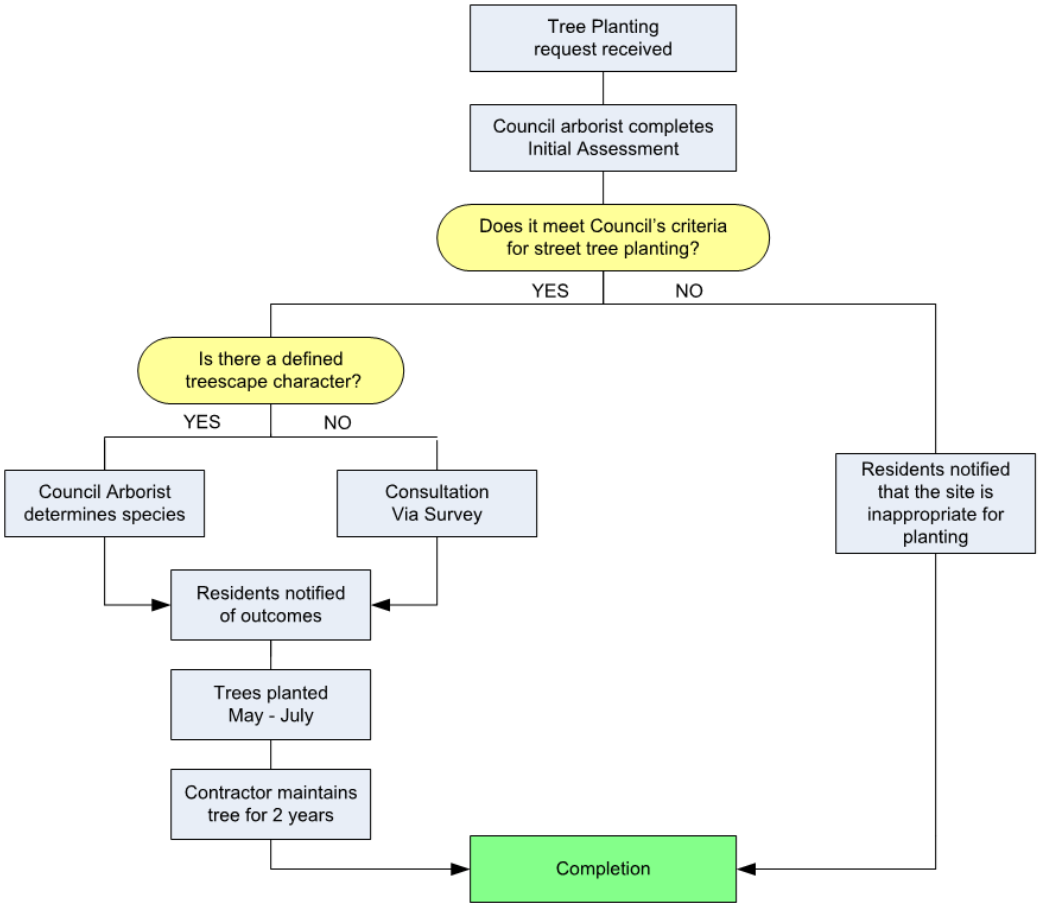
Step 5: Monitor and Review Risks

- Record actions in the Business Plans and follow up
- Refer residual risks with a rating of medium or above to Corporate Risk Register

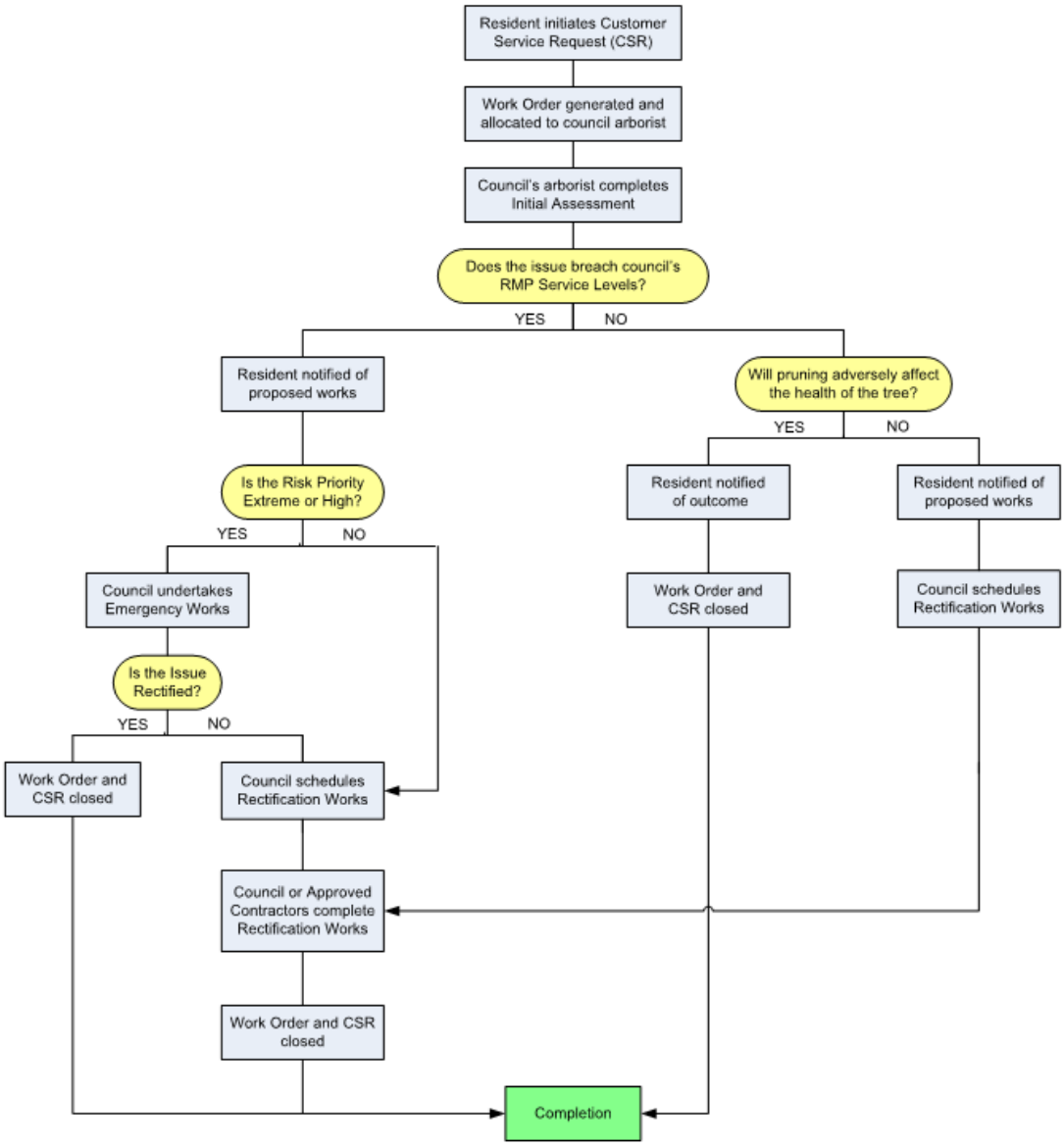
Appendix J: Common Street Tree Procedures

(This Appendix is current as at May 2016)

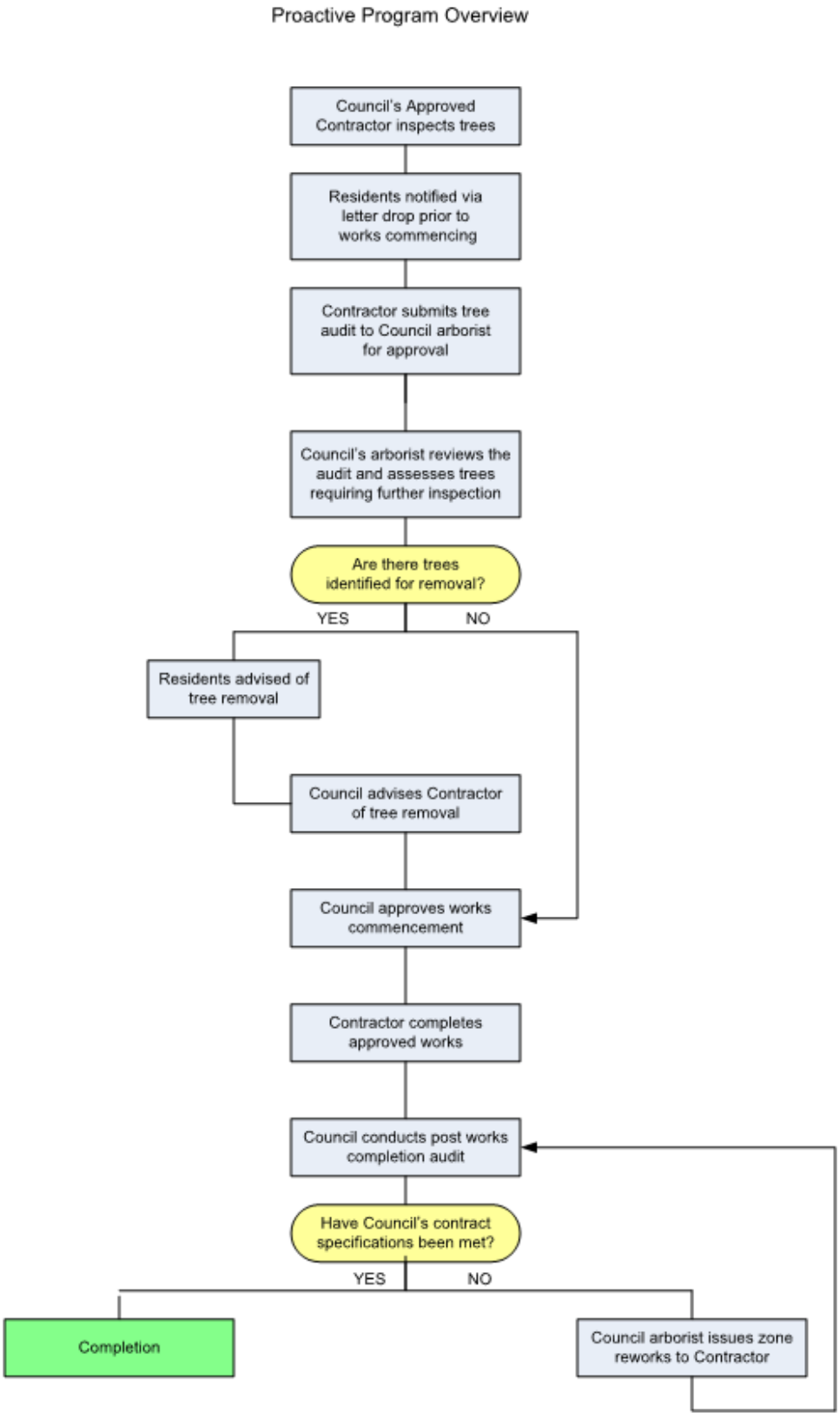
1. Tree Planting Requests



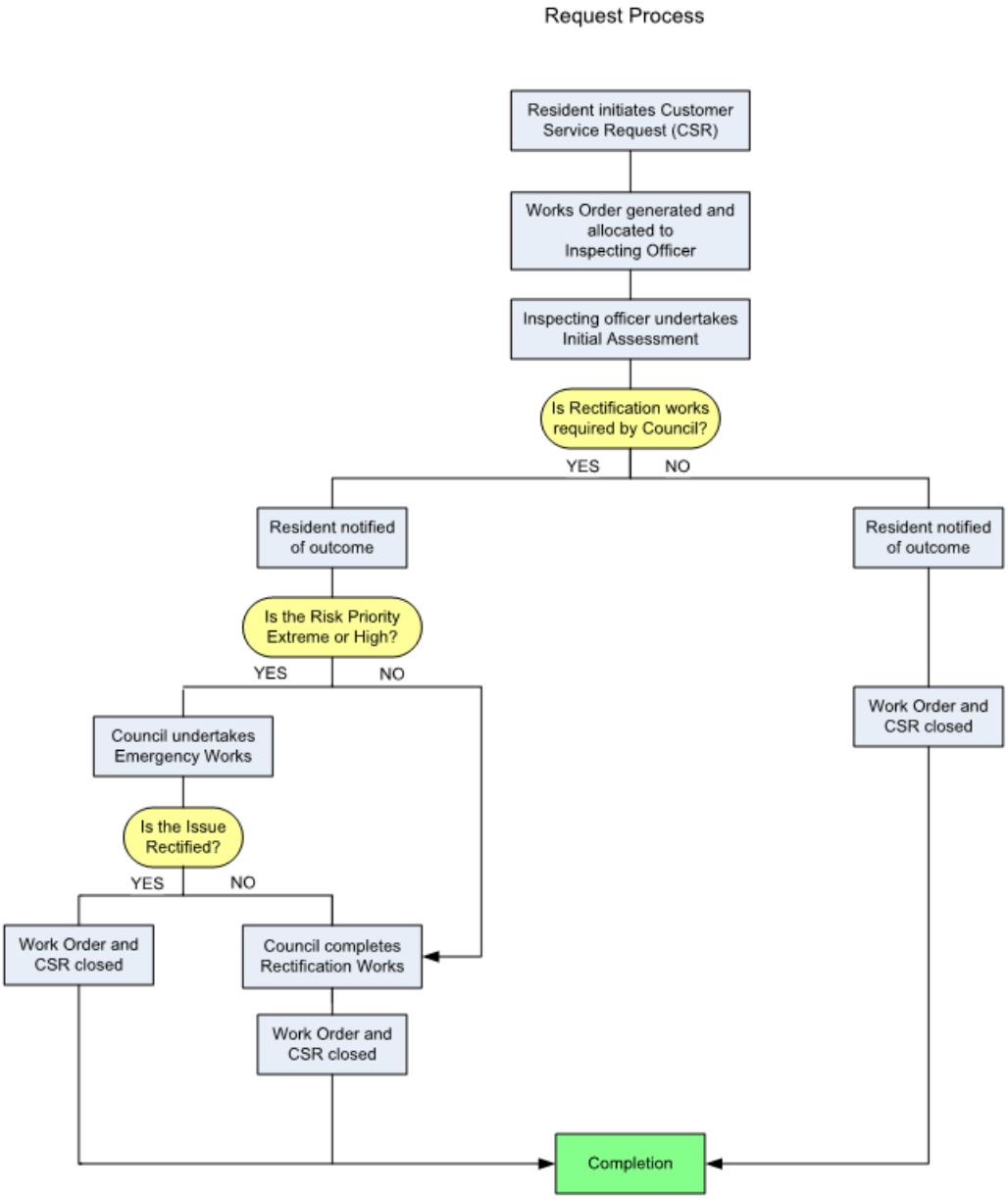
2. Tree Pruning – Reactive Requests



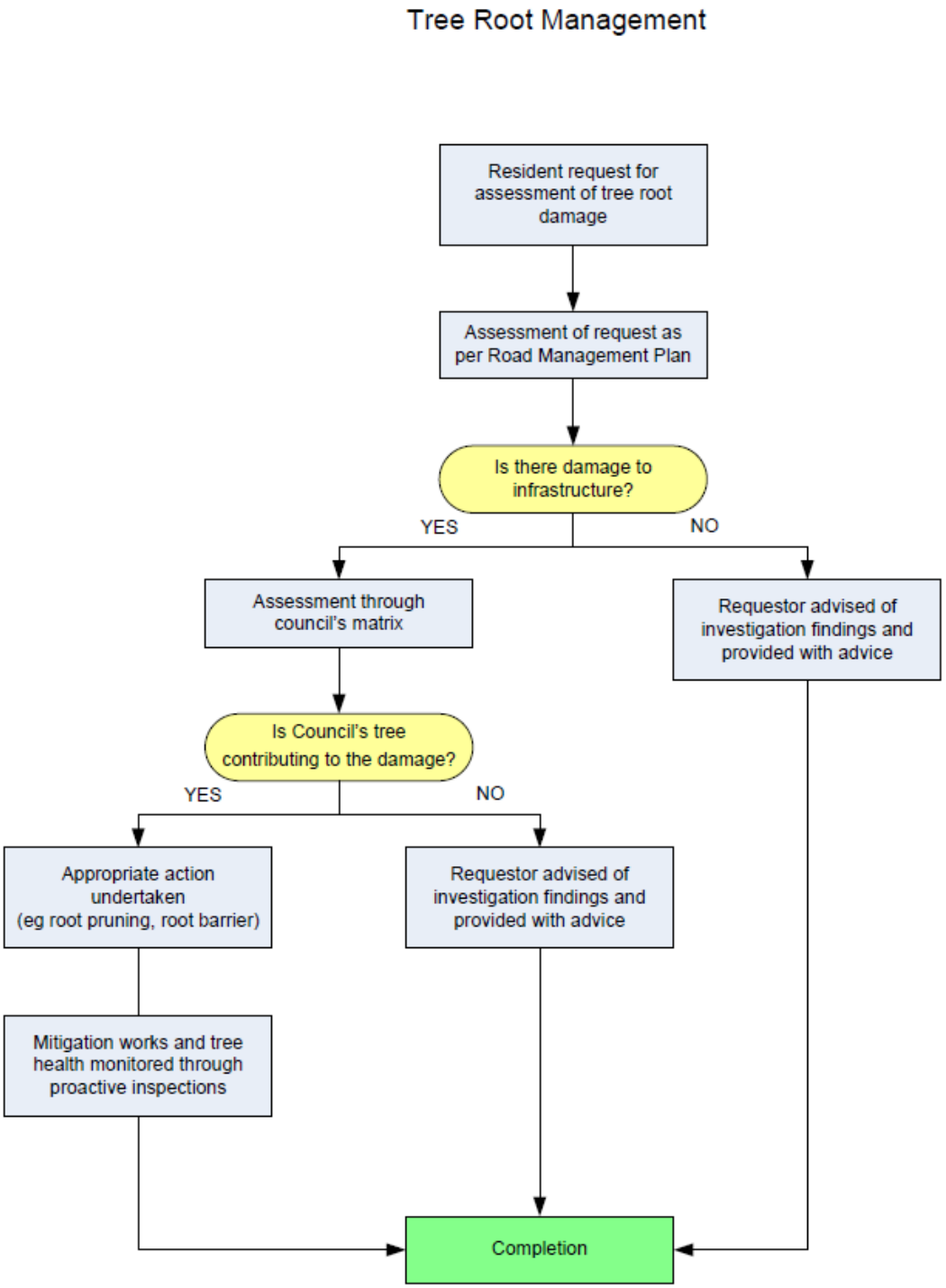
3. Council Contractor Proactive Program Overview



4. Tree Maintenance Request Process



5. Tree Root Management Request Process



Appendix L: Knox Planning Scheme Overlays

(This Appendix is current as at May 2016)

The following vegetation controls are documented in the Knox Planning Scheme.

Significant Landscape Overlay (SLO)

A permit is required to remove, destroy or lop a tree if it has a height of 5 metres or more or a trunk girth greater than 0•5 metre when measured at a height of 0.5 metres above adjacent ground level (on sloping ground to be taken on the uphill side of the tree base) or immediately above the ground for multi-stemmed trees.

Vegetation Protection Overlay Schedule 1 (VPO1)

A permit is required to remove, destroy or lop native vegetation.

Vegetation Protection Overlay Schedule 3 (VPO3)

A permit is required to remove, destroy or lop native vegetation which complies with both of the following:

- Has a height of 8 metres or more.
- Has a trunk more than 300mm in diameter (measured at 1200mm above the base of the tree).

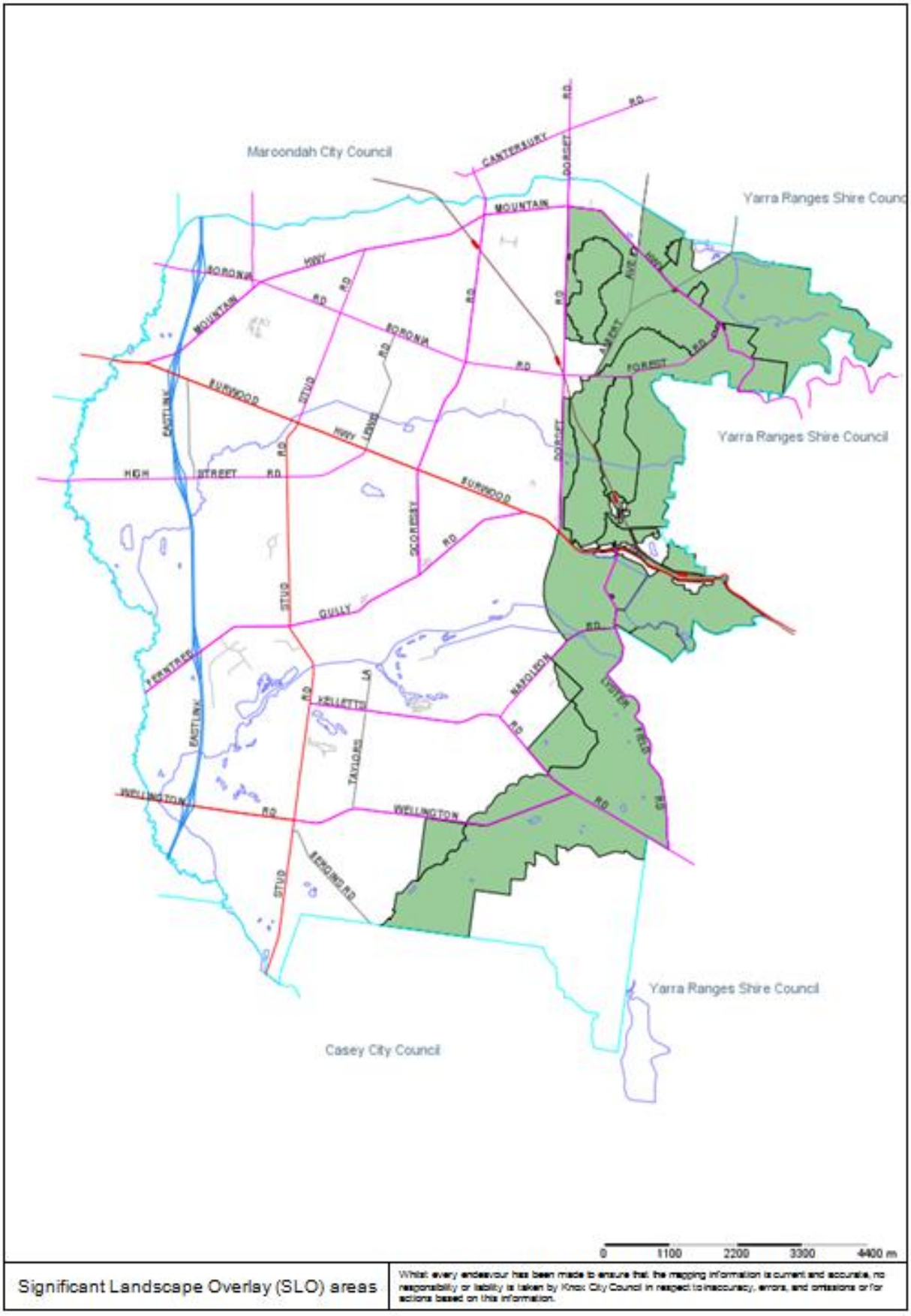
Vegetation Protection Overlay Schedule 4 (VPO4)

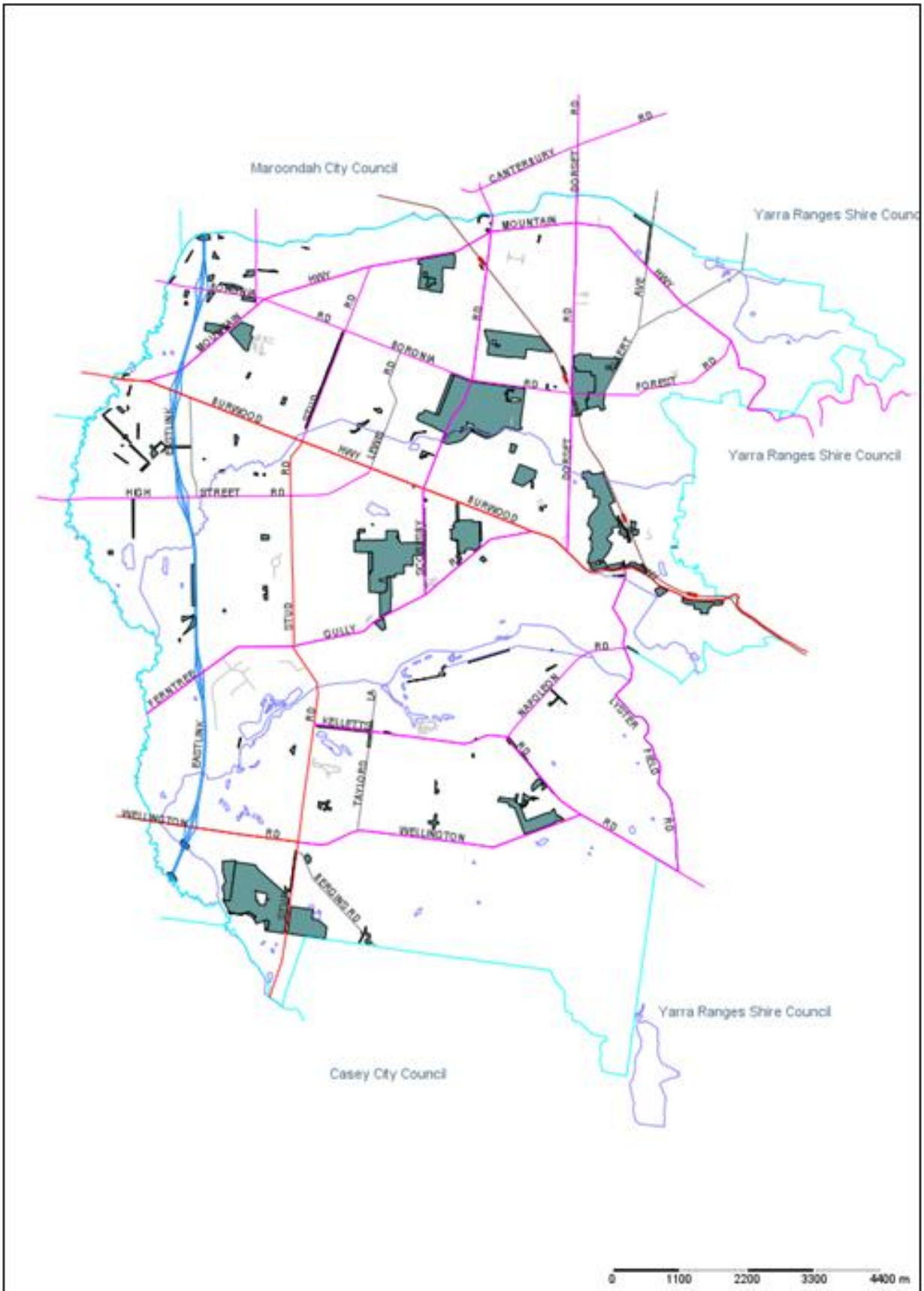
A permit is required to remove, destroy or lop native vegetation if it has a height of 5 metres or more or a trunk girth greater than 0•5 metre when measured at a height of 0.5 metres above adjacent ground level (on sloping ground to be taken on the uphill side of the tree base) or immediately above the ground for multi-stemmed trees. A permit is also required for the following trees;

- Lemon-scented Gum Corymbia citriodora, Eucalyptus citriodora
- Narrow-leafed Black Peppermint Eucalyptus nicholii
- Wallangarra White Gum Eucalyptus scoparia
- Brush Box Lophostemon confertus, Tristania conferta
- Red-flowering Gum Corymbia ficifolia, Eucalyptus ficifolia

Environmental Significance Overlay (ESO)

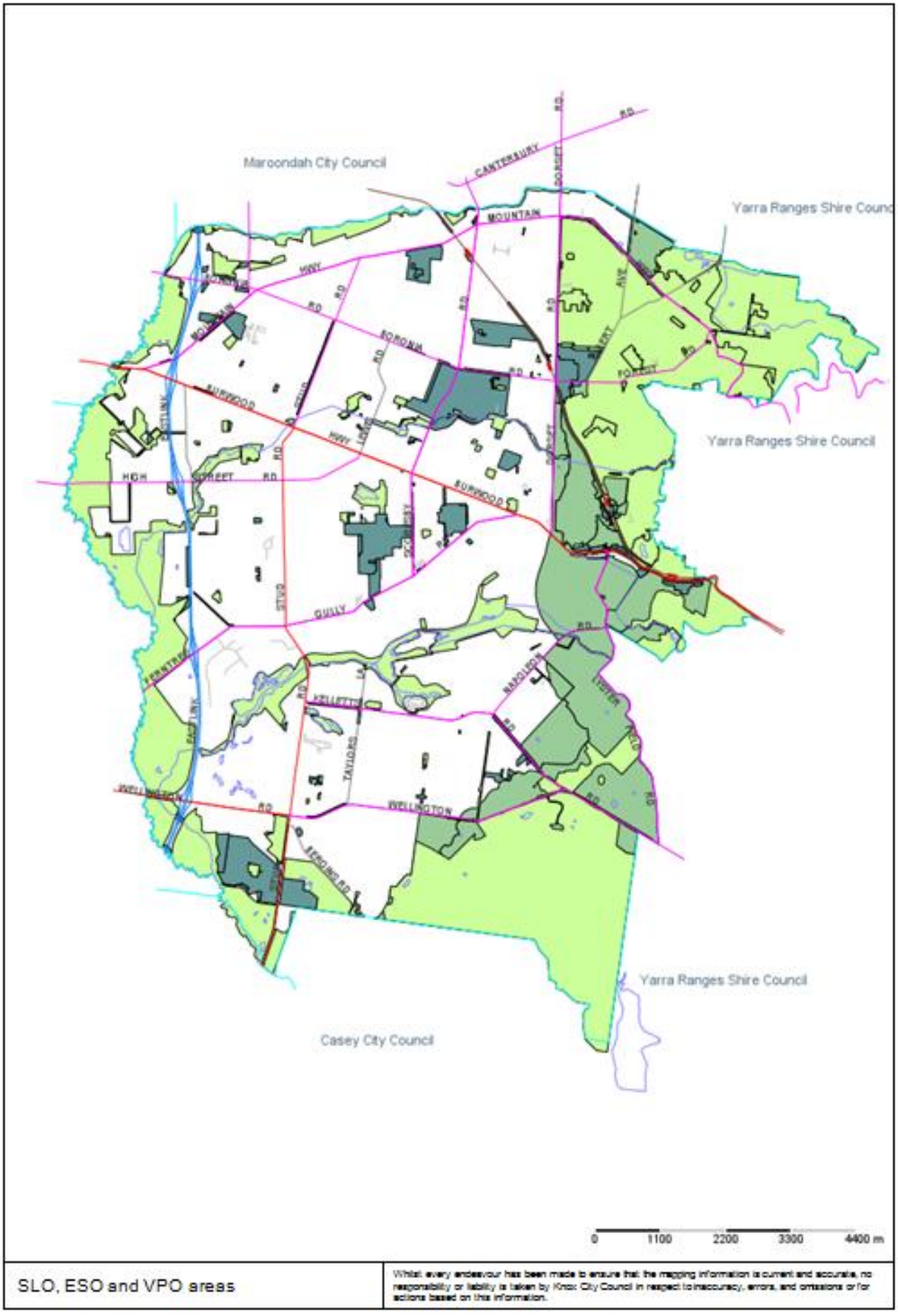
A permit is required to remove, destroy or lop native vegetation (Indigenous to Knox).


Maroondah City Council
Yarra Ranges Shire Council
Yarra Ranges Shire Council
Yarra Ranges Shire Council
Casey City Council
CANTERBURY RD
MOUNTAIN HWY
BORONIA RD
BURWOOD HWY
HIGH STREET RD
SCORESBY RD
GULLY RD
KILLETT LA
WELLINGTON RD
FERNTREE GULLY RD
STUD RD
DORSET RD
FOREST RD
EASTLINK
TAYLORS RD
LOWER FERNTREE GULLY RD
0 1100 2200 3300 4400 m
Significant Landscape Overlay (SLO) areas
Whilst every endeavour has been made to ensure that the mapping information is current and accurate, no responsibility or liability is taken by Knox City Council in respect to inaccuracy, errors, and omissions or for actions based on this information.



Vegetation Protection Overlay (VPO1, VPO3, VPO4) areas

Whilst every endeavour has been made to ensure that the mapping information is current and accurate, no responsibility or liability is taken by Knox City Council in respect to inaccuracy, errors, and omissions or for actions based on this information.



SLO, ESO and VPO areas

Whilst every endeavour has been made to ensure that the mapping information is current and accurate, no responsibility or liability is taken by Knox City Council in respect to inaccuracy, errors, and omissions or for actions based on this information.

Appendix L: References (external)

(This Appendix is current as at May 2016)

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Street Tree Asset Management Plan

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