Visual Tree Assessment Report

For

Various Trees on the corner of

Molonglo and Malbon Streets Bungendore NSW

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Phone	+61 2 6282 1244
Report Date	20 February 2019

Project Details

Job	425653 Reference# PUO26126
Site Address	Corner Molonglo and Malbon Streets Bungendore NSW
Client	Queanbeyan-Palerang Regional Council (QPRC)
Client Contact	Lisa Wrona: Tree Manager Officer and Neil Hancock
Contact Phone	02 6285 6144 0407 238 554
Commission Brief	The author of this report has: • visited the site • observed the health of 10 trees • provided a Visual Tree Assessment (VTA) • addressed present risk management of the trees • provided recommendations and a Tree Management Plan. The retainment of all 10 trees, T1-T10 of various genus, is to be in accordance with: *Australian Standards; Pruning of amenity trees AS 4373-2007 also AS 4970-2009*

Version History

Ver. No.	Ver. Date	Revised By	Description
V0.1	02/1/19	Steve Griffiths	Initial draft report
V0.2	27/1/19	Jan Bartlett	Proof and format content
V1.0	28/1/19	Steve Griffiths	Final Report for submission
V1.1	20/2/19	Steve Griffiths	Amended Report
V1.2	20/2/19	Jan Bartlett	Proof and format content

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1. Report Summary

1.1 Background

1.1.1 More space is needed for the proposed new roundabout, traffic islands, kerbing and drainage at the corner of Molonglo and Malbon Streets Bungendore NSW. These construction works will consist of the demolition of some pre-existing bitumen and other structures. This work will effect these mature trees in their Tree Protection Zones (TPZ) of the10 trees to be retained.

1.1.2 The majority of trees have defects that may or may not be detectable without invasive diagnostic tooling methods. These defects could be from environmental, human or genetic factors and may be hazardous to people and property. Major amounts of these 10 trees have their roots zones surrounded by hardpan and compaction. This is the norm for the average urban street tree.

1.2 Tree Identification

1.2.1 When identifying species and cultivars, it is important to note that some macro botanical characteristics change over time. There may be small changes between cultivars and species, and not all botanical signs are featured at the date of inspection. If an absolute identification is required, a further re-examination of micro characteristics will determine species or cultivar.

1.3 Recommendations

1.3.1 All trees mentioned in this report are to be retained.

1.3.2 Preserving as much of the TPZ as possible during all phases of this develop is important for all 10 trees. Tree Protection Fencing (TPF) is to be put in place and not to move until the post-construction phase. TPF is needed for trees T4, T5, T6 and T7. Refer to *Recommended Tree Protection Fencing* illustration on page 13.

1.3.3 It is most important that there is no change to the water flow of the nearby creek and exposed drain, as this is a vital water source for these veteran, 130+ year old, Elm trees namely trees T1, T2, T3, T8, T9 and T10 in part. Open kerbs are recommended for trees to receive water on rain events. Refer to photo on page 21.

1.3.4 All Arboricultural work is to be completed prior to any construction work. This includes the removal of large patches of deadwood in the veteran trees marked T1, T2 and T3. These trees are naturally senescing (aging), which is normal. Stem injecting is also required to de-stress these old Elm trees to rid them of Elm Leaf Beetle. Some of these trees require protective trunk padding, which can be done by Treeworks Pty Ltd.

1.3.5 A watering program is to be implemented at determined rates as prescribed by the Site Arborist (approximately 200 litres per tree per week), using a soaker or drip hose, or by water truck. This is to be in use during all phases of development.

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1.3.6 When this work is completed, it is advised to retain all mulches as this will greatly benefit the soil with good water infiltration and many other benefits. Watering all trees in hot summer months is recommended.

Thank you for the opportunity to provide this report. Should you have any questions, please feel free to call me.

Kind regards

Stephen Griffiths
Level 5 Consulting Arborist

2. Report Details

2.1 Method and Limitations

A Visual Tree Assessment (VTA[1]) was completed on 2 January 2019. Observations and data were collected in one visit. No invasive testing was conducted (VTA[3]), nor was an aerial inspection required (VTA[2]). It was a clear sunny day.

Tools used to collect data for this report were:

- Soft hammer (nylon type) for detecting acoustic variances in the trunk
- Tape measure for measuring trunk diameters at breast height (DBH)
- A camera for documentation of photos for further examination
- Digital microscope camera
- Soil bag and root pruning spade.

2.2 Site

All of these trees from T1 to T10 are subjected to urban compaction and heat sink, however they are well looked after. Retainment of the soil is of great importance and refrain from natural soil level changes.

A minor soil test has been conducted in this urban setting, the soils have often been manipulated and are therefore highly variable; for instance, on some parts of this site foreign soils have been added that have little similarity to the original soils' characteristics. However, Treeworks can provide the council with a more detailed soil survey analysis, if required to collect vital data on:

- approximate depth available for tree roots
- colour, texture and structure of soil profiles
- infiltration and drainage qualities
- history of the soil formation.

The basic test conducted on 2 January 2019 shows soil around the trees marked T1, T2, T3 and partly T4, T8, T9 and T10 are of a uniform colour, young unweathered soils, often good for root penetration and tree growth. These alluvial soils are great for the trees in this area with their fine clay, silt, sand and gravel deposits.

The remainder of the trees on this site T5, T6, T7 are in a heavy hardpan area and much of the trees TPZ is to be protected.

2.3 Tree Survey Schedules

Tree #	Botanical Name	Height (m)	DBH (mm)	Basal dia. (mm)	Live Crown %	Health	Average Canopy Spread (m)		Age Class	Tree Status
							N/S	E/W		
T1	*Ulmus procera*	22	1220	1510	75	Fair	18	16	Veteran	Council Tree
T2	*Ulmus procera*	20	1390	1500	75	Fair	16	14	Veteran	Council Tree

Tree #	Botanical Name	Height (m)	DBH (mm)	Basal dia. (mm)	Live Crown %	Health	Average Canopy Spread (m)		Age Class	Tree Status
							N/S	E/W		
T3	*Ulmus procera*	22	1720	2020	75	Fair	21	18	Veteran	Council Tree
T4	*Quercus pulustris*	24	1090	1240	95	Good	22	22	Mature	Council Tree
T5	*Fraxinus oxycarpa*	11	710	900	90	Good	16	16	Semi-Mature	Council Tree
T6	*Platanus acerifolia*	10	680	770	90	Fair	6	8	Semi-Mature	Council Tree
T7	*Ulmus procera*	12	840	870	95	Good	14	13	Semi-Mature	Council Tree
T8	*Quercus pulustris*	16	800	900	90	Good	17	16	Mature	Council Tree
T9	*Quercus pulustris*	17	770	900	85	Fair	15	13	Semi-Mature	Council Tree
T10	*Quercus pulustris*	17	660	780	85	Fair	15	12	Semi-Mature	Council Tree

Table 1. Tree Survey Summary

2.4 Tree Data Tables

T 1	***Ulmus procera* (English Elm)**		
TPZ = 14.64 m (radius from trunk centre)	**Condition; Fair**	**SRZ = 3.8m (radius)**	**RPA = 673.34m²**

This English Elm is one of three veteran Elm trees in this report. It is normal for veteran trees to senescence (age) and there is a lot of deadwood in the upper canopy, some greater than 160mm in diameter. This deadwood will need to be removed. This tree has Elm Leaf Beetle *Xanthogaleruca luteola,* throughout. This is also the case for the other Elm trees T2, T3 and T7. This pest is showing signs of *second instar larvae* on the underside of the leaves which greatly harms these trees. This coleoptera bug depletes the tree's ability to photosynthesize. Five years of this infestation will deplete the tree of its starch supply and kill it. We recommend a stem injection of Imidacloprid around the base of these four trees as soon as possible. Stem injecting is the best methodology due to the creek nearby. There are lots of tree suckers in and around trees T1, T2 and T3. If at all possible, these should be left.

Useful Life Expectancy (ULE) is 40 years at this stage.

Parking under the trees TPZ (carpark) is acceptable providing pod foundation are laid down with porous cement, in this TPZ.

Table 2. T1 Survey Detail

T2	***Ulmus procera* (English Elm)**		
TPZ = 15m (radius from trunk centre)	**Condition; Fair**	**SRZ = 3.92m (radius)**	**RPA = 706.86m²**

This English Elm is similar to the other veteran Elm trees in this report. T2 requires the removal of deadwood due findings of senescencing (aging) in upper canopy. This deadwood will need to be removed. This tree has Elm Leaf Beetle Xanthogaleruca *luteola* throughout. We recommend the stem injection of Imidacloprid around the base of the tree as soon as possible. There are signs of slime flux, which is to be monitored as it can lead to carbohydrate depletion within the tree, and signs of mechanical damage at base, which appears fine. This decurrent (branches extending downwards) shaped tree has a natural suppression or a codominant crown class – the tree has adapted to this over time. If there are changes or reduction in water irrigation, the tree will not cope.

Useful Life Expectancy (ULE) is 40 years at this stage

Tree Protection Fencing will be needed to prevent heavy construction vehicles parking or storage of material in this TPZ. A layer of 75mm of mulch is to be laid by hand, not machinery. Care is to be taken in the post-construction stage where there will be the introduction of soils, lawn and footpaths. All foundations are to be of pod foundations and of a permeable surface. There is to be no introduction of nitrogen fertiliser within the

T2	*Ulmus procera* (English Elm)		
TPZ = 15m (radius from trunk centre)	**Condition; Fair**	**SRZ = 3.92m (radius)**	**RPA = 706.86m²**
TPZ area of this tree for at least three years, as this allows time for the tree to recover from the Elm Leaf Beetle and regain a supply of needed starch levels. The creek system that passes on the northern side of this tree must be retain and to continue to allow stormwater through as normal, open kerbing is needed here on these three trees that are in a row. See photo of open kerbing on page 21.			

Table 3. T2 Survey Detail

T3	*Ulmus procera* (English Elm)		
TPZ = 15m (radius from trunk centre)	**Condition; Fair**	**SRZ = 4.61m (radius)**	**RPA = 706.86m²**
This English Elm is similar to T2 in this report. T3 also requires the removal of deadwood due to findings of senescence (aging) in upper canopy. This deadwood will need to be removed due to concerns of pedestrian traffic below. This tree, just like T1, T2 and T7, has Elm Leaf Beetle *Xanthogaleruca luteola* throughout. We recommend the stem injection of *Imidacloprid* around the base of the tree as soon as possible. There is some bark included forks findings (compression unions) in the tree, and there is a history of branch failures throughout the tree. No weight reduction is required, but rather retain as many green leaves as possible. There to be no more dumping of green grass clipping in or around the tree's TPZ, as this draws nitrogen out of the soil. Useful Life Expectancy (ULE) is 40 years at this stage. Tree Protection fence (TPF) will be needed to prevent heavy vehicles parking or storage of material in the Tree Protection Zone (TPZ). A layer of 75mm of mulch is to be laid by hand, not machinery. Great care is to be taken conducting any construction under this tree, minimal vibration and rolling is to be applied in the TPZ and SRZ of this tree in construction and post-construction stages. There is to be a spotter to watch out for tree branch damage. There is to be no unnecessary cutting of branches, but rather lifting the branches with rope, then released when finished. Pipes can be laid within the trees TPZ providing pipes are laid as tunnel boring at a depth of 500mm or hydro vac method a half pressure. Water can flow into a water garden then into creek by ways of gaps in the kerb - see picture on page 21. All footpath foundations are to be of pod foundations and of a permeable surface. There is to be no added nitrogen fertiliser within the TPZ area of this tree for at least three years to allow time for this tree to recover following the removal of the Elm Leaf Beetle and gain a supply of needed starch. The creek system that passes on the northern side of this tree must be retained and continue to allow stormwater through as normal using open kerbing (see page 21).			

Table 4. T3 Survey Detail

T4	*Quercus pulustris* (Pin Oak)		
TPZ = 13.08m (radius from trunk centre)	**Condition; Good**	**SRZ = 3.62m (radius)**	**RPA = 537.48m²**
This Pin Oak is of good health and has been well maintained. There are findings of improper lopping many years ago, and tree has recovered well with endo epicormic attachments. There is also natural bracing in the tree which should never be removed. Tree branches are also rubbing on the stone building. This tree is of a mature age, about 50 years old and there is no reason why it can't live for another 100 years. Great care is to be taken when laying the bitumen; minimal vibration and rolling is to be applied in the TPZ and SRZ in the post-construction stage. There is to be a spotter watching for possible tree branch damage and exhaust burn from large machinery. There is to be no unnecessary cutting of branches, but rather lifting the branches with rope, then released when finished. There is to be no trench digging for storm water pipes within any of these trees' TPZ. Minimal disturbance within the TPZ is 13m radius from centre of trunk.			

Table 5. T4 Survey Detail

T5	*Fraxinus oxycarpa* (Desert Ash)		
TPZ = 8.52m (radius from trunk centre)	**Condition; Good**	**SRZ = 3.17m (radius)**	**RPA = 228.05m²**
This Desert Ash is of good health and has been well maintained, considering it's surrounded mostly by a hard pan area. There are findings of epicormics, which are just minor stress signs, most likely due to compacted soils nearby. This tree is of a semi-mature age, about 40 years old and there is no reason why it can't live for another 50 years. Great care is to be taken when laying the bitumen; minimal vibration and rolling is to be applied in the TPZ and Structural Root Zone (SRZ) of this tree in the post-construction stage. There is to be a spotter watching for tree branch damage. There is to be no unnecessary cutting of branches, but rather lifting the branches with rope, then released when finished. The depth of the tree's roots are only 500mm from ground surface. Hydrovac or tunnel boring is acceptable within the trees TPZ.			

Table 6. T5 Survey Detail

T6	Platanus (London Plane)		
TPZ = 8.16m (radius from trunk centre)	**Condition; Fair**	**SRZ = 2.97m (radius)**	**RPA = 209.18 m²**
This London Plane has a bundle of low voltage powerline cables nearby. Over the years the tree has been trimmed away from these cables creating a very lopsided tree. There are findings of fungal decay where these cuts have been made. There are many hollows in the tree which is good for arboreal animals but could pose a problem in tree structure stability. Life expectancy is less than 30 years, with consideration for its replacement in a few years. This tree is of a semi-mature age and has a lot more growing to do. Perhaps a *Lagerstroemia indica* (Crepe Myrtle) would be a more suited genus tree to replace it with. Trunk and branch protection in the form of wooden boards and strapping, is needed (see diagram on page 20). Due to the proximity to the road, footpath and shop, TPF is not viable, however watering of this tree is needed just like the others. Parking of vehicles is allowed near the tree's TPZ area providing there is a porous pod foundation with minimal vibration and compaction allowed. The root zone of this tree is 8.16m radius from central tree's trunk. Recommend a Level 5 Arborist to assess and inspect tree hollows severity in two years' time.			

Table 7. T6 Survey Detail

T7	*Ulmus procera* (English Elm)		
TPZ = 10.08m (radius from trunk centre)	**Condition; Good**	**SRZ = 3.12m (radius)**	**RPA = 319.21m²**
This English Elm is surrounded by hard pan area of bitumen and concrete with exposed roots being constantly damaged. It is in good shape but has a minor infestation of Elm Leaf Beetle *Xanthogaleruca luteola,* which will be dealt with prior to the stress this tree will receive during this construction around its TPZ. Life expectancy is 40 years, providing situations to the tree's TPZ is not changed too much. Trunk and possibly branch protection, in the form of wooden boards and strapping, is needed for this tree. See diagram on page 20. Branches are low and may require a canopy lift to allow easier access. Due to the proximity to road, footpath and shop, TPF is not viable, however watering of this tree is needed just like the others. Parking of vehicles is allowed near the tree's TPZ area providing there is a porous pod foundation with minimal vibration and compaction allowed. The root zone of this tree is 10.08m radius from central tree's trunk.			

Table 8. T7 Survey Detail

T8	*Quercus pulustris* (Pin Oak)		
TPZ = 9.6m (radius from trunk centre)	**Condition; Good**	**SRZ = 3.17m (radius)**	**RPA = 289.53m²**
This Pin Oak has most of its TPZ compacted due to vehicles parking under the tree. The proposed construction will help this tree and help prevent vehicles parking close to trunk and under its canopy. Due to this compaction, an aeration of soil and mycorrhizae treatment is required prior to commencement of works: a treatment to improve the health of trees by soil decompaction and introduction of *mycorrhizal fungi* and other supplements into the soil. Forking, spiking and hand-digging or sub-soil aeration using compressed air injection equipment, can also be utilised as well as hand drilling method. TPF is needed for around part of this tree's TPZ and area mulched and regularly watered. There is minimal Oak Leaf Minor infestation and no action is needed at this stage to rid this pest. *(British Standards 2005, p. 21)*			

Table 9. T8 Survey Detail

T9	*Quercus pulustris* (Pin Oak)		
TPZ = 9.24m (radius from trunk centre)	**Condition; Fair**	**SRZ = 3.17m (radius)**	**RPA = 268.22m²**
This Pin Oak is in the middle of a row of three Oak trees and is showing lots of deadwood greater than 40mm in diameter, which is also encroaching on to the building. It is in a fair condition with good structural unions. Due to the visual stress of the tree, it is important to leave as much of its TPZ undisturbed, as present vehicle compaction is only 3m from the tree trunk, bearing in mind, the TPZ is 9.24m (radius) from central trunk. TPF and Terravent procedure is required prior to commencement of works. Mulch is to be laid down and the tree to be regularly watered. There will be a lot of post-activity around the tree's trunk. Tree trunk protection is required.			

Table 10. T9 Survey Detail

T10	*Quercus pulustris* (Pin Oak)		
TPZ = 7.92m (radius from trunk centre)	**Condition; Fair**	**SRZ = 2.98m (radius)**	**RPA = 197.06m²**
This Pin Oak is the smallest of the trees in this row and also appears to have a lot of dead branches which should be removed prior to construction activity. It is in a fair condition with good structural unions. It is important to leave as much of TPZ undisturbed, bearing in mind the TPZ zone is 7.92m (radius) from the central trunk. Terravent procedure is required prior to commencement of works. Mulch is to be laid down and tree to be regularly watered. There will be a lot of post-activity around the tree's trunk. Tree trunk protection is required.			

Table 11. T10 Survey Detail

2.5 Recommended Sequence of Events

The table below outlines the advised works to be conducted and the correct timing to follow, in order to help maintain these trees.

TIMING	MODE OF ACTION	REASON FOR
Before commencement of any works on the trees or the soil near the trees.	Deliver this VTA report to the appropriate Council. Approval of this report is needed before any of this Arboricultural Management Plan is put in place.	Before commencement of any works on the trees or the soil near the trees.
Ensure all parties understand the following works that are about to take place.	The Site Arborist, (must be a Level 5 Arborist) will induct the Arborist conducting this work to ensure all works are clearly understood.	For easy identification of what is to be done, when to do it and by whom.
Close off the TPZ area, or designated area allowed with 1.5m wire fencing with signage on it.	Begin erecting TPF around designated area and put a sign up "K*eep Out - Tree Root Zone*". Secure this fencing. See fence positioning on page 13.	Close off the TPZ area or designated area allowed, with 1.5m wire fencing with signage on it.
After TPF is up.	Removal of deadwood from trees T1,T2 and T3 and stem inject trees T1, T2 T3 and T7 against *Xanthogaleruca luteola.*	To make trees safer and rid Elm Leaf Beetle for reduction of stress.
First item to address after fence erection.	Drill holes around the soil areas of TPZs and apply *mycorrhizal* and *trichoderma* with coarse sand mixture into the holes. The trees that require this are T8, T9 and T10	To prevent flooding, help with gas release and to apply nutrients to the root system in these enclosed TPZs.
After drilling has been done	Spread a layer of mulch all within the TPF area to a depth of 75mm	To help retain moisture levels during times of high evaporation in summer.

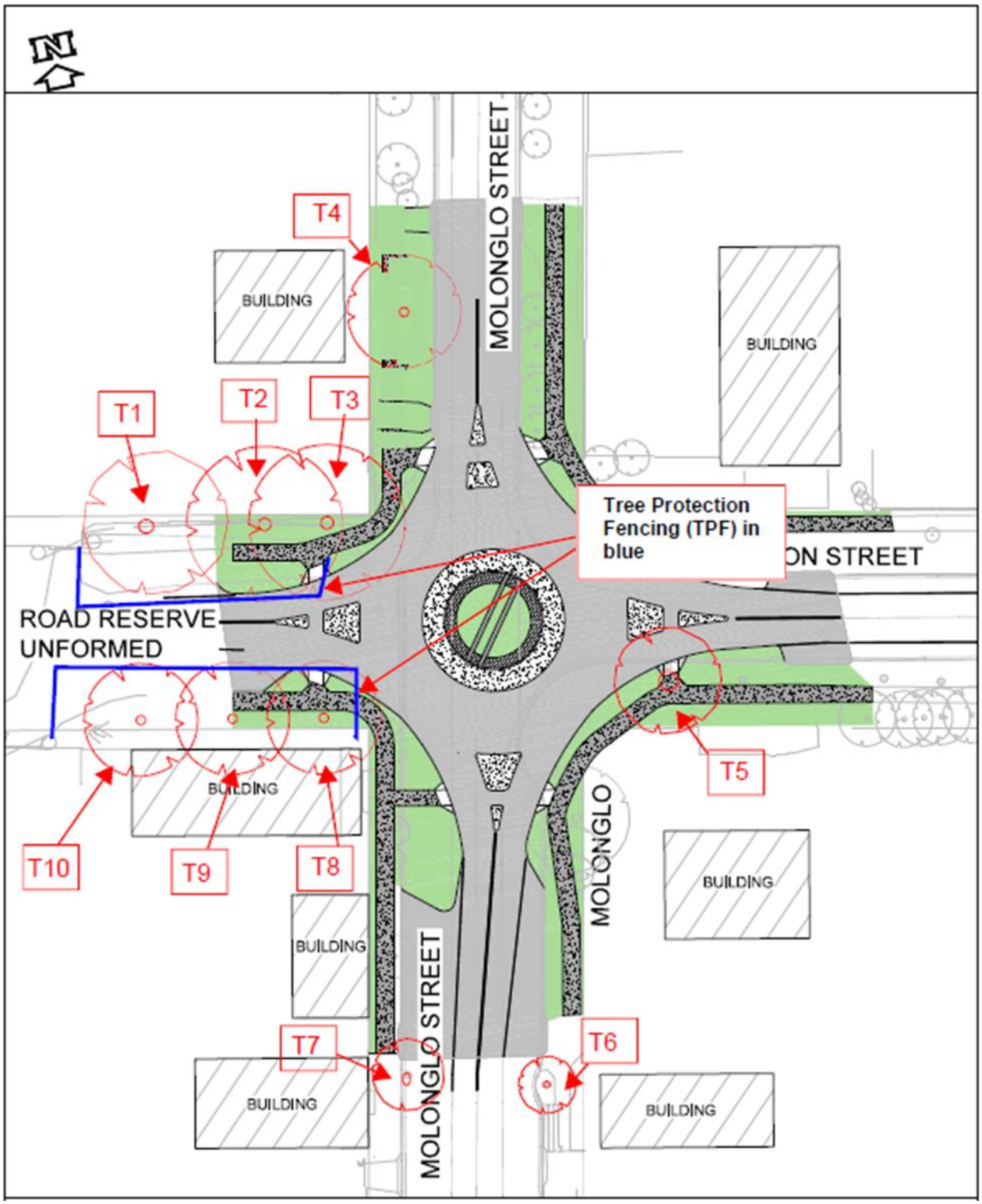
TIMING	MODE OF ACTION	REASON FOR
After mulch is laid.	Spread out line dripper around all the TPZ area and place under the mulch, with a calibrated output of 60% field moisture. Alternatively, water weekly with a water truck.	To keep moisture levels up.
Construction to start.	Construct new roundabout and post constructions.	
After post-construction is finished.	Remove the TPF.	Removing the TPF allows for easier access for any further post-landscaping such as adding shrubs and flowers in the area.
Regular maintenance of water levels.	Regularly maintain the water tank levels for the next two years	So these trees can get a regular amount of water.
Monitor the tree yearly.	To conduct tests on soil and trees.	To document progress.

Table 12. Recommended Sequence of Events

2.6 Recommended Tree Protection Fencing (TPF)

Figure 1. Recommended Positioning of Temporary TPF

Due to the proximity of some trees, their TPF cannot be installed. TPF are marked in blue lines.



3. Legal

3.1 Legislation

The Australian Standards; Protection of trees on development sites 4970-2009, outlines the required procedures for the protection of significant trees. This report highlights the relevant standards you need to follow.

This report is submitted and acknowledged by the client as prepared by Steve Griffiths, Arborist of Treeworks (ACT/NSW) Pty Limited, as instructed on a limited basis after visual inspection of the trees at ground level only.

Australian Standards; Protection of Trees on Development Sites 4970-2009

3.2 Acknowledgements

3.2.1 The client acknowledges:

a) That Treeworks (ACT/NSW) Pty Limited has not conducted any invasive procedure or ultrasound test on the trees, nor inspected it at crown level or below surface level;

b) This report does not and cannot make comment upon, determine or assess defects that may exist in the trees internally. Whether arising from decay, disease, effect of drought, insect infestation or any other inherent condition that may exist.

3.2.2 No Warranty for Non-Discernible Defects or Damage

Accordingly, this report cannot and does not warrant that defects or damage do not exist within the trees that may not be discernible to a competent Arborist making an inspection at ground level.

3.2.3 Reliance Period

The client acknowledges that no reliance may be placed on this report after twelve months following the date of inspection.

3.2.4 Disclaimer of Liability to Third Parties

To the extent permissible by law, Steve Griffiths, Arborist of Treeworks (ACT/NSW) Pty Limited, is not liable for any loss, damage, personal injury, costs or expenses suffered by any person or persons other than the recipient of this report.

Appendix 1 Photos of Trees Assessed

Figure 2. T1 *Ulmus procera*

Figure 3. T2 *Ulmus procera*

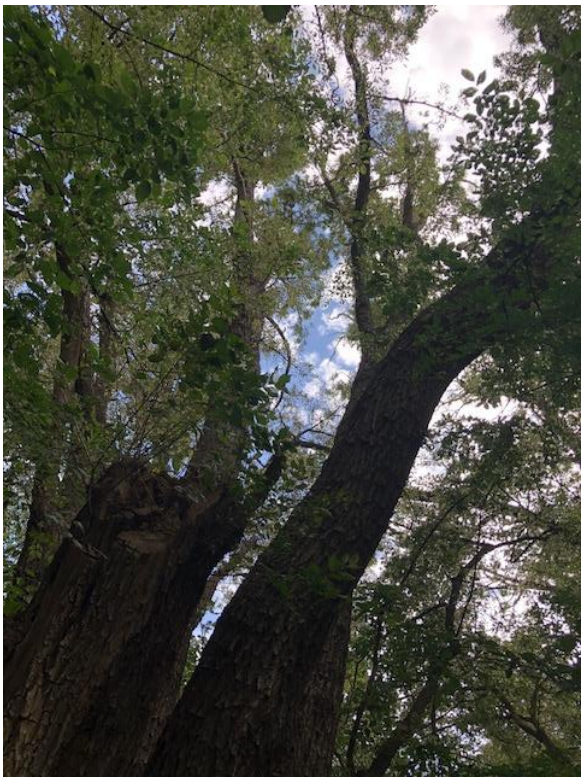


Figure 4. T3 *Ulmus procera*

Figure 5. T4 *Quercus pulustris*

Figure 6. T5 *Fraxinus oxycarpa*

Figure 7. T6 *Platanus sp.*

Figure 8. T7 *Ulmus sp.*

Figure 9.* T8 *Quercus pulustris

Figure 10. T9 *Quercus pulustris*

Figure 11. T10 *Quercus pulustris*

Appendix 2 Further Information

A2.1 Soil Compaction

The health and structure of a tree reflects the soil health within and around its perimeter. Where humans, with all our necessary infrastructures and machinery are active, soil compaction is very likely. It is mostly harmful to street trees and shade trees.

The ideal soil is:

- 50% pore space consisting of water and air-filled pores
- composed of 45% minerals plus 5% living and dead organic matter
- rich in organic matter near the surface which provides cation and anion exchange.

Soil Compaction Stress & Trees: A Workbook of Symptoms, Measures and Treatments - Coder, 2016, p. 5 & p. 8

A2.2 Soil Compaction Avoidance

In order to avoid soil compaction, there should be no vehicle or machine plant access within a tree's SRZ.

Where compaction has occurred, advice from an Arborist on decompaction measures is advised. Terravent procedure is best; a treatment to improve the health of trees by soil decompaction and the introduction of *mycorrhizal fungi* and other supplements into the compacted soil. Forking, spiking and hand-dug radial trenching or sub-soil aeration by using compressed air injection equipment, can also be utilised.

In order to avoid soil compaction, there should be no vehicle or machine plant access within a tree's root protection areas.

Where compaction has occurred, advice from an arborist on decompaction measures is advised. Terravent procedure is best: a treatment to improve the health of trees by soil decompaction and introduction of *mycorrhizal fungi* and other supplements into the compacted soil. Forking, spiking and hand-dug radial trenching or sub-soil aeration by using compressed air injection equipment can also be utilised.

BS 5837:2012, p. 30

A2.3 Concerning Tree Roots

Standards Australia's *Protection of trees on development sites* explains clearly the nature of roots:

Root growth is opportunistic and takes place wherever the soil environment is favourable. The most limiting factor for root growth is air. A number of studies have indicated that roots are much more extensive than commonly thought. In general roots extend outward from the trunk and occupy irregularly shaped areas 4 to 7 times larger than the projected crown area with an average diameter of two or more times the height of the tree. It is a fallacy that tree roots only extend to the edge of the crown.

Root systems consist of three main parts:

a) the structural woody roots (anchorage, storage and transport);

b) lower order roots (anchorage, storage and transport); and

c) non-woody roots (absorption of water and nutrients, extension, synthesis of amino acids and growth regulators)

AS 4970-2009 concludes its section on roots with these important words:

In addition to lateral root spread being underestimated, root depth in trees has also been grossly exaggerated. Deep root systems or taproots are the exception rather than the rule. Most roots of most trees are found in the very top of the soil. The vast majority of these roots are small non-woody absorbing roots which grow upward into the very surface layers of the soil and leaf litter. ***This delicate, non-woody system, because of its proximity to the surface, is very vulnerable to injury.***

Emphasis added; AS 4970-2009, p. 24-25

A2.4 Tree Protection Fencing (TPF)

As set down in *Australian Standard: Protection of trees on development sites*

Fencing should be erected before any machinery or materials are brought onto the site and before the commencement of works including demolition. Once erected, protective fencing must not be removed or altered without approval by the project arborist. The TPZ should be secured to restrict access.

Shade cloth or similar should be attached to reduce the transport of dust, other particulate matter and liquids into the protected area.

(AS 4970-2009, p.15)

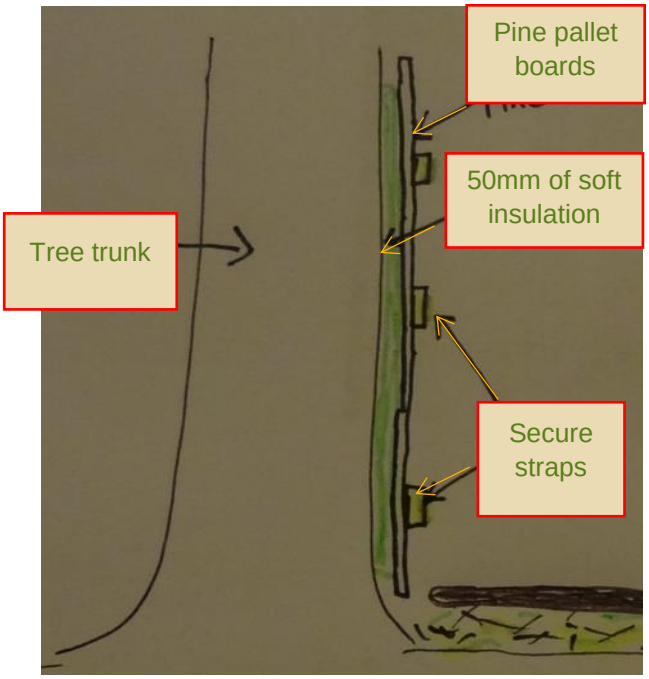
Signage is also required to be attached to the TPF declaring "*Do not Enter*" or "*Tree Protection Zone - Keep Out"*. See AS 4970-2009, App. C, p.28 for a suitable example.

AS 4970-2009, App. C, p. 28

A2.5 Trunk Protection

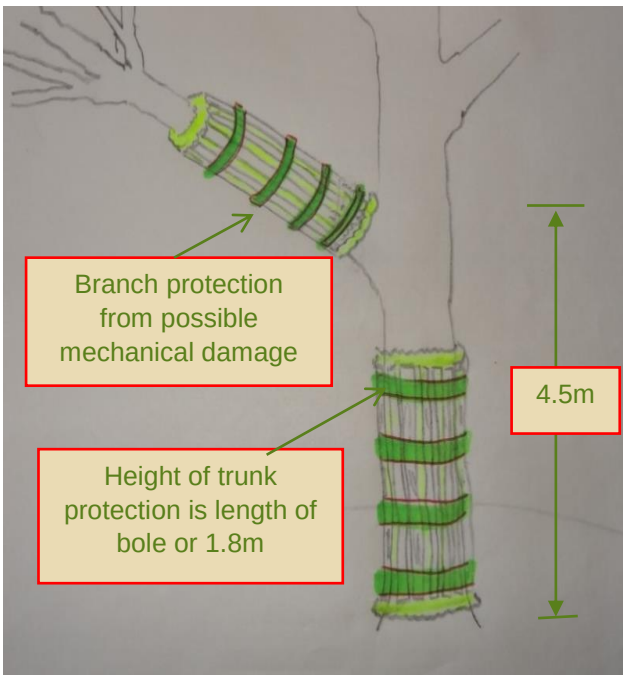
A2.5.1 Trunk and Lower Branch and Ground Protection

Figure 12. Side View of Trunk Protection



Shows a side or internal section of trunk protection on a tree trunk. This protection wraps all the way around the trunk. Illustration drawn by S. Griffiths.

Figure 13. Branch Protection



Branch protection is to be placed around the bark of branches that may be in the way of any construction work. Trunk protection is to be fitted like this illustration. Illustration drawn by S. Griffiths.

AS 4970-2009; Chp. 4.5.3 fig. 4

A2.6 Open Kerb

Figure 14. Example of an Open Kerb

Photo showing open kerbs. Rain runoff is moved and stored in the tree's TPZ area rather than running away down a drain. This type of kerb will be beneficial for the trees in this report.

A2.7 The Importance of *Mycorrhizal Fungi* to the Roots

Mycorrhizal fungi have a symbiotic association with the roots of vascular host trees. *Mycorrhizas* play an important role in the biology and chemistry of the soil. The fungus colonises the host plant's root tissue and a mutualistic association results, although in certain circumstances a *mycorrhiza* may be a pathogen for the host tree. This treatment is needed for some trees.

https://en.wikipedia.org/wiki/Mycorrhiza

The *mycorrhizal* mutualistic association provides the fungus with relatively constant and direct access to carbohydrates, such as glucose and sucrose. The carbohydrates are translocated from their source (usually leaves) to root tissue. In return, the plant gains the benefits of the *mycelium's* higher absorptive capacity for water and mineral nutrients. This is what these trees need, giving larger surface area of *fungal hyphae*, which are much longer and finer than plant root hairs. The effect improves the plant's mineral absorption capabilities.

http://www.anbg.gov.au/fungi/mycorrhiza.html

A *mycorrhizal fungus* also helps protect the associated plants against *pathogenic fungi*. In most soils there simply are not enough native *mycorrhizal fungi* close to the new plant's roots to colonise fast enough, to show the incredible range of benefits complete colonisation can achieve. This is why it needs to be introduced to these trees.

A2.8 Fertilisers Applications (Post Construction)

It is advised that no new applications of any fertilisers are to be added around and uphill from the tree's TPZ for one year.

Sharon Lilly 2010, p. 226

When fertilisers or nitrogen are added to the soil, this boosts new growth in the form of flushing growth. This new growth adds to an already heavy load on the tree's root system, bearing in mind much of the root system could have been damaged due to recent construction activity near that tree.

If soils are to be added, organic soils mixed in 50/50 with local soils are recommended. What the tree's needs just after construction is mulch and extra water; however, these are to be monitored. Any changes within the TPZ are to be discussed with the Site Arborist.

A2.9 Night Lighting

Street or footpath lights emitting far-red light (700 to 850nm), plant dormancy is likely to be delayed and stems elongated, while light waves of 625 to 700nm can promote unusual flowering times. Sodium-vapour lamps have a wavelength near 589nm. There are two types that can be used near trees:

- low-pressure sodium (LPS) lamps, efficient electrical light sources but give inadequate outdoor lighting for such purposes as street lights; and
- high-pressure sodium (HPS) lamps producing a broader spectrum of light, however rendering a slightly poorer colour than other types of lighting.

From his research, Andresen (1977) concluded

"it is safe to install HPS lamps up to 1,000 W in the presence of transplanted or mature trees"

Andresen (1977)

(Harris, Clark & Matheny 2004, p. 67).

A2.10 Drainage

There needs to continually be good drainage for these 10 trees on this site, or it will cause flooding. Flooding can affect various trees differently, however, long-term flooding effects every stage of their development from:

- seed germination
- flowering to sprouting
- vegetative growth.

Urban environments are often ill-equipped to cope with long heavy rainfall, having insufficient and outdated drainage systems and an ever-increasing cover of impermeable surfaces.

Natale & Savi, 2007

Scalenghe & Marsan, 2009

A2.11 Mulch

A2.11.1 Nitrogen Draw Down

This is where you lay out green humus (hot) mulches on the bare soil. It draws nitrogen from the soil and possibly stressing the roots of the tree. It is best practice to put down mulches that have undergone pasteurisation - mulches that have been turned over and allowed to sit for six weeks.

This process can be sped up if the mulch pile is watered daily and blood and bone is sprinkled over the top of the mulch, reducing the time to two weeks. The recommended mulch is coarse in structure, having,

At least 70% by mass of its particles with a maximum size of greater than 16mm

AS 4454-2012, Composts, soil conditioners and mulches, Chp. 1.5.2, p. 7

A2.11.2 Appropriate Mulches

Application of mulch under the trees can only be of benefit, reducing competition with turf roots for water and nutrients. Care should be taken to ensure:

- the latter mulch does not form a waterproof mat
- appropriate depth of mulches is between 50mm to 75mm
- the area around the tree is well watered before mulch application
- heat should be avoided for reasons of sustainability
- Refrain from “hot” mulches, as this type of mulch is biotic and has not broken down yet and will extract nitrogen from the soil.

British Standards 5837:2005, Chp. 12.6.2, p. 1

Appendix 3 References

A3.1 Glossary

Term	Definition
Abiotic Matters	Non-living considerations, e.g. shade, erosion, obstruction, erosion prevention.
Age Class	Grouped from young to old, sapling, young, mature and over mature.
Basal Roots	Large woody roots, close to the trunk.
Botanical Name	Botanical name is the formal scientific name which conforms to International Code of Nomenclature.
Common Name	The common layman's name for a tree.
Crown	The diameter of the leaf mass in the tree (leaf coverage diameter).
DBH	Diameter of the trunk or trunks at breast height (1.4m).
Hardpan Surface	Constructed elements such as walls, pathways and seating.
Height	The estimated height of the tree.
Macropores and Micropores	Macro - larger air space holes in the soil. Micro - are small spaces in the soil.
Retention Value	The value of retaining, preserving and continuing to hold on to the tree for future. High, low or poor.
Saturation Point	Maximum amount of water the soil can hold without running off.
SRZ	Structural Root Zone.
Structure Integrity	The ability of the tree to hold together under a load, in regard to weight, wind throw, weakened unions and diseases, without breaking excessively.
TPF	Tree Protection Fencing.
TPZ	Tree Protection Zone.
TPZE%	TPZ encroachment percentage.
Urbic Soils (dust)	Rubbish left over by builders like cement and lime that has made its way into the soil.
ULE	Useful Life Expectancy measures the amount of years left in a tree before it becomes a possible mitigation problem or a tree in decline.
Vigour	The health and resilience of a tree; the overall condition on a qualitative scale from 'high' to 'low'.
VTA	Visual Tree Assessment.
VTA[1] On-ground Inspection	Identification of structural defects while on the ground using simple equipment such as acoustic mallets, probes and binoculars.
VTA[2] Aerial Inspection	Where a tree is climbed to get a better observation of the tree.
VTA[3] Invasive Testing	Where drilling or coring is required, often a very small drill is used.

A3.2 Figures

A3.3 Tables

A3.4 Report References

Australian Standards; Pruning of amenity trees AS 4373-2007 also AS 4970-2009 2
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Soil Compaction Stress & Trees: A Workbook of Symptoms, Measures and Treatments - Coder, 2016, p. 5 & p. 8 18
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