

TREE PROTECTION, AUSTRALIAN STANDARDS AND THE LAW: GETTING IT RIGHT

G.M.Moore

School of Ecosystem and Forest Sciences, University of Melbourne, Burnley Campus, 500 Yarra
Boulevard RICHMOND 3121

Abstract

It is a little surprising that all of the Australian Standards related to arboriculture have been controversial, so it is no great revelation that the Protection of Trees on Development Sites (AS 4970-2009) is the subject of controversy, debate and misuse. However, the standard is widely and successfully used, despite some criticisms. Prior to 2009 there was no consistency in managing trees on development sites, which put the health of trees and human safety at risk. Disputes over tree size and the size of protection zones pitted arborists against each other over measurements rather than the arboriculture of the trees to be protected.

Despite reservations about aspects of the formula, most people have accepted the calculation of the Tree Protection Zone (TPZ). However there are some issues with the standard related to the Structural Root Zone (SRZ) and the asymmetrical and unpredictable architecture of urban tree roots systems and the meaning, interpretation and application related to encroachment of the TPZ. The standard is quite clear on this matter and if the definitions of encroachment are clear, then it must be the interpretation and application where problems are perceived to arise.

There is concern among arborists that the standard fails to be effective when other professions involved in the development processes do not value trees. There is also concern in some States that local government agencies are not incorporating the standard in their bureaucratic processes or are using it without appropriate arboricultural expertise. Overwhelmingly there is agreement that no one wishes to return to a situation where there was no standard for the protection of trees on development sites. No one wishes to go back to those bad old days prior to 2009!

Introduction

It is both disappointing and a little surprising that all of the Australian Standards directly related to arboriculture have been controversial. The proposed standard(s) on Amenity Tree Value (AS Various Drafts) holds the record for Standards Australia for an unresolved standard at nearly 30 years, before attempts were abandoned. The Pruning of Amenity Trees standard (AS 4373-2007), which is now widely-used and accepted took years to develop, was subject to a very large number of comments initially. Fortunately, its later review was a much easier process. The standard on Tree Stock for Landscape Use (AS 2303-2015) was finally adopted after decades of debate. Now the standard on the Protection of Trees on Development Sites (AS 4970-2009) is the subject of some controversy, debate and occasional misuse. This was to be expected as new regulation when previously there was none always attracts some controversy!

The first British Standard on code of practice for trees in relation to construction dated from 1980 and was extensively revised in 1991 (O'Callaghan and Lawson 1995). Various tree retention and protection schemes were in use in the USA well before 1990 (Clark 1995; Green and Young 1995). These systems were considered at the time that AS 4970-2009 was being formulated. AS 4970-2009 was developed from Draft Standard DS4970 and it was amended in 2010 in ways that applied to the Preface and made changes to Figure 1 of the standard. The significant changes from the draft to the approved AS 4970-2009 related to the removal of a Root Protection Zone (RPZ) in favour of simpler zoning components, changes to the wording in relation to encroachment and replacement of the word *must* by *should* in several places. These changes seem to have had wide acceptance.

The expectations that many arboriculture stakeholders place on Australian Standards is that they will be perfect and apply to each and every situation. Such expectations are simply unrealistic and the development of a perfect standard that involves the biological is impossible. When you are dealing with living organisms, such as trees, there will be variation, unexpected situations and the unique.

This is certainly the case with any standard relating to trees and development sites. AS 4970-2009 recognises this and, unlike most standards, incorporates a level of flexibility in its interpretation and use, which demands a high level of professional competence and integrity from arborists who use it.

This is really where the controversy, if any, related to the standard arises.

The standard is to be used by well-qualified arborists (at least Australian Qualifications Framework (AQF) Level 5 or equivalent) who interpret and use the standard based on data that have been collected on-site to inform and justify decisions in relation to protecting the tree. In taking this approach, which was developed with the best interests of the tree in mind, the standard may be open to misuse by the incompetent and unscrupulous. Such misuse and deliberate misinterpretation will probably only be resolved finally through the Australian legal system – probably after things have gone badly wrong!

The flexibility that the standard allows recognises the uniqueness of the individual amenity tree in its specific location. However, the standard requires the consulting arborist to assess the tree in its situation and gather sufficient data about the tree’s root system, canopy and general condition to make informed decisions that will protect the tree on the particular development site. In this sense, AS 4970-2009 gives the arborist license to make decisions that take into account the particulars of the development process, but only to the extent that they do not compromise the protection of the tree.

The Standard

As the Standards Australia website notes about standards in general:

Standards are voluntary documents that set out specifications, procedures and guidelines that aim to ensure products, services, and systems are safe, consistent, and reliable. They cover a variety of subjects...and to ensure they keep pace with new technologies, standards are regularly reviewed by Standards Australia technical committees. On their own, standards are voluntary. There is no requirement for the public to comply with standards. However, State and Commonwealth governments often refer to Australian Standards®(AS) or joint Australian/New Zealand Standards (AS/NZS) in their legislation. When this happens, these standards can become mandatory. In addition, Australian Standards® are sometimes incorporated into legal documents, and considered as a ‘benchmark of acceptability’.

On their own standards are neither law nor legally binding and AS 4970-2009 is no exception. However, consider the situation with trees on development sites prior to 2009 when there was no consistency or reliability in the approach, which put the health of trees and human safety at risk. How often did disputes about the size of tree protection zones end up before courts and tribunals, such as the Victorian Civil and Administrative Tribunal (VCAT) and its equivalents in other States, because different methods (Table 1) of calculating the Tree Protection Zone (TPZ) were in use? Often in such cases the method of calculation accepted by the adjudicating officers depended on which expert was the better qualified or which lawyer ran the better argument, but invariably the method chosen was that which gave the smallest TPZ. Certainly, no one wishes to go back to these bad old days!

Table 1. Tree Protection Zone calculations for a mature *Corymbia maculata* specimen prior to 2009 and after the adoption of Protection of Trees on Development Sites (AS 4970-2009).

	Method of TPZ Calculation	
Height (m)		12.0
Canopy spread radius (m)		7.0
Trunk DBH (m)		0.5
TPZ radius (m)	Protection of Trees on Development Sites (AS 4970-2009) (12 times DBH)	6.0
	2/3 Tree height method	8.0
	British Standard (10 times DBH)	5.0
	Dripline method or Dripline plus 1.0m	7.0-8.0
	ISA (Matheny and Clark, 1988) good	4.5
	moderate	6.0
	poor	7.5

It is often forgotten by those working in arboriculture that the standard is not designed exclusively for their use, but for the protection of trees by all of the professions involved in the development process (Text Box 1). However, the role, of arborists and the collection of arboricultural data on site are central to the proper and effective application of the standard, described and summarized in AS 4970-2009 Table 1. This is made clear in both the Preface and Section 1.2 Application of the standard (Standards Australia, 2010). In Section 1.1 Scope, the standard states that it does not apply to the establishment of new trees; some of the implications of which will be discussed later in this paper.

Protection of Trees on Development Sites (AS 4970-2009) has a wide and useful definition of what constitutes a development site (Text Box 2). Such a definition is a little unusual for standards in general, but has the benefit of widening the situations to which the standard can be applied. Indeed it is difficult to think of a situation involving potential damage to a tree that cannot be included under one of the clauses of the definition provided. Such a wide definition can become a major asset for competent arborists in protecting trees in a diverse range of situations, including temporary use of sites for occasional or one-off events that require approval.

One of the most obvious and widely appreciated benefits of the standard is that trees are assessed consistently in the same way by arborists and other stakeholders. Size is measured as diameter at breast height (DBH) at 1.4m from the ground. This simple measure removed a major cause of dispute over tree size and the size of the various protection zones so that they were no longer a bone of contention between arborists or in courts and tribunals. Today, it is sometimes forgotten how time-consuming, costly and petty these disputes could become, pitting arborists against each other over measurements rather than the arboriculture of the specimens to be protected.

Protection Zones

In relation to the various protection zones, the calculations are clear and simple and so generally free from interpretational disputes. However, it was well-understood at the time of drafting the standard that not all tree root systems would conform to these general formulae. Every arborist has confronted situations where tree roots were not found where they were expected or within the area proscribed by the formulae of the standard, but were found where they were not predicted. Such biological variation was expected and anticipated by those drafting the standard; hence the need for arboricultural expertise and the gathering of data to support the application of the standard in real world situations.

The TPZ, which incorporates the Structural Root Zone (SRZ), is the principal means of protecting trees on development sites and so is at the core of the application of the standard (Text Box 3). So it is not surprising that criticisms of AS 4970-2009 tend to focus upon aspects of the standard related to the TPZ and SRZ. However, despite some minor reservations about the arbitrary nature of some aspects of the formula, there is a general acceptance of the formula for calculating the TPZ.

Text Box 1 Preface to the standard, part of which is repeated in 1.2 Application (Standards Australia, 2010)

This Standard provides guidance for arborists, architects, builders, engineers, land managers, landscape architects and contractors, planners, building surveyors, those concerned with the care and protection of trees, and all others interested in integration between trees and construction.

This document describes the best practices for the planning and protection of trees on development sites. The procedures described are based on plant biology and current best practices as covered in recently published literature.

Text Box 2 Definition of “development” (Standards Australia, 2010)

Development includes the following:

- (a) The use of land (e.g. festival events, use of park areas and other events) that requires approval.
- (b) The subdivision of land.
- (c) The erection of a building.
- (d) The carrying out of a work.
- (e) The demolition of a building or works.
- (f) Road works.
- (g) The installation of utilities and services.
- (h) Any other act, matter or thing as defined by the relevant legislation.

There was initial contention about the formula for the TPZ. Should it be height or diameter based? Both had been used in Australia and overseas (Green and Young 1995) and if stem based, what multiplier value should be used? What was the justification of a multiplier of twelve over other possible multipliers and should the same multiplier apply to trees of different ages and size. Indeed this latter aspect varied from the draft standard, DS 4970, circulated for comment and that which was finally approved. It was a simplification of the calculation that has been widely supported. There also seems no rationale for the statement that the TPZ should not be less than 2m nor greater than 15m, but the clause does not seem to attract any significant criticism.

The structural root zone is a little more contentious. It is often forgotten that the SRZ needs to be calculated only when major encroachment of the TPZ is proposed. However, most arborists consider it wise to calculate it in all situations as a guide to decision making. The structural root zone is the critical area required for tree stability and does not consider tree health, which will generally require a much larger area (Text Box 4). The standard recognizes that many factors affect the actual size of the structural root zone, including tree age, height, crown area, soil type, soil moisture and site and species specific factors. The area of the SRZ determined using the trunk formula is considered indicative (a general guide indicating where structural roots are likely to be located). Thorough investigation including data collection would show the actual location of the roots and the edge of the root plate. It is curious that trunk diameter used for this calculation is not based on DBH as it would reduce the number of tree measurements required.

Crown Protection is a specified area above ground set aside for the protection of the canopy. The perimeter of crown protection will usually be located one metre outside the perimeter of any crown that is to be protected. A number of arborists commented that they had never used, or had cause to use, the crown protection so considered the SRZ to be the only essential protection. There are so few concerns expressed about crown protection that it will not be further addressed in this paper.

Encroachment

An area of contention with AS 4970-2009 centres around the meaning, interpretation and application related to encroachment. However, the standard is quite clear on this matter and gives clear guidance for the application of the terms. So if the definitions are clear, it must be the interpretation and application where the problems are perceived to arise. There is nothing magical about the 10% value that constitutes the point of differentiation between major and minor encroachment. It is not really different from 9% or 11% in reality but it does provide a threshold at which data to inform decisions must be gathered.

Text Box 3 Definition and calculation of Tree protection Zone (TPZ). (Standards Australia, 2010).

A specified area above and below ground at a given distance from the trunk set aside for the protection of a tree's roots and crown to provide for the viability and protection of the tree to be retained

The TPZ is the combination of the root area and crown area requiring protection.

TPZ = (12 x DBH) + any need for crown protection

The radius of the TPZ is calculated by

$$TPZ = DBH \times 12,$$

where DBH is measured 1.4m above ground level

The TPZ should not be less than 2m nor greater than 15m, except where crown protection dictates

Text Box 4 Definition and calculation of Structural Root Zone (SRZ). (Standards Australia, 2010)

The area around the base of a tree required for the tree's stability in the ground. The woody root growth and soil cohesion in this area are necessary to hold the tree upright, so the entire profile (depth) of the root zone is included in the structural root zone. The SRZ is nominally circular with the trunk at its centre and is expressed by its radius in metres. This zone considers a tree's structural stability only, not the root zone required for a tree's vigour and long-term viability, which will usually be a much larger area.

Determine SRZ radius from the trunk diameter (measured immediately above the root buttress) using the following formula or Figure 1 of the standard.

$$R_{SRZ} = \text{Radius of SRZ} = (D \times 50)^{0.42} \times 0.64,$$

Where:

D = trunk diameter (metres), measured above the root buttress

NOTE: The SRZ for trees with trunk diameters less than 0.15 metres will be 1.5 metres

The SRZ formula does not apply to pachycauls

This does not apply to trees with asymmetrical root systems

Minor encroachment (work) or variation (up to 10% of the area) is well covered by the standard. If the proposed encroachment is less than 10% of the area of the TPZ, and is outside the SRZ, detailed root investigations should not be required. The area lost to this encroachment should be compensated for elsewhere and be contiguous with the TPZ. Variations must be made (approved) by the project arborist considering relevant factors, for which clause 3.3.4 provides an indicative list. The list should not, however, be considered either restrictive or prescriptive by the project arborist. While there are few criticisms of minor encroachment, it is worth noting that in the draft standard (DS 4970).....*minor encroachment will generally not require detailed investigation such as root mapping.*

For major encroachment or variation (greater than 10% of the area or into the SRZ), if the proposed encroachment is greater than 10% of the TPZ area or inside the SRZ, the project arborist must demonstrate that the tree(s) would remain viable. The area lost to this encroachment should be compensated for elsewhere and be contiguous with the TPZ. This may require root investigation by non-destructive methods and consideration of relevant factors (the same as for minor encroachment). The wording was changed from the draft standard.....*the project arborist must demonstrate that the tree(s) would tolerate any resulting impacts. This will involve thorough root investigation by non-destructive methods and consideration of relevant factors listed. It must be demonstrated that any variations or encroachment into the Root Protection Zone (including SRZ) would not affect structural roots and would not adversely affect a tree’s vigour, stability or long-term viability.* There is some angst about what constitutes an acceptable (or unacceptable) level of impact with suggestions that it would be worthwhile providing guidelines as to what constitutes acceptable and unacceptable encroachment (Table 2). These suggestions are very much based about managing risk when the SRZ is encroached.

Table 2. Examples of two suggested guidelines for deciding on what constitutes acceptable and unacceptable encroachment of the Tree Protection Zone.

Encroachment of TPZ (%)	Suggested Guideline (a)	Suggested Guideline (b)
≤10% in area	proceed with caution and standard tree protection measures	and outside SRZ-tolerable with simple explanation
>10% but ≤20%	proceed with a high level of caution by recommending design changes to reduce the impact to 10% and/or by modifying construction methods Ensure that any construction has arborist supervision	encroachment and possibly some SRZ encroachment (assessed on a case by case basis)-tolerable with suitable and defensible explanation (such as detailed root mapping)
>20 but ≤30%	only proceed after detailed root investigation has verified the presence or absence of roots in the vicinity of the construction proposal. Significant tree protection measures under project arborist supervision	and/or SRZ encroachment-root investigation and detailed investigation/explanation
>30%	do not proceed- you are encroaching too close to the tree, unless alternate design and construction techniques reduce impact	and/or SRZ encroachment-root investigation and detailed investigation/explanation

Arborist appraisal of the Standard

There is general and widespread stakeholder support for the standard. Engineers and planners have embraced the standard as it provides certainty and a framework for resolving disputes before courts and tribunals. The general public is also supportive of standards in general. Arborists’ opinions on the standard vary enormously depending on the arborist, their work and qualifications and the State within which they operate. Some believe that the standard is the best thing that has happened in arboriculture in recent times, because it has standardized practice and virtually eliminated disputes over things such as measuring size and tree protection zones.

It has changed focus from argument about measurement and qualifications to the protection of the tree. Others, while generally supportive of the standard as a whole have their particular criticisms and frustrations with some of the detail of AS 4970-2009. Criticisms, misinterpretation and abuse tend to focus around TPZs and SRZs.

Root System Architecture and AS 4970-2009

A number of arborists and others who work with the standard regularly, made the point that tree root systems are opportunistic, unpredictable, variable, site specific and unique. The standard takes a simple, indeed formulaic approach to the TPZ and SRZ, while recognising that it cannot apply to every tree in every situation. A number of people contrasted the different roots systems of elms (shallow, dense, moderate sized with structural and absorbing roots to the drip line) compared to eucalypts and plane trees (large structural roots extending for many metres from the trunk, often with few, if any, smaller roots within the drip line). This was based on their own experiences and the two field day exposures of root systems at the Waite Arboretum during previous TREENET field workshops. Many commented that tree roots are never (or rarely) found under paved roads, but often run parallel to the curb, but others were of the view that this was age and site related and that roots did grow under roads.

The roots of street trees have often been cut multiple times for past utility service installation, which results in unpredictable, unusual and asymmetric roots systems. Often the roots are growing along and interfering with current or past service lines. They often extend far beyond canopy drip lines and the TPZ much to the surprise of other professions involved in the development process. Proper site inspection and data acquisition will allow the determination of where the zone of rapid taper (roots larger than 50mm are rare beyond this zone) and the edge of the root plate occur. The responsiveness of roots must also be considered by the project arborist because severed large roots can regrow, if cut properly, which can contribute to the successful retention of the tree.

The differences in root system architecture and the disparity of arborist experience and views of roots growing under and along roads illustrates the variability and site specific occurrences which the standard has to encompass (Watson and Himelick 2013). The frustration is that the standard may deal very well with elms under most circumstances, but its simple application does not necessarily protect common species with different root structures and architecture. In understanding this frustration, it must be pointed out that if there are data to support a different distribution or pattern of roots than the standard anticipates, then the TPZ can be varied – to a limited degree admittedly, but at least it is data dependent.

Some arborists are uncomfortable with the obsessive reliance on assessment in relation to TPZs and SRZs in all urban situations when other factors, such as available space, pavement and multi-storied buildings may be both relevant and constraining. There is also a strong belief that the standard fails to be effective when other professions that are involved in the planning, decision making or building processes do not value trees. This situation is compounded when the penalties (fines or forfeited bonds) for failing to protect trees are so insignificant that they do not act as a deterrent to developers or builders. Many local government agencies have incorporated the standard into their planning schemes, but there is concern in some States that local government agencies are not incorporating the standard in their policy processes or are using it in a simplistic and dogmatic fashion that does not involve appropriate arboricultural expertise. Some of these and other issues are considered in greater detail below.

Encroachment

Currently one of the biggest areas of contention and legal dispute centres around what is an acceptable (or unacceptable) level of impact. These concerns intersect with issues surrounding encroachment. Theoretically, the standard allows 100% impact on the TPZ, provided that the project arborist can adequately demonstrate that the tree will remain viable. The assumption implicit in this approach is that the arborist has data to support their interpretation and that there would be a great deal of design, engineering, care and thoughtful implementation and post-construction site management to ensure an appropriate outcome for the tree. This may happen in rare circumstances, but they will be the exception rather than the rule.

Many municipal planners and arborists are interpreting a major encroachment as unacceptable impact, which clearly is not the case under the standard.

However, it may be good for the tree if the situation can be managed to preserve the SRZ, but more often such encroachment is used to justify tree removal. Some arborists advise that if the SRZ cannot be substantially preserved, then the tree should be removed. This is not in accord with the standard, and might be seen as an easy or perhaps safe approach. In other situations damage within the SRZ is seen as being a *death warrant* for the tree, and it may well be, but the standard demands that in all situations data is gathered to support the decisions that are made

On the other hand some arborists are choosing to justify encroachment of 40%, 50%, 60% of a TPZ as a major encroachment but still acceptable, arguing that the tree will survive the encroachment. This may be a reasonable approach, but the arborist must be able to justify their decision for that particular tree in that specific situation. This does open up the potential for disagreement between arborists and legal dispute, but at least it will be about the arboriculture and biology of the tree. This would seem to be a part of the standard where further guidance regarding what is an acceptable level of encroachment into a TPZ may be of considerable benefit.

It is not uncommon for architects and landscape architects to ignore protection guidelines if it interferes with their design process. Municipal arborists can spend many hours, going through plans and drawings and calling the architects to account, only to see the tree ignored in contract documents or during construction. Other professions are much more attuned to tree protection if they have had a tree fall over in the past from roots being severed. While penalties and bonds (Melbourne City Council no date) are increasing as more stakeholders and the public see trees as community assets, developers and builders would show a greater commitment to protecting trees if the penalties for breaching the standard were higher. Often the keys to successful tree protection are the site and project managers and the availability of appropriately trained arborists to inspect the site and tree at critical stages of construction.

Some suggestions in relation to a review of the Standard

The following are suggestions made in relation to the regular review that is made of all Australian Standards. Many, but not all, of these are relatively minor and the question raised is whether these changes are worth the risk involved in opening up the standard to contention and unexpected change when there is such widespread, general support:

Procedures and process

- Change the title of the standard by replacing protection with retention. This may be worth considering, but the standard is not just about retaining trees at any cost or in any condition. Protecting trees is also about maintaining the quality of the specimen. However, the use of retention does explicitly express the intention of retaining the tree at the end of the processes, and so perhaps the title could be the Protection and Retention of trees on Development Sites
- Table 1 of AS 4970-2009, is indicative of the processes to be followed in applying the standard and has general support, but is considered to be cumbersome by some. Some businesses have developed checklists and pro forma that simplify things on site for the project arborist. Including a checklist (Table 3) in an appendix to the standard is worthy of further consideration.
- Figure 1 of AS 4970-2009 was the subject of the only substantial amendment to the standard in 2010. Some who use the standard still find the formula and figure difficult to use and would prefer it to be more user friendly.

However, given its significance to the standard as a whole, it is difficult to envisage how it can be effectively altered. Furthermore the majority of users have no problems in applying the formula or using the figure and consider that the outcomes of application are generally acceptable and practical.

- There can be difficulties in obtaining suitable qualified arborists. The standard requires....AQF level 5, Diploma in Horticulture (Arboriculture) and/or equivalent experience, the knowledge and skills enabling that person to perform the tasks required by this standard....In some states it is hard to find suitable qualified arborists who meet this requirement, and of course, there are some who claim that they have equivalent experience, knowledge and skills, but have nothing to prove it. It is probably time that this aspect of the standard was tightened.

- The use of mulch is an important component of successfully protecting and retaining trees on development sites (Green and Young 1995). While mulching is mentioned in sections 4.5.3 Ground Protection and 4.6 Maintaining the TPZ, greater emphasis could be placed on appropriate use of mulches prior to, during and post both construction and development. A general recommendation concerning mulching the area of the TPZ to a depth of 75-100mm with and reference to Composts, Soil Conditioners and Mulches (AS4454-2012) could be inserted in section 5. Furthermore the mulching shows that the TPZ is physically part of the construction site and there is a tree root zone to protect.

Table 3. An example of an arborist checklist for application of AS4970
(Slightly modified from Ryder and Associates).

Project Arborist Checklist			
Project:			
Project Arborist:			
Commencement date:			
Item	Completed		Date
Site Preparation	Yes	NO	
Initial Induction Meeting			
Small infrastructure removed by hand			
Pruning for clearance completed by qualified arborist to AS4373-2007			
Tree Protection Fencing, mulch and signage installed to specification			
Building materials storage area identified and marked on plans			
Site excavation within TPZs completed under supervision of project arborist			
Construction			
Initial Induction Meeting			
Irrigation installed as per specification			
Project arborist to supervise fencing, any specialised foundation excavation and Tree Protection Fencing realignment			
Inspections completed every 4-6 weeks			
Meeting 1			
Meeting 2			
Meeting 3			
Meeting 4			
Landscape Construction			
Initial Induction Meeting			
Tree Protection fencing to be removed			
Final Certification			
Final inspection			
Final certification report			
All Works completed			
Signed			

Root system management

- AS 4970-2009 specifies that the TPZ of palms and other monocots, cycads and tree ferns (pachycauls) should not be less than 1 m outside the crown edge projection. There have been some concerns that for pachycauls with small crowns this may not protect structural roots.

Given the landscape importance of palms in some parts of Australia, it would probably be wise to deal with the lack of a SRZ for monocots. While they do not conform to the definition of trees, and do not technically have a SRZ, in the real world pachycauls are dealt with as trees, so perhaps some guidance in relation to the size of a SRZ for palms should be provided. The simplest approach would be to remove the note excluding pachycauls from the application of the SRZ formula and Figure 1 of the standard. This would provide protection to the important supporting root mass of palms.

- Given the concerns about root systems and unpredictable root distributions in heavily built up and paved areas, it may be worth considering a statement for inclusion in section 3.3 or as an addendum to Appendix D as follows:.....*Trees planted in highly urbanised areas including streets tend to have highly atypical, asymmetric root systems due to the presence of hard landscape components, utilities and long-term soil and land form manipulation. In such places, the use of the standard TPZ formula may not be appropriate and so a suitable TPZ should be determined based on investigations that accurately determine the location of tree roots. This may result in larger, smaller or irregular shaped TPZs.*
- The standard anticipates situations where root systems are not typical (circular) in the calculation of the SRZ. In the notes to Figure 1 of the standard, it states.... This (presumably the formula and graph) does not apply to trees with asymmetrical root systems; the implication being that in such circumstances the project arborist must/should determine the SRZ using site specific data.
- Some arborists have pointed out that for a newly planted 45L tree a TPZ of nearly 13m², based on the minimum 2m radius specified by the standard is too large and in inner suburban streets is unnecessary and often restrictive. However, in section 1.1 it is made clear that the standard does not apply to the establishment of new trees. Using data that confirms when trees are established (Leers et al. 2018) could be used to codify criteria for establishment and the appropriate application of AS 4970-2009. What the minimum TPZ does provide is protection of a newly planted or young tree from compaction and damage during development.
- One of the most common difficulties encountered with using the standard, is the variability of tree root systems. Species differences in root systems are well known and documented – the differences in the architecture, structure and distribution of elm, plane and eucalypt root systems, for example, are obvious. There are also intra-specific differences and site specific differences that affect root systems and structures. Roots are notoriously opportunistic and so the need to establish where roots are growing by the collection of data is fundamental to the proper use of the standard.
- The lack of tree roots below paved road surfaces is so common that it might be worth including something that deals with the situation in AS 4970-2009, such as:.....*where the project arborist has determined from on site data collection that there are no roots under a paved road surface, the areas of the TPZ and SRZ will be compensated, but the variation deemed to be minor.*

Encroachment

- In relation to encroachment, AS 4970-2009 requires that the area lost to encroachment should be compensated for elsewhere and be contiguous with the TPZ. In some situations where data collected by the project arborist indicate that significant roots are located at a distance from the trunk, a non-contiguous area that compensates could be in the interests of retaining the tree. Such an approach may be beneficial in heavily urbanized areas, including city streets.
- Some arborists are using an encroachment of greater than 30% of the SRZ as guideline for recommending removal. They believe that such a level of encroachment carries with it added risk of tree death or failure, and that on new housing development sites new owners might find it difficult sleeping and living under affected trees.

In these situations a request for guidelines in terms of acceptable SRZ encroachment is often made (Table2), but this is not consistent with the requirements for data based decision making in AS 4970-2009. When encroachment is at a high level, alternative design and construction techniques, such as screw piles, raised decking and pier and beam structures may preserve functioning structural roots. High and medium density housing development inevitably leads to tree loss and lower canopy density. This is the realm of planners that neither arborists nor AS 4970-2009 can change.

- The use of boring equipment that allows the laying of utility services under trees is now cost-effective in many situations and modern equipment is far more sophisticated and manoeuvrable than its predecessors. The standard makes it clear that the TPZ (which incorporates both crown protection and SRZ) extends above and below ground, but does not do so explicitly for the SRZ. Perhaps it should. Some arborists and councils have developed guidelines as to how close boring equipment can approach a tree (Table 4), but each situation has to be evaluated as the boring is done. Many arborists were of the view that boring a 200mm hole at a regulated depth of 600mm, as required for some electrical services, would have a minimal impact on the tree, but that guidelines and data acquisition were still worthwhile.
- The standard could also benefit from the insertions of a section entitled Boring as follows: . . . *Installation of underground services below trees are to be bored, with the entry and exit pits positioned outside the designated TPZ of each tree, unless the project arborist has data on root distribution and has been determined that access within the TPZ will not significantly affect the tree* (Melbourne City Council, no date). *The depth of boring (measured to the top of the pipe (TOP) or the top of the bore hole, whichever is the deeper will be as specified in (Table 4).* Such an approach would be dependent on soil type and the presence and depth of rock.

Table 4. Guidelines for using boring equipment under trees on development sites or under street trees (TOP = top of pipe in its final position. Modified from Melbourne City Council, no date).

	Trunk diameter	Minimum Depth to TOP
Absolute depth limit size	All trees regardless of size	750mm
Variable depth limit	<100cm	800mm
	100-150cm	950mm
	>150cm	1100mm
Trees planted <2 years	All trees regardless of size	500mm

Local Government and AS 4970-2009

- Local government agencies have demonstrated a mixed approach to tree protection (Victorian Law Reform Commission 2017) and to the application of AS 4970-2009. Some have whole-heartedly adopted it within their development frameworks and some have worked to strengthen it and broaden its scope. For example, the City of Melbourne applies the standard to trees with a DBH of 100mm (often young trees), provides a list of what is not permitted within the TPZ and guidance for boring (Melbourne City Council, no date), all of which are within the framework of AS 4970-2009. It is also important that requirements made in conjunction with the standard do not become so onerous as to be unachievable in the real world and are ignored.
- On the other hand some councils, such as the City of Whittlesea, have rejected the standard in favour of their own tree protection guidelines..... Council’s tree protection zone guideline shall supersede AS4970 – 2009 and/or any other tree protection zone standard/calculation. In this regard, Council’s guideline considers both the ongoing health of the tree and has been developed to protect people, infrastructure and property (i.e. the shape considers the impact of falling limbs and delineates a pedestrian exclusion zone) whereas AS4970 – 2009 only considers the impact of works on the on-going health of the tree. Tree protection zones are defined by a circle, whose centre point is the centre point of the tree at ground level and whose radius is equal to half the height of the tree or half the crown width (whichever is the greatest) plus the tree canopy plus one metre. Tree protection zones shall be determined by a consulting arborist and pegged on site by a licensed surveyor. City of Whittlesea (2014).....

It is of interest that this guideline does not allow the flexibility in relation to encroachment that AS4970 – 2009 permits, which could lead to more tree removals.

There may be an implied criticism of AS4970 – 2009 in this guideline, but the real test of this approach is whether it is accepted in a court of law when things have gone wrong. Under such circumstances, the local government's policies and process would almost certainly come under close and critical comparison with AS 4970-2009 in court. Only time and case law will provide answers, but courts generally uphold the use of standards.

- Across Australia, many local governments have no consistent tree protection policies or procedures dealing with each tree and development on a case-by-case basis. A common approach is to apply AS 4970-2009 when there is an element of future risk. Council officers apply the standard to “cover your back (CYB)” when things might go wrong and so follow the standard's protocols. Others use the SRZ as a basis for making decision about tree removals, especially if the SRZ is encroached. Sadly a number have a de facto rule that if there is encroachment of the SRZ then a tree is removed, which is not consistent with the proper application of the standard.
- The general acceptance of AS 4970-2009 in many parts of Australia suggests that it would be wise for all arborists to use it. It provides a framework and benchmark for managing trees that is defensible in courts for situations where things have subsequently gone wrong with a tree after development of the site has concluded. The very existence of AS 4970-2009 means that other approaches to protecting, or not protecting, trees on development sites will be judged against it. If these systems are found wanting, then arborists could find themselves exposed in courts. The obvious question that could arise would be, “Why wasn't AS 4970-2009 used during the site development process?” It is hard to find a defensible answer.

Conclusion

One of the great things about AS 4970-2009 is that it provides a process for all trees on development sites to be assessed in the same way. It has eliminated debate about measurement and allowed arborists to focus on the arboriculture of the tree on site. The standard is also about asset and risk management. It sees trees as assets worth managing and protecting and is consistent with the funding arrangements for local government agencies, which demand proper risk and asset management systems. The only major area of contention with the standard relates to what constitutes acceptable and unacceptable encroachment of the TPZ, which seems likely to remain an issue until research and improved and/or new technologies allow a better understanding of the root systems of urban trees.

To be effective all those working on a development site, not just the project arborists, have to value the trees on site and the standard must be properly incorporated into the policies and procedures of those authorities responsible for development sites. Any standard can only be as good as the professionals who apply it and AS 4970-2009 demands a high level of competence from project arborists, which is not always available. The standard is not a specification, but a *process* that is evidence-based and which has as its goals the protection of trees on development sites and the persistence of trees that have good form and health at the end of the process.

In AS 4970-2009, arborists have a standard which recognises the value of trees, offers flexibility and utilises their professional expertise. The standard is well-understood by architects, engineers and planners. So many agencies and stakeholders are using the standard that those who do not make use of it, do so at their peril. The time for debate and nit picking has passed as the application of the standard is in the best interests of all involved in the protection of trees on development sites, and especially the trees. It is about securing good trees for future generations.

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