3.1 Risk management strategies for existing trees

Strategy	Description
Monitor trip points	Where no other practical method can be employed to prevent this occurring, a regular trip point inspection program should be instigated and pavement replaced or repaired as necessary.
Flexible pathways	Use of flexible material such as bitumen, paving, or rubber compounds for footpaths and tree surrounds, will reduce the occurrence of trip points and is less expensive and easier than concrete to maintain or replace when necessary.
Re-direct pathways	Where space allows, pathways should be re-directed away from trees/tree roots. It may also be beneficial to reduce the newly directed pathway
Bridging Footpaths	Self-supporting construction methods, such as pier and beam could be used to raise pathways above the roots, allowing for root expansion without damaging the pavement. Timber bridges are an effective option.
Root pruning	Non-structural roots could be pruned on a predetermined basis under the guidance of a qualified arborist. This practice could be combined with installation of root barriers where appropriate.
Root barriers	Where future problems are perceived, barriers could be installed to deflect roots away from pavement or services.
Tunnelling for services	Tunnelling (directional boring) rather than open trenching for underground services will greatly reduce public risk as well reducing injury to tree roots. If located deeply, root contact with the pipeline may be minimised as the majority of roots of most species will remain within the top 1 metre of soil (based on a soil with medium texture).
PVC welded piping	Replacement of old porous clay pipe mains with PVC or polyurethane mainlines will significantly reduce the potential for tree root entry.
Preventative tree maintenance	Trees in public areas should be regularly inspected and maintenance, such as dead-wooding and developmental pruning carried out as prescribed. Pruning should always be undertaken in accordance with AS 4373-2007 Pruning of amenity trees.
Raising pathways	Where appropriate, pathways could be raised to reduce direct root pressure on the pavement. Care must be taken not to build up soil against the trunk of a tree. Aeration piping, in conjunction with geo-textile fabric and gravel should be installed between root zone and new pavement to aid with gas exchange to roots. Care should be taken to shape the new surface to drain water away from the trunk of the tree.
Insulated (ABC) cabling	Replacement of uninsulated overhead powerlines with insulated & bundled cables will reduce both the clearance needed and the pruning costs and severity.
Underground power and communications cables	The initially high cost of installing power underground may in fact be a practical option when compared with the projected cost of repeated pruning, the risk that this work involves to operators, the negative impact on trees, loss of public amenity and of urban forest economic contributions.

Strategy	Description
Diverting services	Services could be diverted along roadways, rather than in the nature strip where a valuable stand of trees is present. To make this option more attractive to service providers, Council's may wish to consider waiving road opening fees.
Diverting kerb/gutter	When possible, kerb/gutter could be diverted around tree roots or further away from the trunk, creating an island around the tree.
Enlarging root zone	Where space allows, a designated area above the root zone of the tree should be enlarged/created to accommodate surface roots. Rather than turf, this area could be formed into a garden bed, mulched or covered with a suitable tree grate.
Formative pruning	Early pruning will reduce the development of structural weaknesses in older trees. Refer to AS4373-2007 Pruning of amenity trees.
Remove target	In some situations it is preferable to remove a potential target, such as a seat rather than to remove a tree in order to abate a hazard.
Remove the defect	This could include pruning of live or dead branches or the removal of co-dominant stems.
Tree engineering	In some cases cabling may be used to support tree structure or to control the direction of a possible failure. This is highly specialised work.
Tree removal	In some situations it may be preferable to remove a tree and replace with a more suitable species, perhaps in an alternative location. In all cases of tree removal it is necessary to ensure that the removal is mitigated in order to ensure the future integrity of the urban forest.

Table 3.2: Common interactions and impacts between trees and structures

Structure	Typical causes of conflict with trees	Impact by trees	Impact on trees
Footpaths Concrete, Pavers and Bitumen	Pathways located too close to trees, bitumen laid over tree roots.	Lifting, heaving and cracking leading to trip hazards and increased risk.	Root pruning and root scalping leads to root decay & a potential loss of stability; reduced water and nutrient uptake; reduction of soil oxygen; loss of natural nutrient recycling; and elevated tree stress.
Kerb and Gutter Concrete	Pathway cross overs located too close to trees. Lifting, heaving, cracking and displacement.	Lifting, heaving, cracking and displacement Drainage interruptions.	Restricted root distribution effects tree stability and the critical availability of water and elements.
Underground Services Power, fibre optic, water, gas	Improperly laid eg. poorly jointed, inadequately compacted backfill; inappropriate backfill materials, pipes retained past their useful life and requiring renewal, use of technology that does not account for the dynamics of tree root development.	Blockages, crushing, displacement and heaving.	Root loss during installation; incipient decay following excavation. Changes in water table fluctuations; gas leaks; soil saturation.

Structure	Typical causes of conflict with trees	Impact by trees	Impact on trees
Overhead Services Power lines, Phone and Cable TV	Inappropriately located poles, poles shorter than prescribed heights, wires lower than prescribed height, uninsulated wires where insulated cables would be less restrictive on tree planting and safer near people, above ground transformers.	Branch and whole tree failures; wind whipping. Electrical outages, blackouts, fire, restricted access to poles.	Reduced amenity and environmental contributions ie. shade and shelter, aesthetics, PM 10 absorption; incipient decay. Poor public image for street trees.
Buildings and other load bearing structures	Minimum distances not observed, reactive soils.	Lifting and cracking of foundations; subsidence; branch and fruit shedding; reactive soils drying and wetting cycles.	Damage during site preparations and construction, reduced sunlight, wind tunnelling.
Traffic and pedestrians	Compaction.	Vehicle hitting trees. Blocked vision of road signs and access places. Trip points in footpaths.	Trees damaged or killed by vehicle accidents. Heavy and repeated pruning to achieve visibility. Decay of roots and loss of stability from root grinding for footpaths.

Table 3.3: Tree planting risk zones in streets

	ZONE A Most constraints (Greatest risk)	ZONE B Moderate constraints (Moderate risk)	ZONE C Fewest constraints (Minimum risk)
Electrical and telecommunications	uninsulated low and high voltage wires bushfires areas	bundled cables (ABC) insulated cables	no powerlines
Below ground services typical layouts	fibre optic cables high voltage power	water mains, gas mains stormwater	no underground services
Slope	steep slope	moderate slope	generally flat land
Paved areas	area wholly paved surface wholly sealed brick pavers laid on sand bedding	partially paved areas non reinforced concrete	grass up to 6m
Verge width	less than 3m	from 3m to 4m	4m or wider
Building set back	None	Less than 6m	6m or greater
Street lighting	over pedestrian crossing traffic intersections	street lighting other than crossings and intersections	no street lighting
Safety signage ie. traffic signs	dual carriageways arterial roads high density residential streets	medium density residential streets arterial roads in rural zones	low density rural/residential streets
Traffic	heavy vehicles public transport in heavy volumes	public transport in moderate volume heavy vehicles in moderate volumes	public transport in low volume residential traffic in low volume Cul-de-sacs
Soils	severely compacted shallow reactive clay acid sulphate poor drainage	moderately compacted urban fill moderate drainage	Undisturbed soil deep profile medium texture good natural drainage
Water table	high	moderate depth	deep water table

Table 3.4: Risk management control strategies

Control Strategy	Description
Root Barriers	Installation of root barriers to manufacturer's specification at the time of planting will assist tree roots to develop away from services, pavements and other structures. **Note of caution:** Tree root barriers do require periodic monitoring as roots deflected downwards will return to the surface if soil oxygen levels are not sufficient to support growth at depth. Roots can also grow over the barrier in some situations.
Soil Compaction	Proper compaction of the soil when back filling trenches or around utility easements and house footings will direct tree roots away from these areas. By achieving and maintaining compaction to 95% root growth can be inhibited through the depravation of oxygen.
Pseudo Street Trees	Residents could be encouraged to plant trees within their boundaries in preference to street tree planting. This might allow larger species to be used, and reduce pressure on pavements and services.
Design of new roads and pathways	The design of new roads and footpaths should be undertaken with consideration for tree planting on the nature strip or in the road pavement to ensure appropriate allocation of space.
Provision of aeration and irrigation	Where there is to be continuous paving around a tree, the installation of an aeration and irrigation system should be considered. Where irrigation is installed and properly operating, a tree root system will be proportionally smaller than without irrigation.
Pavement Openings	Pavement openings at the base of the tree should be as large as possible to reduce the future impact of buttressing roots on pavements. Position of the tree should be a good distance (eg. 1m) from the kerb line to reduce the likelihood of future cracking.

Table 3.5: Tree planting site characteristics

	A Most Constraint	B Moderate Constraint	C Least Constraint
Climate	• Frontline salt wind exposure • Prevailing wind exposure • Rain shadow • Extensive sealed ground surface	• Second line coastal salt influence • Moderate wind exposure • Partial rain shadow • Partial ground surface sealed	• Minimum salt influence • Minimal wind exposure • No rain shadow • Minimal ground surface sealed
Slope	• Steep slope	• Moderate slope	• Minor slope to flat land
Aspect	• Southern & western exposure	• Either southern or western exposure	• Northern & eastern exposure
Street Width and Usage	• Narrow; CBD residential and commercial • Arterial (high traffic volume)	• Non CBD; narrow residential & commercial • Suburban collector roads (medium volume traffic)	• Average to wide residential/commercial • Wide residential
Soil Type and Drainage	• Reactive clay • Poor drainage • Salinity	• Non-reactive clay • Average drainage	• Free draining open textured soil
Services	• Above ground and below ground utilities	• Above or below ground utility services	• No utility services