Arborist Network

Connecting people and trees™

Arboricultural Impact Assessment Report

Site Address: 6 - 8 Linksview Avenue
Leonay NSW

Prepared For: Dominic Hogan
Glenstone Constructions
Unit 3 152 Old Bathurst Road
EMU PLAINS NSW 2750

Prepared On: 18th December 2018

Report Number: CD2001

Prepared By:
Mark Hartley
Senior Consulting Arborist- AQF Level 8
Grad Cert Arboriculture (1st Class Honours)
Dip Hort (Arboriculture) with Distinction
Dip Arboriculture, Dip Horticulture
LMAA; LMISA; LMIPS
ISA Certified Arborist WC-0624 (since 1990)
Registered Consulting Arborist™ #0005
ISA Tree Risk Assessment Qualified
Registered QTRA user (No. 807)
Member - Society of Risk Analysis Australia & NZ

Prepared on behalf:
The Arborist Network
58 South Creek Road
Shanes Park NSW 2747
Phone (+612) 9835 1234
Email: *reports@arboristnetwork.com.au*

Table of Contents

Copyright Release

Arborist Network

Connecting people and trees™

Executive Summary

A proposal exists to demolish an existing cottage and associated infrastructure and to then construct six villas along with access driveway and landscaping. The proposed development shows the removal of all trees on the site.

Protection of the trees on the adjacent properties has been provided for. To that extent, a Tree protection Plan (specifications) and Tree Protection Plan (drawing) have been included as a part of this report.

Provided that the Tree Protection Plan is followed there is no reason to be leave the tree proposed development will have any adverse impact on the

Brief

The author has been asked to;

- visit the site,
- identify the trees present and within 10 metres of the development,
- assess existing site conditions,
- assess the current health of the trees,
- undertake a Preliminary Tree Assessment,
- assess and discuss the impact of the proposed development on the trees,
- produce a Tree Protection Plan (specifications) and a Tree Protection Plan (drawing),
- compile an Arboricultural Impact Assessment Report.

Information Provided

Plan Name	Plan Number	Drawn By	Date	Revision
Plan of Details and Levels	18732	Richard Hogan and Co	23/10/2018	A
Site plan	DA0100	Integrated Design Group	10/12/2018	A
Ground floor plan	DA1100	Integrated Design Group	10/12/2018	G
Roof plan	DA1101	Integrated Design Group	10/12/2018	C
Concept planning	SK1102	Integrated Design Group	19/09/2018	A

Method

A site inspection was carried out on the 4th december2018 and the site related observations contained in this report arise from the inspection on that date.

This report considerers trees that are covered by the Tree Preservation Order and relies on the definition and exemptions contained in the Tree Preservation Order in determining what constitutes a tree, and which trees are exempt. This report also considers all trees on the neighbouring properties that are likely to be impacted by the proposed development regardless of the definition contained in the Tree Preservation Order.

All trees were inspected from the ground and involved inspection of the external features only. Inspection of trees on the neighbouring property was from client's property and or the public footpath. The inspection included the performance of a **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 on broad 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.

The trees that were not located on the survey plans provided are shown with their approximate centres marked on the Tree Protection Plan (drawing) (See Appendix 2).

Only the plans referred to above, have been used in assessing the impact of the proposed DA on the trees. Where recommendations are made in this report including those recommendations contained in the Tree Protection Guidelines it is essential that these recommendations be able to 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** – Visual Tree Assessment, as referenced below, is a systematic inspection of a tree for indicators of structural defects that may pose a risk due to failure. The first stage of this assessment is made from ground level and no aerial inspection is undertaken unless there are visual indicators to suggest that this is merited. Details of the visual indicators are contained in *The Body Language of Trees* by Mattheck & Breloer (1994). The use of a Visual Tree Assessment is widely used and standardised approach. Invasive and other diagnostic fault detection procedures will generally only be recommended when visual indicators of potential concern are observed.

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

Observations

For details of individual trees see the Tree Schedule attached as Appendix 1.

The trees are all exotic and have been planted by the current owner over the last five decades. They comprise a mix of conifers and broadleaf trees. The trees are mostly in good health.

The site is a large residential corner lot. It slopes to the south at about 5 % and to the east by 1 to 2%.

The proposed design is for six units with the access handle coming from Linksview Avenue to service garages that are entered internally from the site. As a result, there driveway and turning circles take up a moderate proportion of the internal space of the final built form. There is an additional driveway from Linksview also services Unit 4.

Discussion

Tree Removal and Retention

The proposal calls for the removal of all trees on the site. To some extent, the loss of trees could be offset over time by new plantings that form a part the landscape works that are a part of the landscape works.

It is unclear what consideration has been given to retaining trees as a part of preparing the proposed development. It may be possible to retain some of the boundary planting particularly near the corner of Fairways and Linksview Avenue along with Trees 13 and 14.

There is an obvious need, however, to protect the trees on the neighbouring properties. This need forms part of the primary thrust of this document.

Design Issues

The proposed development should consider whether it is possible to retain any of the trees and vegetation on the boundary.

As a result of Work Health and Safety requirements, the cleaning of gutters on a multistorey building is becoming more problematic. Because there are a number of larger trees on and adjacent to the site, consideration should be given to installing a gutter system that will not be significantly impacted by leaves. This could include one or more of the following

- installing a quality leaf screening system that is installed over the lower portion of the roof and the top of the gutters, and
- installing 'Tornado Rain Heads' to increase the flow and reduce the likelihood of any blockages, and
- installing one or more syphon-based diverters such as Gutter Pumper®, and
- installing overflow spouts that allow for the discharge of water in the event of a blockage taking place. (Spouts prevent damage to the building and make it clear that there is a blockage – see http://tinyurl.com/ycrortww),

Root systems

All roots start as '**pioneer roots'**, pushing their way through the soil in order to take advantage of newly available soil moisture and solutes that are in the zone that 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. This '**zone of elongation**' is typically a few millimetres to less than 100 mm in length.

Cell elongation uses water, and the presence or readily available water, solutes (soluble nutrients), and soil temperature (generally around 16 ^{O}C for most temperate trees) stimulates 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 surface of the root and these roots with '**root hairs**' to form '**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, in association with beneficial fungi, they can last a year or more.

Where trees are already growing well, we can typically assume that soluble nutrients are present at satisfactory levels. Likewise, we can assume that the soil surface temperature often exceeds 16 degrees Celsius most of the year and that at depth, the soil temperature does not vary significantly throughout the year. The biggest limiting factor, therefore, is usually the ready availability of water.

A percentage of these pioneer/absorbing root structures survive the various environmental stresses and within a few weeks or so they become woody.

'**Woody roots**' are effectively underground branches. These roots can be a little under a millimetre in diameter and can grow to be hundreds of millimetres in diameter over time. Their bark prevents them from drying out, but as a result, they are restricted from being able to absorb water and solutes from the soil to any great extent.

Whilst many young woody roots die as a result of disease, environmental damage or competition; they have the potential to be long-lived, sometimes lasting for hundreds of years. Woody roots act as the connection between the absorbing roots and the rest of the tree

'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 greater content of lignified cells and, as a result, tend to be much thicker to allow for strength, as well as transport.

In response to the forces of compression and/or tension, these structural roots 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 moderately quick growing soils, such as is the case on this site, the majority of roots are likely to occur in the first metre or so of soil depth.

Damage to roots

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

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

The loss of roots can result in wilting or thinning of the foliage, the loss of foliage and death of smaller branchlets and sometimes the death of specific larger branches. The ready availability of soil moisture is important in minimising this impact.

Not only do higher soil moisture levels, reduce the energy expended to absorb water, it also stimulates new root development. The faster that sufficient new roots are developed, the less the impact on normal function

Roots are often close to the surface, and therefore construction activity can indirectly impact on the health of roots through direct damage or soil compaction. Even regular pedestrian activity has an effect on the roots close to the surface. In addition, altering of levels by adding fill has the potential to alter the movement of water into the soil and in some circumstances, can cause the soil to become anoxic, in turn causing the death of the roots and potentially the death of the tree.

By far the easiest and most efficient way of limiting construction damage to trees is to establish and enclose a Root Protection Area (RPA) using a rigid fence. The function of this fence is to protect the tree, and the roots in particular, by eliminating or restricting all construction activity in this area.

Methods of Tree Protection

It is important that we understand the processes and methods of tree protection. For that reason, a number of images have been included in Appendix 5 along with the information in this section to assist in ensuring that appropriate implementation of tree protection.

Protect the roots

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

The most appropriate method of protecting a tree is to establish an exclusion zone using some form of rigid temporary fence (a Tree Protection Zone or TPZ). Whilst it may seem easier 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 comparison, damaging a rigid fence requires more of a hit can damage machinery and involves the cost of repair or replacement of the damaged fence.

Sometimes, however, it may become necessary to work within or to gain access through a Tree Protection Zone. To do this, we need to develop a method to stop soil compaction and prevent direct physical damage to 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 harm the roots of a tree.

There are a number of ways to protect roots against compaction and physical damage. We can divide these into two simple groups;

- Systems that share the load and
- Systems that are fully load bearing.

Load-sharing surfaces are temporary and usually lightweight systems. Load-sharing surfaces sometimes can be as simple as mulch beneath plywood or planks or the use of scaffolding, to heavier duty systems such as the use of plastic or metal road plates or even rail decking. Photographs in Appendix 4 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 of 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 is a risk of impact to the trunk. 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 result in an impact to the trunk of the tree should be avoided. Where this is not possible, it is important to protect the trunk. Strapping pieces of timber to the trunk of the tree has been the traditional method for achieving this task.

Conservation of Momentum (as demonstrated by Newton's cradle) tells us that this force is basically transferred through the pieces of timber to the trunk of the tree often providing little to no protection and in some circumstances actually resulting in increased damage.

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

A more appropriate system needs a hard, but flexible outer surface bonded to a soft impact absorbing material that has 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 greatly reduce the likelihood of impact. To be effective, the observer should maintain direct visual contact with the tree and the machine and should have direct audio contact with the operator. (Two-way earmuff systems are useful for this task).

Protection of the canopy

The canopy of the tree is often the part of the tree that is least harmed in the construction process. Even so, there are two ways that the construction process can harm the canopy. The first is by direct impact between equipment and the branches of the tree, and the second is from incorrect or excessive tree pruning.

Avoiding impact between machinery and branches simply 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 branches of the tree 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.

Tree Protection Plan (Specifications)

Design Issues

#	Recommendation	Reason
1	Explore the possibility of the retaining trees and shrubs on the road perimeter.	Trees are a valuable part of the ecological system and add a sense of age to a project.
2	All copies of the plans should include a copy of the Tree Protection Plan (drawing) and a note on each and every plan or drawing to "check the Tree Protection Plan (drawing)"	Tradespeople often read plans rather than written details. Including the Tree Protection Plan (drawing) in the plan set will help the awareness of all tradespeople

Pre-construction

3	Appoint a project arborist to oversee and certify all works in the Tree Protection Zones	A project arborist is needed to supervise and oversee the care and protection of the trees.
4	Establish a 'tree protection' policy document for inclusion as a part of the site induction.	Ensuring all site personnel are aware of the tree protection requirements.
5	A copy of this Tree Protection Plan including the Tree Protection Plan (drawing) **must** be on site prior to any work commencing on the site AS 4970-2009 (5.2)	To ensure that documentation is present and available as a reference for all site personnel. **Note**: The Tree Protection Plan (drawing) can be found in Appendix 2
6	Prior to commencing work on the site, establish Tree Protection Zone as shown on the plan using a load-sharing surface	Tree Protection Zones prevent unnecessary damage to the roots of trees
7	Correct and complete installation of Tree "Protection measures **are** to be certified by the project arborist" AS 4970-2009 (5.3.2).	This is to ensure the tree protection is correct and completed in accordance with the Tree Protection Plan

Load sharing surface

8	Any load sharing surface for pedestrian and light machinery access **must** be comprised of plastic road plate on top of a 10 – 15 cm mulch layer.	To allow for suitable load sharing. **Note:** 19 mm may be used where only pedestrian access is required.
9	Use a geotextile fabric below the mulch to allow for the later removal of the mulch, in areas where turf will be laid.	To allow mulch to be removed by hand and to limit root growth into the overlying mulch.
10	Decommissioning the load-sharing surface by removing all much by hand starting from closest to the tree and moving outwards.	To minimise the impact on roots as a result of the removal of the load sharing surface.
Note: If concerns exist that the works will damage the finished surface the same work will almost certainly damage the tree roots, and a temporary surface must be used		

During site works

11	as per AS 4970-2009 (5.4.1), Have the project arborist inspect the trees at least quarterly including the critical checkpoints listed below	To monitor tree health, to be present at critical checkpoints, and to ensure that the Tree Protection Plan is being followed.
12	If an inspection reveals a breach of the Tree Protection Plan, the project arborist **must** specify any remedial works and the timeframe in which these works must be completed.	To ensure that all problems are appropriately rectified and that any remedial works required are carried out in a timely manner.
13	If at any stage an inspection reveals the Tree Protection Plan (Specifications) has not been complied with, site inspections **must** be carried out weekly thereafter.	This is to provide additional supervision to help avoid repeat problems and to ensure the correct and timely performance of remedial works.
14	Maintain natural ground level within the Tree Protection Zones. Do not trench, stockpile materials or change grades within this zone.	To prevent unnecessary or unauthorised damage to the trunk, roots, and branches of the tree
15	Maintain the Tree Protection Zones until construction work is completed.	To provide protection for the duration of the works that impact on the tree.
16	Machinery access is **not** permitted in the Tree Protection Zones to perform landscaping works	To avoid damage caused by machinery as a part of landscaping activities.
17	Notify the Project Arborist, the Council, and the Certifier not less than 7 days before removing the Load-sharing surface	This allows a check to be undertaken to determine if the remaining works are likely to adversely impact on the trees

Critical checkpoints

18	Have the project arborist present at the following checkpoints: • During demolition of the existing retaining wall greater than 500 mm high • Before backfilling of any trench dug for the purpose of installing the pump-out line • After excavation but before installing any footing within 1 metre of a tree • Prior to cutting any root greater than 15 cm in diameter Note: These can form part of the periodic inspections specified in item 10

Post Construction

19	At practical completion, the project arborist **should** "assess tree condition and provide certification" that the tree protection works have been in accordance with the Tree Protection Plan.	This is to provide a completion to the document trail for the certifier and or the certifying authority.
20	"Certification **should** include a statement on the condition of the retained trees, details of the deviations from the approved tree protection measures and their impacts on [the] trees" and provide specifications for any remedial or rectification work required.	This is to comply with AS 4970-2009 (5.5.2). It provides a documented record of the final condition of the tree. It audits and certifies the correction of any problems.

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

Mark Hartley
Senior Consulting Arborist- AQF Level 8
Grad Cert Arboriculture (1st Class Honours)
Dip Hort (Arboriculture) with Distinction
Dip Arboriculture, Dip Horticulture
LMAA; LMISA; LMIPS
ISA Certified Arborist WC-0624 (since 1990)
Registered Consulting Arborist™ #0005
ISA Tree Risk Assessment Qualified
Registered QTRA user (No. 807)
Member - Society of Risk Analysis Australia & New Zealand

Appendix 1:

Tree Schedule

Client Name: Dominic Hogan, Glenstone Constructions **Site Address:** 6 - 8 Linksview Avenue, Leonay

No	Scientific Name	Health	Height (m)	Spread (m)	DBH (cm)	ITPZ (m)	MTPZ (m)	TI/ME (m)	Retention Value	Comments	Retain / remove
1.	*Liquidambar formosa*	Good	18	9	E50	6.0	2.5	4.2	Low		Remove.
2.	*Cedrus deodara*	Good	18	12	50	6.0	2.5	4.2	Low		Remove.
3.	*Cedrus atlantica glauca*	Fair - Good	18	8	40	4.8	2.0	3.4	Nil		Remove.
4.	*Triadica sebifera*	Good	15	12	40	4.8	2.0	3.4	Nil		Remove.
5.	*Cryptomeria japonica* 'Elegans'	Fair	12	5	15/18/45	6.1	2.6	4.3	Nil	DBH calculated as 51cm	Remove.
6.	*Cedrus deodara*	Good	20	16	95	11.4	4.8	8.0	Low		Remove.
7.	*Cupressus arizonica*	Fair	12	12	E60	7.2	3.0	5.0	Low		Remove.
8.	*Cupressus macrocarpa* saligna	Fair	14	14	75	9.0	3.8	6.3	Low	Reverted/ some damage	Remove.
9.	*Pyrus ussuriensis*	Good	10	8	E30	3.6	1.5	2.5	Low		Remove.
10.	*Nyssa sylvatica*	Good	16	12	80	9.6	4.0	6.7	Low		Remove.
11.	*Cedrus deodara*	Good	18	12	90	10.8	4.5	7.6	Low		Remove.
12.	*Fraxinus griffithii*	Good	7	8	E35	4.2	1.8	2.9	Nil		Remove.
13.	*Juniperus* sp.	Good	6	6	20	2.0	0.8	1.3	Nil		Remove.
14.	*Cupressus sempervirens* 'Swanes golden'	Good	10	3	20	2.4	1.0	1.7	Low		Remove.
15.	*Cupressus sempervirens* 'Swanes golden'	Good	10	3	20	2.4	1.0	1.7	Low		Remove.
N1	*Liquidambar styraciflua*	Good	14	12	50	6.0	2.5	4.2	Low		Retain and protect.
N2	*Thuja plicata*	Good	12	12	50	6.0	2.5	4.2	Essential		Retain and protect.
N3	*Thuja plicata*	Good	12	12	60	7.2	3	5	Essential		Retain and protect.

Notes on Tree Schedule

Number (No)	N – Neighbours tree within proximity of the development
Scientific Name	Identification is made on the basis of visual features visible from ground level at the time of inspection
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. **Poor** – Significant health or structural defects with management likely to be inadequate or inappropriate
Height (m)*	Palm height is given for trunk only and does not include the height of the fronds.
Spread (m)*	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 or approximated at 1.4m above ground as outlined in "Appendix A" AS 4970 – 2009 **E** – Estimated equivalent trunk diameter where multiple trunks and branching exist.
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 development of the site **N = Nil** - Site suitability less than 5 years, or retention sterilises development of 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
Recommendations	Unless otherwise stated trees are to be retained**.**

* All dimensions are approximate.

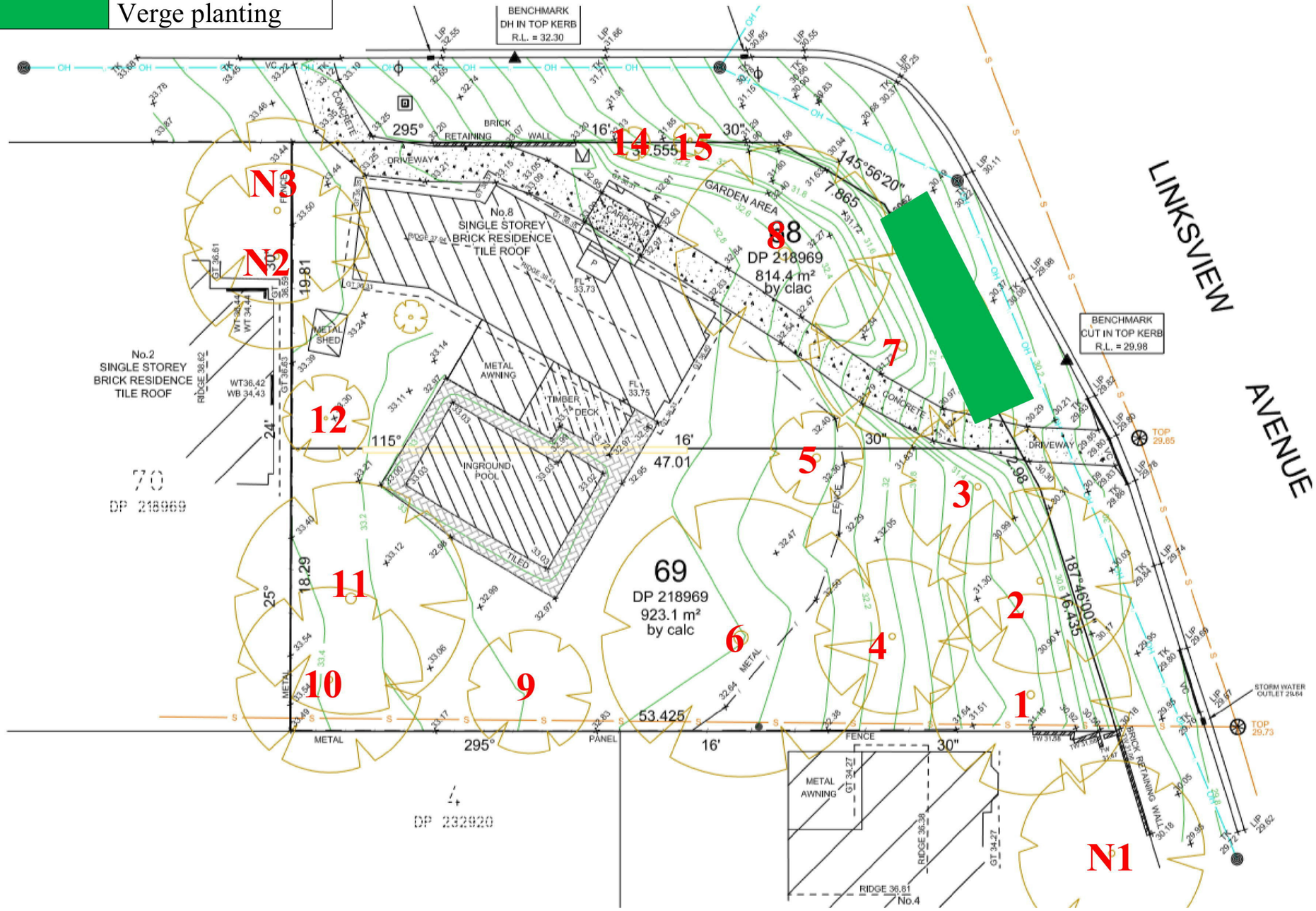
Appendix 2:

Tree Protection Plan (drawing)

Key	
	Load sharing surface.

Tree Location Plan (drawing)

Key	
	Verge planting



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 radius of the tree protection zone. Interestingly Matheny and Clark site the British Standard as the source of the formula. Such a circular argument is of concern, particularly 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 potentially 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 health of the tree 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) If we are to find benefit in the **TPZ** given in either the British Standard or Trees and Development, it is that 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 is often able to 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 that is 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 a long period that we have a good understanding 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 that is appropriately protected and cared for.

The site constraints, more often than not, 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 relates to the size of the root plate that would be required to transplant the tree successfully. In most instances 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. A number of formula and test exist to determine the size of the **S**tructural **R**oot **Z**one (**SRZ**). There is however generally no need to consider the issue of structural stability if work is performed outside the **MTPZ**. In most circumstances, it is undesirable and often unwise to cut roots located in the Structural Root Zone.

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. Where 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 to 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 important 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 important 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. In the same manner, 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 starts on the development.

Appendix 4:

Generic Tree Protection Guidelines

1. Pre-Construction:

1.1. Prior to the commencement of construction, the consulting Arborist will issue a report outlining the following:

1.1.1. 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.

1.1.2. 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. e.g. the fence around trees is incomplete because of boundary fences.

1.1.3. 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.

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

2.2. Where the Tree Protection Zone occurs impart 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:

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

3.1. 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.

3.2. Irrigation

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

3.3. Soil amelioration

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

3.4. Mulching

3.4.1. The fenced area should be mulched with seed-free mulch to a depth of at least 50mm.

3.5. Weed Control

3.5.1. 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.
3.5.2. Weed control shall not be performed by mechanical cultivation or by scraping or back burning.

3.6. Crown cleaning

3.6.1. Crown cleaning (AS4373-1996, Pruning of Amenity Trees) shall be performed in accordance with the 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.
3.6.2. Any concerns about health or safety that are observed by the arborist on the site will be reported in writing within 7 days to the superintendent/principal/client and/or head contractor.
3.6.3. The use of spurs on live trees and internodal cutting is strictly prohibited.

3.7. Tree Removal and Stump Grinding

3.7.1. Remove trees in a controlled or sectional felling to avoid any damage to the trees to be retained.
3.7.2. All shrubs, under-scrub and woody weeds that are to be removed shall be removed by hand as per 3.4 above.
3.7.3. No tree shall be removed unless it has been 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 prior to the commencement of ANY work, including demolition and land clearing by earth moving 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 will 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 alternatively copies of the log entries for the month 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:

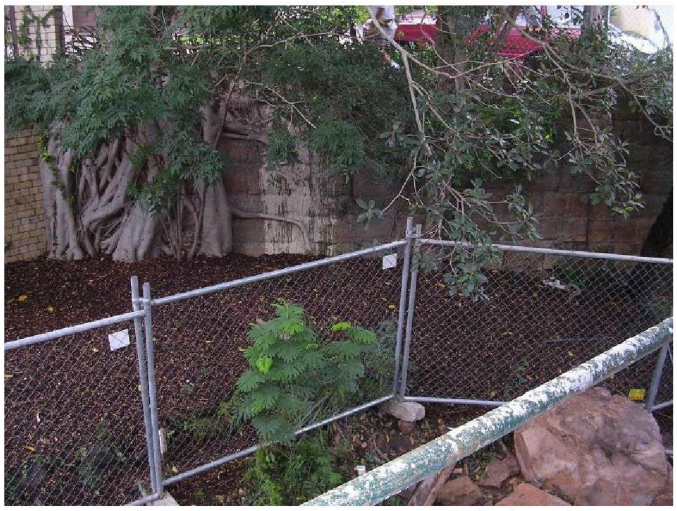
8.1. The following are non-conformances that need to be managed when they occur.
- 8.1.1. The removal or relocation closer to the tree of all or part of any protective fence prior to landscaping.
- 8.1.2. The performing of any activity noted as prohibited on protection zone signage
- 8.1.3. The failure to maintain adequate soil moisture or the 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.

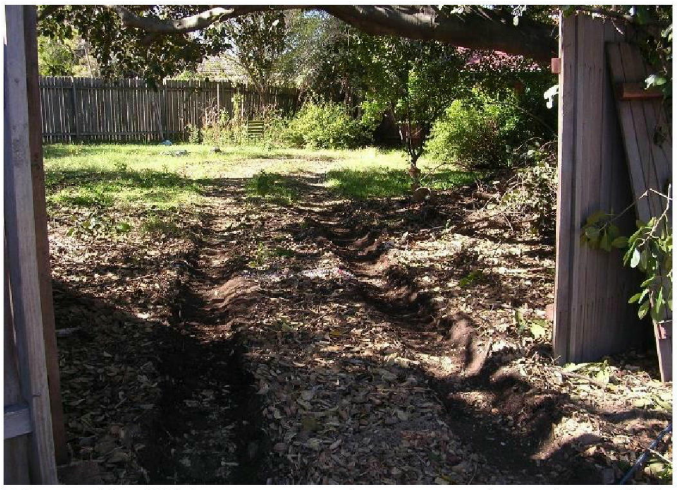
Appendix 5:

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 to 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 roots are broken and damaged.
 **Photo 11:** The goal is to ensure that there is minimal impact on the roots that are being protected.	 **Photo 12:** Keep equipment away from the tree by using appropriate tree protection.

Trunk Protection

Good Work	Poor Work
 **Photo 13:** TrunkGuard is designed to absorb impact just like a bicycle helmet.	 **Photo 14:** Trunk damage is usually irreparable and frequently causes long-term problems!
 **Photo 15:** It is flexible for a better fit and is attached using screws to avoid even 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.