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Preliminary Tree Assessment Report

Note: This document is not for use as a part of a DA submission

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Prepared on: 22nd September 2023

Report number: CD2516

Version: 1

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Table of Contents

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Version control

Version	Summary of changes	Date	Edited by
1	Initial proposal – no Preliminary Tree Assessment prior to provision of plans – no changes provided or sought	22/9	J.C

Executive Summary

Consideration was given to the suitability of six trees identified by the Council for retention, transplanting or replacement planting as a part of a proposed development. In the process of undertaking the assessment, it became apparent that the Council may have erroneously assumed that Trees 2 – 5 were on the northern boundary. While this is currently the case, the proposal incorporates an additional four properties to the north of this site, rendering the retention of these trees impossible.

Of the six trees, only one tree is in a suitable location and condition such that it merits consideration for transplanting, and this is something that the design team can further assess. That said, I believe that the cost of moving the tree is not the best way to allocate the landscape budget.

Replacing the trees is an easy option, but it has numerous pitfalls. This report raises the majority of these. While it would be inappropriate at this stage to address all of the issues, it is fair to assert that they can be appropriately addressed, and an exemplar of specifications and conditions has been provided for some of the issues.

Brief

For the six (6) trees identified by the Council the author has been asked to:

- Identify the trees.
- Assess the soils, topography and site conditions.
- Check for compliance with the Threatened Species Conservation Act
- Assess the health and general condition of the trees.
- Record dimensions of the trees
- Undertake histochemical testing to determine health where required
- Take any supporting photographs required
- Determine the retention value of each tree
- Assess the approximate age and potential longevity of the trees
- Calculate the Idealised Tree Protection Zone as specified by AS4970-2009 and the Minimum Tree Protection Zone
- Tabulate this information for use by the design team with a corresponding tree location plan

Information Provided

Plan Name	Plan Number	Drawn By	Date	Rev
Landscape masterplan	C100	Site image landscape architects	28/4/2023	A
Detail and contour plan	1 of 6	Structerre surveying		
Detail and contour plan	2 of 6	Structerre surveying		
Detail and contour plan	3 of 6	Structerre surveying		
Detail and contour plan	4 of 6	Structerre surveying		
Detail and contour plan	5 of 6	Structerre surveying		
Detail and contour plan	6 of 6	Structerre surveying		

Method

A site inspection was carried out on the 21st September 2023 and the site related observations contained in this report arise from the assessment on that date.

This report considers trees that are covered by the Development Control Plan. It relies on the definition and exemptions contained in the statutory controls in determining what a tree is and which trees are exempt. This report also considers all trees on the neighbouring properties that may potentially be impacted by the proposed development regardless of the definition contained in the DCP.

All trees were inspected from the ground and involved inspection of the external features only. Inspection of trees on the neighbouring property was from the client's property and/ or the public footpath. The inspection included the performance of a Stage 1 **V**isual **T**ree **A**ssessment (**VTA**)[1,2]. This inspection did not include any invasive, diagnostic or laboratory testing.

The identification of the trees was made using the features visible from the ground at the time of inspection. It was not based upon a full taxonomical identification or comparison against a herbarium specimen. The genus and probable species are provided wherever possible.

Only the plans referred to above have been used in assessing the impact of the proposed Development Application on the trees. Where recommendations are made in this report, including those recommendations in the Tree Protection Guidelines, it is essential that these recommendations be implemented. Any additional drawings, details, or redesign that impact on the ability to do so may negate the conclusions made in this report.

[1] **VTA** – VTA – Visual Tree Assessment, as referenced below, is a systematic inspection of a tree for features that may significantly alter the likelihood of a tree or tree part failing (a Factor). The first stage of the assessment is made from the ground. No aerial inspection is undertaken unless there are visual indicators to suggest that this is merited. Details of the features are contained in The Body Language of Trees by Mattheck & Breloer (1994). The use of a Visual Tree Assessment is a widely used and standardised approach. Normally, invasive and other diagnostic procedures will only be recommended when there is a need to in some way quantify a Factor.

[2] **Mattheck, C & Breloer, H** 1994 *Field guide for visual tree assessment (VTA),* Arboriculture Journal 18:1-23

Observations

The trees of concern are all relatively young, with most being around 40 years old, and all are in good health. Most have a few health or structural issues. For dimensions of individual trees, see the Tree Schedule attached as Appendix 1.

Based on the historical aerial imagery, Tree 1 (a *Eucalyptus* tereticornis) is the oldest of the trees assessed. It is a small tree in 1971 and was not present in 1955. The images show that the remainder of the trees of concern were planted between 1982 and 1986.

Image 1: The site in 1971

Image 2: The site in 1986

Tree 1: Forest Redgum (*Eucalyptus tereticornis*)

This is a tree about sixty years old and is growing in a small opening surrounded by bitumen. It is less than 20 cm from a concrete drainage culvert. It has a basal wound on the southern side covering about 25-35 per cent of the circumference and a second large stem wound about a metre above ground on the southern side.

Image 3: The stem on Tree 1 has a basal wound and is very close to the culvert

Tree 2: Spotted Gum (*Corymbia maculata*)

This tree is around 40 years old. It is in a narrow landscape planting. The tree bifurcates into two stems at about 3 metres above ground and has large amounts of included bark above this point. In response, the southern stem has started to engulf the northern stem with woundwood.

Image 4: The southern side of the inclusion on Tree 2

Image 5: The north side of the inclusion on Tree 2

Tree 3: Willow Gum (Eucalyptus scoparia)

This is a tree that is under forty years old. It is growing in a narrow landscape garden near the boundary, and its canopy is suppressed by the spotted gum growing on either side. In the last year or so, the tree has had a codominant stem removed, which removed around half the canopy. There appears to be an old failure point in the same area as the pruning cut.

The tree had low levels of active Winter Bronzing Bug (*Thaumastocoris peregrinus*).

Image 6: The location of the stem removal on Tree 3

Tree 4: Spotted Gum (*Corymbia maculata*)

This tree is around forty years old and is performing extremely well in the location. The tree had a number of limbs over the property to the north removed in the last year or so. This work included the use of climbing spikes and poor final cuts.

Tree 3: Willow Gum (Eucalyptus scoparia)

This tree is less than 40 years old and is growing in the same landscape garden bed. The tree is codominant at about 1.6 metres from the ground. Included bark is present. The side unions of the two stems were nicely rounded. The northern stem has a large wound just above the fork on the southern side of the stem. There was evidence of recent pruning, including poor cuts and the use of climbing spikes.

There were low levels of active Winter Bronzing Bugs (*Thaumastocoris peregrinus*).

Image 7: Location of the stem wound on Tree 3

Tree 4: Spotted Gum (*Corymbia maculata*)

This tree is at the southern end of the property and is growing in a landscape mound. It is less than a metre from the boundary fence, and the boundary fence has cracked and rotated towards the public path. The tree has had at least one and possibly two limbs fail.

Image 8: A branch failure on Tree 6 at about 10 metres

Discussion

The Council have requested that consideration be given to retaining these trees in situ or transplanting them to new locations. In the alternative, they have requested that the loss of the trees be appropriately compensated for.

Retention with adequate space in the design

The design team have advised that retention of all six trees would significantly impact on the proposed design, particularly if the trees were protected with a Tree Protection Zone (TPZ) of 12 times Diameter at Breast Height (DBH). Design possibilities and limits are outside of the author's expertise. That said, design input is within the capacity of this report.

Initially, it appeared that several of the trees on the northern boundary (Trees 2-5) could be retained. However, a closer examination of the plans revealed that these trees would be in the middle of the site, and this may not have been evident to the Council, who evidently inspected the trees from outside the site. It is entirely understandable how they may have missed this point.

Tree 1 is growing exceptionally close to the concrete culvert. This, combined with the two major wounds, raises concerns about the merit of going to great effort to retain this tree. That said, this tree is likely to have been self-seeded, so there is probably some merit in propagating from this tree to preserve the local genome. However, other specimens nearby could be used for that purpose if required.

The structural issues with both Tree 2 and Tree 5 suggest that their retention may not be the best option, particularly considering the young age of these trees. A better option would be to replace these trees with sufficient new trees to compensate for the canopy loss within a decade or two.

Eucalyptus scoparia is generally a shorter-lived species in the Sydney region, which has been made worse by the Winter Bronzing Bug. As a result, I believe Trees 3 and 5 do not merit great consideration. When the pruning of these boundary trees is also considered, it seems more appropriate to have long-lived, slower-growing species along this boundary.

While the retention of Tree 6 seems possible, several issues need to be weighed. The first is the need to interface any new works with the mound. The second issue is the need to repair the boundary fence without causing significant damage to the roots less than 50 cm from the base of the tree.

Transplanting

While not often transplanted in Australia, Eucalypts are commonly transplanted elsewhere and move surprisingly well. The first issue with transplanting is the need to move sufficient roots and soil, and this is usually a root plate with a radius of five times DBH (hence the Minimum Tree Protection Zone provided in Appendix 1). This means that access is needed to excavate and work in the area adjacent to the root plate. This effectively eliminates Tree 1 and 6 because of their proximity to the road or the culvert. It also means that only two of the four trees (Trees 2 – 5) could be moved.

There seems little point in moving Trees 3 and 5 because willow gums are short-lived, and the structural issues with Tree 2 suggest that transplanting this tree would be questionable. This leaves Tree 4 as the only candidate suitable for transplanting.

Figure 1: Large eucalypts moved to Shekvetili Dendrological Park Shekvetili, Georgia. The arrow points to a person mowing the lawn.

While Tree 4 may be suitable for transplanting, this does not necessarily mean it can or should be transplanted. The first issue is that a suitable planting location needs to be found, and this needs to be an area not less than 100 square metres. In addition, that area will need to be isolated from the works and on the eastern side of the powerlines. In considering the location, it must be remembered that the tree canopy has a radius of about 10 metres, so cranes, concrete pumps, etc., would need to operate several metres from the canopy.

Lastly, while not the most critical consideration, the cost of transplanting a large tree like this is likely to come close to $250,000. This is by no means an obstacle to moving the tree. Rather, it raises the question, “Is this the best use of the landscape budget?” In many cases, the answer is emphatically “No!”, particularly given the relatively young age of this tree.

Replacement planting

Replacement plantings are not without their problems, and these need to be addressed if this option is adopted. These issues are that:

1. there is a propensity to utilise smaller, slower-growing species, and
2. the number of replacement trees fails for many decades to replenish the canopy area and biomass lost
3. the species selected are often suitable for and subjected to hedging or routine reduction, preventing them from ever replacing what has been lost.

These three issues can be addressed by

a) using species that are fast to medium-growing, and
b) using a sufficient number of threes such that the tall tree canopy lost is replenished in ten to twenty years, and

c) ensuring Council conditions and strata records align and support the growth of the trees, and
d) ensuring the construction and landscaping take into account the
    i. potential size of the trees, and
    ii. space needs for root and tree growth, and
    iii. the pressure exerted by tree roots.

While it is not appropriate to address all of these at a preliminary stage, considering several of them as an exemplar is worthwhile. For that purpose, let's categorise Trees 1, 2, 4 and 6 as fast-growing species and 3 and 5 as medium growth rate species.

- The use of taller canopy trees from the Cumberland plans woodlands would be ideal. If medium-growth rate trees were preferred, then species *Melaleuca decora*, *Waterhousia floribunda*, and *Cupaniopsis anacardioides*.

- Where faster-growing trees are used, they should be planted at a ratio of 5 to 1 using faster-growing trees or at 10 to 1 if replaced with medium-growth trees.

- Where Trees 3 and 5 are replaced, they should be replaced at a ratio of 3 to 1 using faster-growing trees or at 10 to 1 to replace the medium-growth trees.

- All new trees should be in 45-litre containers.

- Tree planting areas must be protected against compaction during construction or cross-ripened or otherwise de-compacted before new trees are planted.

- All new trees must be maintained and protected. If a tree dies, it must be replaced within 90 days with the largest available sized tree that matches the dimensions of the tree that has died.

- The trees may have formative pruning but must not be hedged or reduction pruned.

Root systems

All parties dealing with trees on development sites must understand how tree roots function. Doing so will help reduce unintended damage and result in a better outcome for the retained trees.

All roots start as '**pioneer roots'**, pushing their way through the soil to take advantage of newly available soil moisture and solutes (soluble nutrients) in the zone they have entered (hence the term pioneer). Cell division at the tip of the root and cell elongation behind this tip creates the pressure to push the roots through the soil. This '**zone of elongation**' is typically a few millimetres to less than 100 mm in length.

Cell elongation requires lots of water. The presence of readily available water, solutes, and soil temperature (generally around 16 C for most temperate trees) stimulate root growth. Whilst elongating cells can absorb some water, at best, they only take up sufficient to meet the water needs associated with cell elongation.

Once the roots have fully elongated, single-celled hairs develop on the root's surface, significantly increasing the surface area of the root. These roots and '**root hairs**' make up the '**absorbing roots.**'

'Absorbing roots' are responsible for the uptake of nearly all the water and the majority of solutes used by the tree. They are highly ephemeral, often lasting only a few weeks. However, they can persist for a year or more in association with beneficial fungi.

Where trees are already growing well, we can assume that soluble nutrients are present at satisfactory levels. As a result, the most limiting factor for growth is usually water.

Some of the new pioneer/absorbing root structures will survive the various environmental stresses, and within a few weeks or so, they become woody.

'**Woody roots**' are effectively underground branches. They act as the connection between the absorbing roots and the rest of the tree. They can be under a millimetre in diameter and may grow to more than a metre in diameter over time. Woody roots are surrounded by bark that helps to prevent the root from drying out. This bark significantly impedes the ability of woody roots to absorb water and solutes.

Woody roots have the potential to be long-lived, sometimes lasting for hundreds of years. However, just like above-ground branches, most woody roots die because of diseases, environmental damage, or competition.

'Structural roots' make up only a small portion of the woody roots. These roots provide physical support for the tree. They grow directly from the trunk (first-order lateral roots) or are roots that branch close to the trunk. These roots provide support in compression and tension. They have a higher concentration of lignified cells to allow for strength and increased transport. As a result, care should be taken to avoid or minimise damage to structural roots.

In response to compression and/or tension forces, structural roots tend to develop an asymmetric shape rather than the normal circular shape. As the roots grow further from the trunk, they get rapidly thinner (zone of rapid taper) and more circular in shape.

In fast-draining sandy soils, such as the case on this site, most roots are likely to occur in the first profile containing the loam, but some roots will penetrate several metres into the sand below.

Damage to roots

Damage to larger roots inside the zone of rapid taper is extremely undesirable and should be avoided in most circumstances. These are often structural roots; therefore, excavation is more significant in its impact than carefully constructing over the top of these roots.

Depending on the amount of root division, cutting a woody root with a diameter of 25mm could result in the death of many millions of root hairs. This loss of absorbing roots directly impacts a tree's ability to absorb water and solutes. It can also impact hormone production, reducing growth above ground until the root/foliage ratio is restored to its ideal levels.

The loss of roots can also result in wilting or thinning of the foliage, the loss of foliage, the death of smaller branchlets, and sometimes the death of specific larger branches. The presence of available soil moisture is essential in minimising the impact of root loss.

Not only do higher soil moisture levels reduce the energy expended to absorb water, but it also stimulates new root development. The sooner that enough new absorbing roots are stimulated, the less impact the root loss or damage will have on the tree's normal functioning.

Some roots are almost always present close to the surface. As a consequence, construction activity can crush, damage or break these surface roots. Soil compaction associated with construction can also indirectly harm the roots and slow root growth. Even regular pedestrian activity may affect the surface roots.

Adding fill under the canopy of a tree has the potential to alter the movement of water in the soil. In some circumstances, the fill can cause the soil to become anoxic, killing the roots or the tree.

The easiest and most efficient way to limit construction damage to trees is to establish and enclose a Root Protection Area (RPA) using a rigid fence. This fence's function is to protect the tree, particularly the roots, by eliminating or restricting construction activity in this area.

Methods of Tree Protection

When working near trees, it is essential to understand the basic principles of tree protection. The information in this section and the images in Appendix 5 are provided to assist in this regard.

Protect the roots

As has already been explained, the purpose of establishing a Tree Protection Zone is concerned with more than protecting the trunk of the tree. A Tree Protection Zone's primary function is the protection of the roots of the tree.

The most effective method of protecting a tree is establishing an exclusion zone that will protect the roots of the tree. This usually involves erecting some form of a barrier around an exclusion zone using temporary fence panels. While it may seem appealing to use a flexible fabric barrier fence, these products tend to fail over time and are easily pushed out of the way or damaged. In addition, damaging a rigid fence involves the cost of repairing and replacing any damaged panel.

Sometimes, however, it may become necessary to work within or gain access through a Tree Protection Zone. To do this, we need to prevent or minimise soil compaction and prevent direct physical damage to surface roots. A simple action such as walking on the same spot half a dozen times or more can lead to soil compaction. Pushing a full wheelbarrow will cause compaction in the first instance. It does not take long for that damage to accumulate and to harm the roots of a tree.

There are several ways to protect roots against compaction and physical damage. We can divide these into two simple groups:

- Systems that share the load, and
- Fully load-bearing systems.

Load-sharing surfaces are temporary and usually lightweight systems. Load-sharing surfaces can be as simple as mulch beneath plywood or planks or the use of scaffolding, or they can be more complex systems such as the use of plastic or metal road plates or even rail decking. Photographs in Appendix 5 show that these can be enough to protect a delicate egg from breaking.

Fully load-bearing structures include finished structures such as the slab of a building, a driveway, or a pathway. Obviously, each of these has a limit to the weight that it can bear and if this is exceeded, the structure and things beneath it can be damaged. Load bearing systems can also include scaffolding and temporary bridging structures.

Protect the trunk

In most instances, enclosing the Tree Protection Zone ensures that the trunk of a tree cannot be damaged. Sometimes, however, work needs to take place within the Tree Protection Zone and, as a result, there may be a possibility of the trunk being hit. Damage to the trunk is extremely undesirable. Where it is possible to treat the wound, treatment is time-critical and is very expensive. When treatment is not possible or is ineffective, a trunk injury can lead to long-term structural and physiological problems.

Where possible, operating machinery or performing activities that may hit the trunk should be avoided. Where this is not possible, it is crucial to protect the trunk. Strapping pieces of timber to the tree's trunk has been the traditional method for achieving this task.

Conservation of Momentum (as demonstrated by Newton's cradle) tells us that this force is transferred through timber pieces to the trunk of the tree. This means such systems offer little to no protection and in some circumstances may result in increased damage.

In response to the failure of timber to absorb impact, hessian or carpet underlay was used. While these improved the situation, the timber still lacked the ability to absorb any of the energy. The use of fabric wraps also creates new problems; in particular, they often hold moisture, and this moist material was in constant contact with the trunk. This can cause disease issues.

A more appropriate system needs a hard, but flexible outer surface bonded to a soft impact-absorbing material with a low water-holding capacity. This system is better at absorbing the energy of an impact, similar to a bicycle helmet. Just as with a bicycle helmet, if the impact damages the protection system, it needs to be repaired or replaced, and at the same time, the trunk of the tree needs inspecting.

Lastly, prevention is the best process. When machinery is operating in close proximity to the trunk, using an observer can significantly reduce the likelihood of impact. To be effective, the observer should maintain direct visual contact with the tree and the machine and should have audio contact with the operator. (Two-way earmuff systems are useful for this task).

Protection of the canopy

The tree's canopy is not frequently harmed by accidents during the construction process. Even so, there are two ways that the construction process can harm the canopy. The first is the direct impact between equipment and the tree branches, and the second is from incorrect or excessive tree pruning.

Avoiding the impact between machinery and branches requires care. When machinery needs to operate near branches, an independent observer should be used. The observer should maintain direct visual contact with the machine and the tree branches and should have direct audio contact with the operator.

All pruning cuts should be made as illustrated in the Australian Standard AS 4373-2007 “Pruning of Amenity Trees.” Anyone who does not fully understand this Standard or who has not had the proper training to perform pruning should not attempt this work. The Project Arborist may instruct site personnel to make temporary cuts for later rectification by an arborist. These instructions should be carefully followed.

Should you require any further information, do not hesitate to call our office for assistance.

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Appendix 1:

Tree Schedule

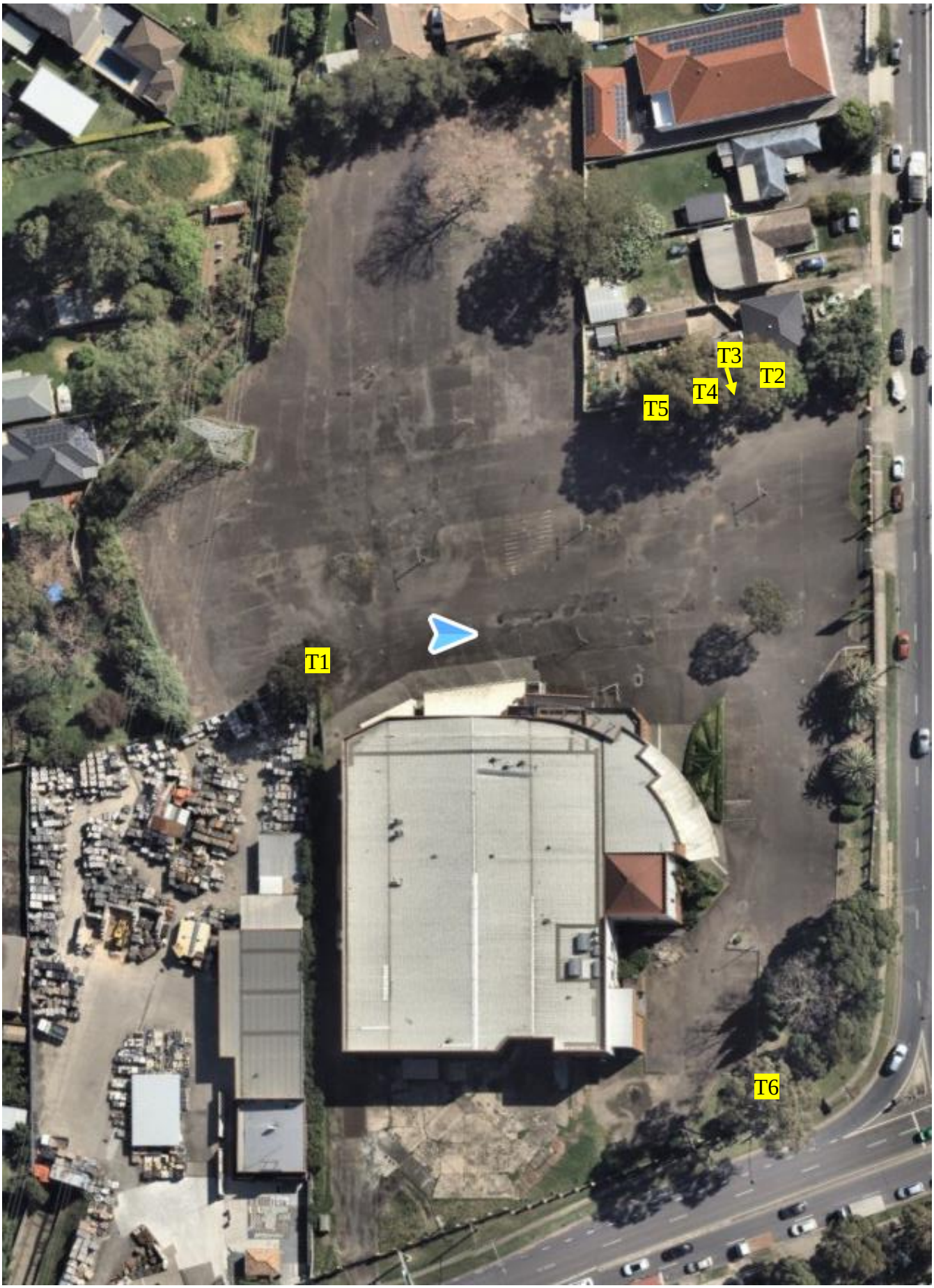
No	Scientific Name	Health	Height (m)	Spread (m)	DBH (cm)	ITPZ (m)	MTPZ (m)	TI/ME (m)	Retention Value	Comments
1.	*Eucalyptus tereticornis*	Good	22	22	82	9.8	4.1	6.9	Low to moderate	Two large wounds and culvert nearby – tree otherwise in good health
2.	*Corymbia maculata*	Good	24	16	51.5	6.2	2.6	4.3	Low	Significant inclusion
3.	*Eucalyptus scoparia*	Good	16	12	50	6.0	2.5	4.2	Low	Has had major stem removed
4.	*Corymbia maculata*	Good	24	20	74	8.9	3.7	6.2	Low	Recently pruned
5.	*Eucalyptus scoparia*	Good	18	20	66	7.9	3.3	5.5	Low	Included stem with wound just above the inclusion on the northern stem
6.	*Corymbia maculata*	Good	28	20	70	8.4	3.5	5.9	Low to moderate	

Notes on Tree Schedule

Health	**Good** – In good health with no significant faults or defects
	Fair – Some faults or health problems. Not likely to cause short-term problems, generally able to be managed.
Height (m)	Approximate dimension.
Spread (m)	Approximate dimension. The average diameter of the canopy unless the asymmetry of the canopy is noted or is critical to the design process
DBH (cm)	Trunk diameter - measured at 1.4m above ground as outlined in "Appendix A" AS 4970 – 2009
ITPZ	The Indicative Tree Protection Zone radius specified by section 3.2 of AS 4970 -2009 and rounded up to one decimal place
TI/ME	The minimum radius for a Tangential Incursion into the TPZ yet still be a Minor Encroachment using AS 4970 - 2009
TPZM	The suggested Tree Protection Zone Minimum radius determined following the process for reducing the TPZ outlined in AS 4970 – 2009. The TPZM usually requires moderate to extensive arboricultural input along with ongoing maintenance for some time
Retention Value	**E = Essential** - Site suitability 40 plus years, good condition, able to be retained without design changes
	H = High - Site suitability 40 plus years fair condition or better able to be retained with minor design changes
	M = Moderate - Site suitability 20 - 40 years, or only retainable with moderate impact on the development of the site
	L = Low - Site suitability less than 20 years, or retention impacts significantly on the development of the site
	N = Nil - Site suitability less than 5 years, or retention sterilises development of the site
	Note: Site suitability considers health, life expectancy, the risk of harm, the desirability of species and impacts on current and proposed land use. Impact on development needs to be considered throughout the planning stage.

Appendix 2:

Tree Location Plan


T3
T2
T4
T5
T1
T6

Appendix 3:

Determining the Tree Protection Area

A simple solution

Over the last two decades, there has been an increasing awareness of the need to protect appropriately and care for trees on development sites. There have been conferences, workshops as well as publications written on the subject. Most notably these include British Standard BS 5837: 2005, "Trees and Development" by Matheny N & Clark J and "Protection of Trees on Construction Site" by Hartley M. These publications all focus on minimising damage to the root system of the tree by establishing appropriate **T**ree **P**rotection **Z**ones **(TPZ).**

The British Standard provides Matheny and Clark as the source of the formula for calculating the tree protection zone's radius. Interestingly Matheny and Clark site the British Standard as the source of the formula. Such a circular argument is of concern, mainly when the Matheny and Clark include many examples of their successful encroachment of their Tree Protection Zone in their text.

Matheny said, ***"It is not that common that we get that much space."*** and ***"With tolerant species, we can squeeze that down by half or two-thirds".*** (ISA Annual Conference 2007) Mathematically that suggests that the Tree Protection Zone could contain as little as 12% of the root volume provided for using either formula.

Calculations and tables in the first two publications aimed at providing a Tree Protection Zone sufficiently large enough to ensure that the tree's health is not adversely impacted and achieves this without the need for arboricultural input other than ensuring the maintenance of the protection zones. The British Standards or Trees and Development are ideal documents to be applied by anybody regardless of their understanding of plant physiology.

Matheny rightly states, **"*Because the tree is an individual the table is not enough. You need to consider all the factors*."** (ISA Annual Conference 2007) Suppose we are to find benefit in the TPZ given in either the British Standard or Trees and Development. In that case, this is a **TPZ** that can be determined by any person and without any arboricultural input since it is a simple formula. Anyone able to measure the trunk diameter and follow the formula can calculate the **TPZ**.

A suitably experienced consulting arborist can often support a smaller **TPZ** when combined with appropriate arboricultural care, and some provision is given in the British Standard for this to take place. This makes no sense unless the formula for calculating the **TPZ** in the British Standard is prefaced with a note saying that this is the point at which arboricultural input is required. Regrettably, the British Standard does not say this, and as a result, it becomes overly prescriptive.

An arboricultural solution

Land and development costs along with the environmental impact of urban sprawl, make it undesirably burdensome to sterilise vast areas of land to enclose an optimum **TPZ**. It is often far more cost-effective to provide even the highest level of Arboricultural care possible to a tree to ensure that it thrives and prospers in the long term than to establish a **TPZ** that is unnecessarily large.

It makes logical sense to adopt a **M**inimum **T**ree **P**rotection **Z**one based on the size of a root plate required to transplant the same tree. Transplanting of large and even very old trees has been carried out with enough frequency, and over such an extended period, we have a good understanding of how transplanted trees respond to root loss. A success rate of 97% can be expected when a transplant is properly undertaken with appropriate ongoing care.

Perhaps the 3% failure rate could be considered as unacceptable, but it is likely that a percentage of these would have died within a few years in any case. Matheny again points out ***"Transplanting is a far greater impact – if we are going to transplant it, we might as well keep it where it is and squeeze the protection zone."*** (ISA Annual Conference 2007) A transplanted tree will undoubtedly undergo a greater degree of stress than a tree that is retained with an identically sized root plate appropriately protected and cared for.

More often than not, the site constraints are likely to benefit from a **TPZ** that is smaller than that specified by the British Standard and Trees and Development. Using a smaller **TPZ** means that there will be a requirement for appropriate levels of arboricultural care. This approach may give rise to the question "What is the minimum area required by the tree?" There is, unfortunately, no absolute answer to this question, but there are some important benchmarks to be considered.

- The protection should be sufficient to allow the maintenance of the tree, with appropriate arboricultural input. In the past, this was called the **C**ritical **R**oot **Z**one **(CRZ)** and frequently related to the size of the root plate that would be required to transplant the tree successfully. In most instances this is an area with a radius of 5 times the trunk diameter. This document refers to this at the **M**inimum **T**ree **P**rotection **Z**one (**MTPZ).**

- Depending on the tree's response to root damage, it is possible to come even closer to the tree particularly when construction impact is going to be limited to one side or better still to one quadrant of the Critical Root Zone, **and** the provision of an additional area around the remaining area of the root zone can be protected.

- The extent of any excavation should not result in the structural instability of the tree. Several formula and test exist to determine the size of the **S**tructural **R**oot **Z**one (**SRZ**). However, there is generally no need to consider the issue of structural stability if work is performed outside the **MTPZ**. It is undesirable and often unwise to cut roots located in the Structural Root Zone in most circumstances.

- There must be sufficient soil volume to allow the tree to grow to maturity with appropriate ongoing care. If the goal is to have little ongoing care, this will undoubtedly take a greater soil volume than a tree that will be extensively maintained (such as a tree growing in a rooftop planting).

The approach of AS 4970-2009

In August 2009, Standards Australia released AS4970-2009 Protection of Trees on Development Sites. In its preface, this document acknowledges its reliance on the British Standard and Matheny and Clark. This Standard suggests an "***I**ndicative*" **TPZ** with a radius 12 times trunk diameter. As already discussed, there is no question that this will provide adequate protection of the tree in almost all conceivable situations. It achieves this by suggesting an **ITPZ** encloses and potentially sterilises an enormous area.

The Standard does acknowledge that it may be possible to encroach on this **ITPZ** if the project arborist can demonstrate that the "*trees will remain viable*." As already stated, we can successfully transplant most trees in good health and vigour, so the use of a reduced sized **TPZ** when combined with appropriate care, has been demonstrated by several hundred years of successful tree transplanting. (Mathematically the standard sized root plate for a transplant has less than 20% of the root area of the **ITPZ** specified in the AS 4970-2009.)

Of equal concern is the impact of the insistence of a **TPZ** with a radius of 12 times trunk diameter may have on tree retention and urban sprawl. There is a conflict between development and tree retention. A decision will need to be made to refuse the development (potentially increasing urban sprawl) or reduce the size of the **TPZ**.

If the development is acceptable, then we need to answer the question "should we be removing trees that cannot be given the **ITPZ** given in AS 4970-2009?" The answer should be "No!" whenever there is adequate potential for retention the tree with appropriate arboricultural input.

Given that the Standard has some significant issues and seeks to be "informative," it is essential the Standard is not viewed as prescriptive or normative. The standard does consider some critical issues such as the timing of the work, the importance of preventative maintenance and ensuring appropriate monitoring of the trees. As far as practical, this document forms an essential part of that process.

There is no doubt that establishing and maintaining a **TPZ** around a tree is the most important thing that a developer can do to protect a tree. Similarly, perhaps the most significant arboricultural input that can be provided is the management of soil moisture levels. The sooner soil moisture is managed, the lower the impact on a tree. Ideally, management would start before any work begins on the development.

Appendix 4:

Generic Tree Protection Guidelines

1. Pre-Construction:

1.2. Before the commencement of construction, the consulting Arborist will issue a report outlining the following:

1.2.1. The trees that have been protected, the maintenance activities (if any) for each tree that have already been performed, that the protective fence or fences have been installed in accordance with the Arborist's Report.

1.2.2. A statement that the physical protection (items 7 and 8 of the POTOCS Standards) of the trees has been performed, to the above Standards or if not, any non-conformances and why. For example, the fence around trees is incomplete because of boundary fences.

1.2.3. All trees to be removed are to be marked with a single white line around the trunk. No tree shall be so marked until council consent for its removal has been given.

1.2.4. Before removal, one of the following will confirm the tree is to be removed by marking the tree with a single horizontal yellow or orange line. One of the following persons, Surveyor, Landscape Architect, Arborist, Project Manager, and Tree Preservation Officer, should do this.

2. Tree Protection Zones:

2.1. The trees are protected by a 1.8-metre high fence to be constructed within 500mm of any construction activity and include as much of the Primary Root Zone as possible.

2.2. The Tree Protection Zone occurs on the adjacent property; the fence will stop at the boundary lines.

2.3. Provision will be made to these protection zones for pedestrian access only.

3. Maintenance activities:

3.01 Timing: Maintenance activities are to be at the commencement of the construction process by qualified Arborists and then required during the construction period.

3.02 The following maintenance activities may be required for this site:

- Irrigation – by hand to comply with current specifications
- Soil Amelioration
- Mulching
- Crown cleaning in accordance with AS 4373-2007 *Pruning of Amenity Trees*,
- removal of trees by sectional felling and stump grinding.

3.1. Irrigation

3.1.1. Soil moisture during construction shall be maintained at not less than 60% of field capacity.
3.1.2. Irrigation is to be applied by hand. No construction activities are to occur within the Primary Root Zone until irrigation has been initiated and soil moisture reaches 70% of field capacity at a depth of 300mm.
3.1.3. On each visit, the consulting Arborist shall check the soil moisture and manually check the irrigation system, when installed.
3.1.4. Soil moisture levels should be checked by physical touch or with a tensiometer.

3.2. Soil amelioration

3.2.1. An arborist may apply an application of rooting hormones, humic acids, soil micro-flora and mycorrhizae in accordance with the manufacturer's instructions.
3.2.2. Chemical fertilisers are to be used only after representative soil testing and based on the soil scientist's recommendations.

3.3. Mulching

3.3.1. The fenced area should be mulched with seed-free mulch to a depth of at least 10 cm.

3.4. Weed Control

3.4.1. Weed control shall be by hand pulling, wiping or spraying with a glyphosate-based herbicide. Material likely to be root grafted to trees to be retained shall be removed manually.
3.4.2. Weed control shall not be performed by mechanical cultivation or by scraping or back burning.

3.5. Crown cleaning

3.5.1. Crown cleaning (AS4373-2007 *Pruning of Amenity Trees*) shall be performed in accordance with The Pruning Standard, by an arborist and in compliance with the appropriate occupational health and safety regulations. All branches down to 50mm in size shall be inspected and appropriately treated.
3.5.2. Any concerns about health or safety observed by the Arborist on the site will be reported in writing within 7 days to the superintendent/principal/client and/or head contractor.
3.5.3. The use of spurs on live trees and internodal cutting is strictly prohibited.

3.6. Tree Removal and Stump Grinding

3.6.1. Remove trees in a controlled or sectional felling to avoid any damage to the trees to be retained.
3.6.2. All shrubs, under-scrub and woody weeds that are to be removed shall be removed by hand as per 3.4 above.
3.6.3. No tree shall be removed unless marked with a horizontal white and yellow/orange line around the trunk.

4. Fences:

4.1. The fencing of the Tree Protection zone as defined in section 8.0 of the POTOCS Standards should be commenced before the commencement of ANY work, including demolition and land clearing by earthmoving machinery but may be erected after tree maintenance activities.

4.2. The fence surrounding the Tree Protection Zone must be a rigid fence not less than 1.8m high.

5. Signs:

5.1. At least every 25 metres attached to all tree protection fence there shall be a sign, a minimum of 600mm x 600mm, bearing the following phrase in red letters on a white background at least 50mm in height:

"TREE PROTECTION ZONE - KEEP OUT"

5.2. On the same sign above or on a separate sign attached adjacent, in red lettering on a white background not less than 25mm in height is to be the following:

"PROHIBITED ACTIVITIES"

Followed by the list below in black letters not less than 15mm in height.

a) Entry of machinery or people.
b) Storage of building materials.
c) Parking of any kind.
d) Erection or placement of site facilities.
e) Removal or stockpiling of soil or site debris.
f) Disposal of liquid waste, including paint and concrete wash.
g) Excavation or trenching of any kind (including irrigation or electrical connections).
h) Attaching any signs or any other objects to the tree.
i) Placing of waste disposal or skip bins.
j) Pruning and removal of branches, except by a qualified Arborist.

5.3. In letters, not less than 25mm in height on the above sign should be the name of the supervising Arborist or Arboricultural Company or other appropriate contact and a contact phone number.

6. Root Cutting

6.1. All roots greater than 50mm in diameter that need to be removed shall be cleanly cut and kept moist at all times and shall not be left exposed to the air for more than 10 to 15 minutes.

7. Maintenance Reports:

7.1. Weekly inspections and monthly reports should be made until the end of construction.

7.2. A consulting Arborist should be on-site during any excavation work within the Critical Root Zone and report on that work in the monthly report.
7.3. A site log shall be maintained and include the Date of each inspection, the person who performed the inspection, the items inspected or tested, the maintenance activities performed, any repairs undertaken or required to be undertaken, and any substantial breaches or non-conformances.
7.4. The Arborist performing the inspection should sign the entries in the logbook
7.5. The log shall be maintained on the site or copies of the month's log entries shall be submitted each month with the monthly report.
7.6. All maintenance shall continue for the 3 months after completion of construction

8. Non-Conformance Reports:

8.1. The following are non-conformances that need to be managed when they occur.
8.1.1. The removal or relocation is closer to the tree of all or part of any protective fence before landscaping.
8.1.2. The performing of any activity noted as prohibited on protection zone signage
8.1.3. The failure to maintain adequate soil moisture or failure in the operation of the irrigation system.
8.1.4. Mechanical damage to the trunk, stems, branches, or retained roots.
8.1.5. The sudden and abnormal or premature shedding or decline of the tree.

8.2. **Substantial breaches and non-conformances**:
8.2.1. Any breach or non-conformance of the tree protection zone, by any party, shall be notified in writing within 2 working days of it being first observed.
8.2.2. Notification of any non-conformance should be made in writing to the site foreman, the consent authority, and any independent certifier.

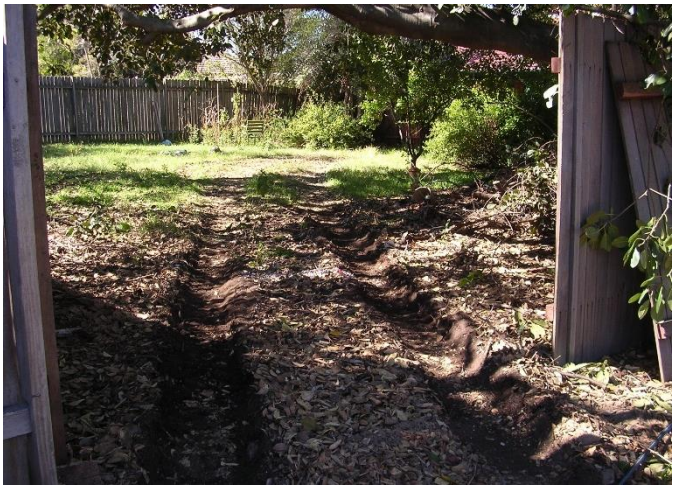
Appendix 5:

Protection of Trees on Construction Sites

Establishing a Tree Protection Zone

Good Work	Poor Work
 **Photo 1:** The fence should be rigid and hard to move.	 **Photo 2:** This style of fence is too easily damaged and collapses when hit.
 **Photo 3:** The TPZ is mulched where appropriate and weed-free.	 **Photo 4:** Put the fence where it should be! The TPZ is not for storage.
 **Photo 5:** The purpose of the fence is to isolate the tree from the works and protect the roots.	 **Photo 6:** Woven fences seldom work, particularly when space is limited.

Protecting the roots

Good Work	Poor Work
 **Photo 7:** Like an egg, tree roots are delicate and easily damaged.	 **Photo 8:** A single movement of a truck can cause significant damage to the absorbing roots.
 **Photo 9:** The load-sharing surfaces should be designed to take the load that will travel over it.	 **Photo 10:** Without appropriate protection, the soil is compacted, and the roots are broken and damaged.
 **Photo 11:** The goal is to ensure minimal impact on the roots that are being protected.	 **Photo 12:** Keep equipment away from the tree by using appropriate tree protection.

Protecting the trunk

Good Work	Poor Work
 **Photo 13:** TrunkGuard is designed to absorb impact just like a bicycle helmet.	 **Photo 14:** Trunk damage is sometimes irreparable and frequently causes long-term problems!
 **Photo 15:** It is flexible for a better fit and attached using screws to avoid light impact.	 **Photo 16:** Even the installation of a poorly designed system can injure a tree!
 **Photo 17:** Able to withstand and absorb moderate construction impact - not that this should happen!	 **Photo 18:** This serves little purpose at all! It does not protect the roots or the trunk of the tree.