

Independent Arboricultural
Services



Arboricultural Impact Assessment

Prepared For: Brookfield Residential Properties

11 MacArthur Avenue, Hamilton QLD 4007

07 December 2018

PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL

Approval no: DEV2018/957

Date: 10 JUN 2019



Queensland
Government

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Document Tracking & Information

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Abbreviations

QSG	Queensland State Government	RPA	Root Protection Area
DA	Development Application	TMP	Tree Management Plan
VPO	Vegetation Protection Order	CMP	Construction Management Plan
ULE	Useful Life Expectancy	VMP	Vegetation Management Plan
BLE	Building Location Footprint	AS	Australian Standard
BLF	Building Location Envelope	AS 4373: 2007	Pruning of amenity trees
TPZ	Tree Protection Zone	AS 4970: 2009	Protection of trees on development sites
SRZ	Structural Root Zone	DBH	Diameter at Breast Height

Map

Figure 1: Subject Site



(Google Maps 2018)

Executive Summary

The following report will address identified Arboricultural issues and the required protection measures for the *Subject Trees* on the verge of the *Subject Site* located at Building 18, Portside East. The proposed works encompass the incursion into the Tree Protection Zone of one (1) tree for the construction of driveway and crossover.

To protect the Subject Tree, the following should be undertaken

- Construction of the driveway within the Tree Protection Zone (TPZ) *Subject Tree* to be suspended with no edge thickening / strip footing.
- Low Pressure Water Excavation – undertaken under Arborist Supervision (minimum AQF Level 5) along the property boundary to allow excavation of the basement within the property.
- Project Arborist requirements are to be followed as detailed below and in the Arborist Comments. All regulatory permissions to be in place before works commence.
- Audit Reports and periodical inspections of the *Subject Trees* to be undertaken during the project and Audit Reports submitted as part of the reporting requirements and Project Arborist signoff.

Project Arborist Requirements / Hold Points
1. Pre-Start Inspection and Audit of Tree Protection Fencing Before Works Commence. Discussion and agreement on project hold points and required Arborist supervision.
2. Any required Tree Works to be undertaken by a minimum AQF Level 3 Arborist under the Supervision of the Project Arborist (Min AQF Level 5). Tree Services Company to be a member of Queensland Arboricultural Association or Arboriculture Australia.
3. All works within the Tree Protection Zones of the retained vegetation to be supervised by the Project Arborist (Min AQF Level 5). Audit Reports to be completed and submitted by the Project Arborist. Any below ground incursion to be water excavated under low pressure, under the supervision of the Project Arborist.
4. The Project Arborist to be consulted if changes to plans are made that affect any retained vegetation.
5. At the Completion of works, Project Arborist to undertake a site assessment and an audit report compile of any further remedial actions required.

Introduction

This report has been compiled at the request of Brookfield Portside East Pty Ltd , to provide Arboricultural advice in relation to requested for information (ref: DEV2018/957) is as follows,

“Submit a Vegetation management report, supported by advice from a suitably qualified arborist, which provides a detailed assessment of the impact of the proposed Laneway D egress to Macarthur Avenue on the existing Significant vegetation – fig tree(s). This assessment is to address:

- a) The details of the existing Significant vegetation (e.g. size, species, health);*
- b) The size and volume of vehicles traversing this egress;*
- c) Any maintenance requirements for the Significant vegetation (e.g. trimming);*
- d) The long-term health of the Significant vegetation;*
- e) Protection measures during the site works and construction phase; and*
- f) Any additional regulatory requirements, as the Significant vegetation is located in road reserve.”*

This report is based on a visual inspection carried out from the ground on 16th November 2018. No soil or tissue sampling has been conducted. Tree assessment and Qualitative Visual Tree Analysis has been carried out in accordance with TRAQ ISA guidelines.

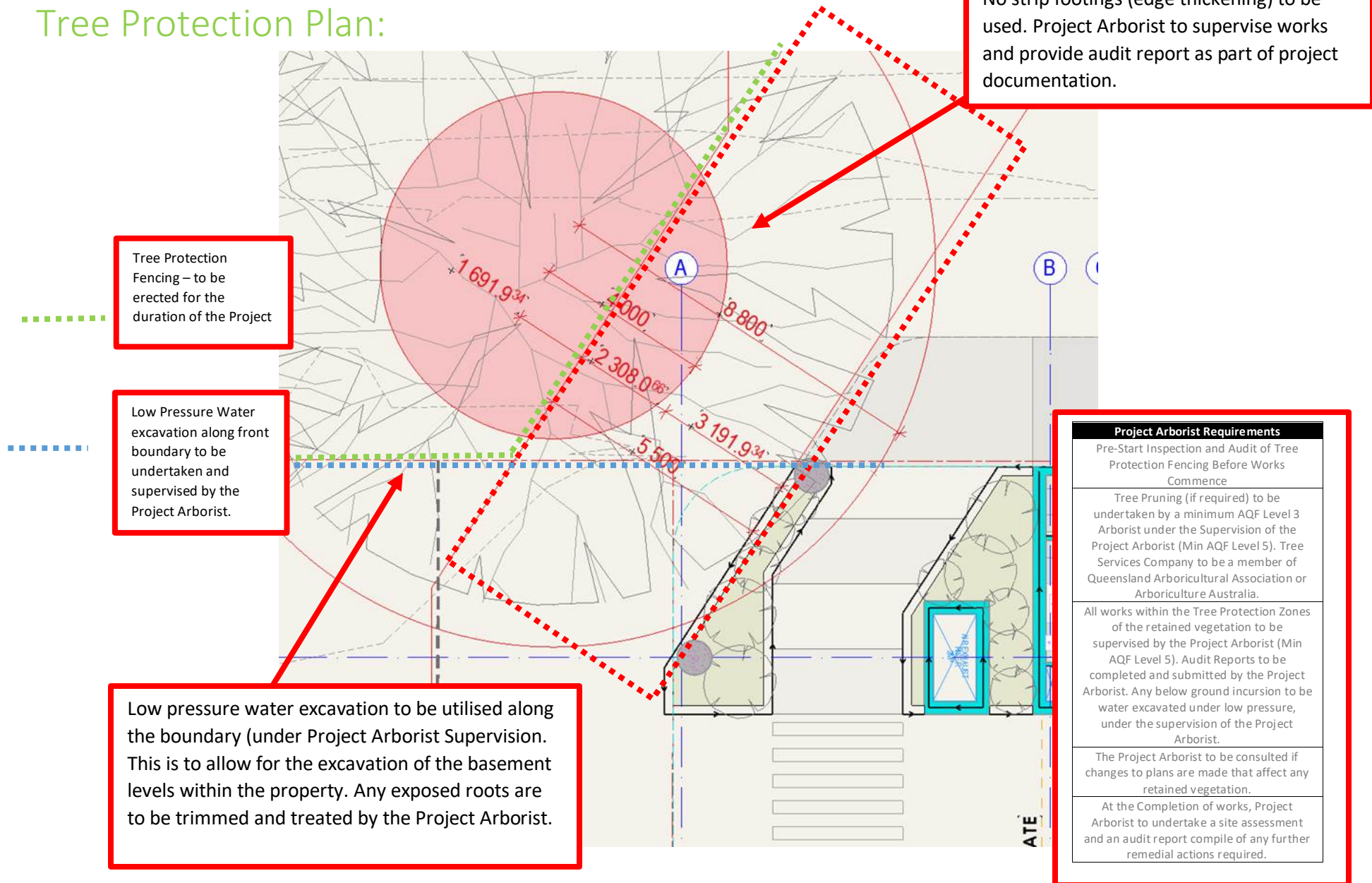
All Arboricultural recommendations contained in this report have been determined in accordance with Australian Standards AS 4373-2007 - Pruning of amenity trees and AS 4970 – Protection of trees on development sites.

For the purposes of this report reference to a Consulting or Project Arborist is held to mean an Arboricultural specialist who holds minimum Arboricultural qualifications of Dip Arb/AQF 5, appropriate professional insurances and has appropriate experience in the protection of trees on construction sites. Where tree work is specified, all recommended tree work is to be carried out in accordance with the above-mentioned standards by an appropriately trained and AQF qualified arborist practitioner/s with an up-to-date record of training and membership of a recognised Australian Arboricultural association, e.g. Qld Arboricultural Association (QAA), Arboriculture Australia (AA), or a recognised international Arboricultural association. No climbing spikes are to be used if pruning is to be carried out on live trees except in the instance of an emergency.

Qualifications of the report authors include Diploma of Arboriculture/AQF Level 5, ISA Certified Arborist accreditation. Report authors hold current insurances and memberships including memberships of Queensland Arboricultural Association (QAA), and Arboriculture Australia (AA) as well as current accreditation and membership of International Society of Arboriculture (ISA).

Independent Arboricultural Services is a qualified registrant on the QAA Register of Consulting Arborists.

Tree Protection Plan:



Tree Protection Plan Continued



Directional Pruning to be undertaken to allow access for trucks & buses and passenger vehicles. Pruning to be undertaken by a minimum AQF level 3 under the supervision of the Project Arborist.

Tree Protection Fencing – to be erected for the duration of the Project and audited by the Project Arborist.

Proposed Pruning



Branch to be removed (to collar point) to allow access to vehicles



A crown lift and directional prune to be undertaken (under the supervision of the Project Arborist) for clearance of the future building. All pruning undertaken as per AS4373-2007 with Audit Reports to be submitted by the Project Arborist.

Arborist Comment

- Use of specific construction methodology for the construction of the driveway
- Protection of retained Trees during construction works

Use of specific construction methodology for the construction of the driveway

The following amended construction methodology is to be utilised for incursion within the tree protection zone of retained vegetation.

- Construction within the Tree Protection Zone (TPZ) of the *Subject Tree* to be suspended on natural ground levels (no strip footing to be used).
- Builders black plastic to be utilised under all concrete surfaces to create a barrier between the concrete and natural ground.
- Project Arborist to audit works and provide audit reports as part of project documentation.

Protection of retained Trees during construction works

An exclusion zone should be established along the TPZ perimeters (or as nominated) of retained trees and cordoned off with a physical barrier of ridged chain mesh fence, 1.8m in height, which is securely anchored. The role of these fences is to prevent any damage to the complete tree including root system (SRZ & TPZ), stem and branch structure as well as the crown or canopy.

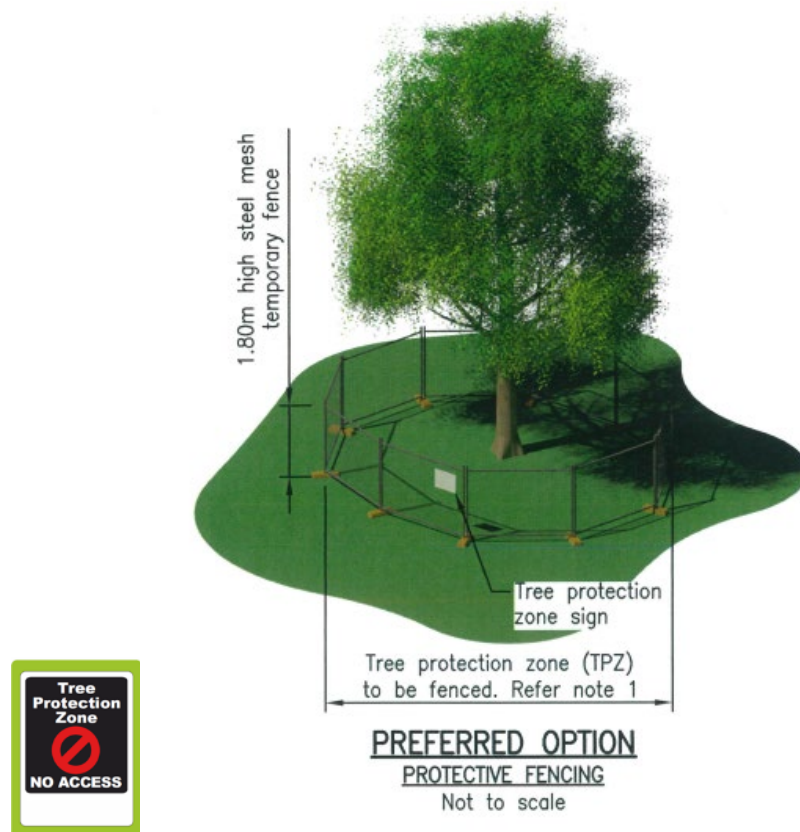
Where incursion in the TPZ's occur, the use of amended construction methodology and low-pressure water or air excavation along exposed TPZ perimeter/s and/or minor areas of proposed incursion (under Project Arborist supervision) should occur. This will assist to ensure ground disturbance and damage to tree roots is minimised within the TPZ of affected trees.

The Project Arborist must be consulted at any time entry into a TPZ of the retained trees is required. No routing of services, parking of vehicles, stacking of builder's materials, equipment etc. is to occur within the TPZ of retained tree/s, nor disposal of fuels, paints, chemicals etc. within the protected TPZ area which could otherwise cause injury and/or adversely affect the health of a retained tree.

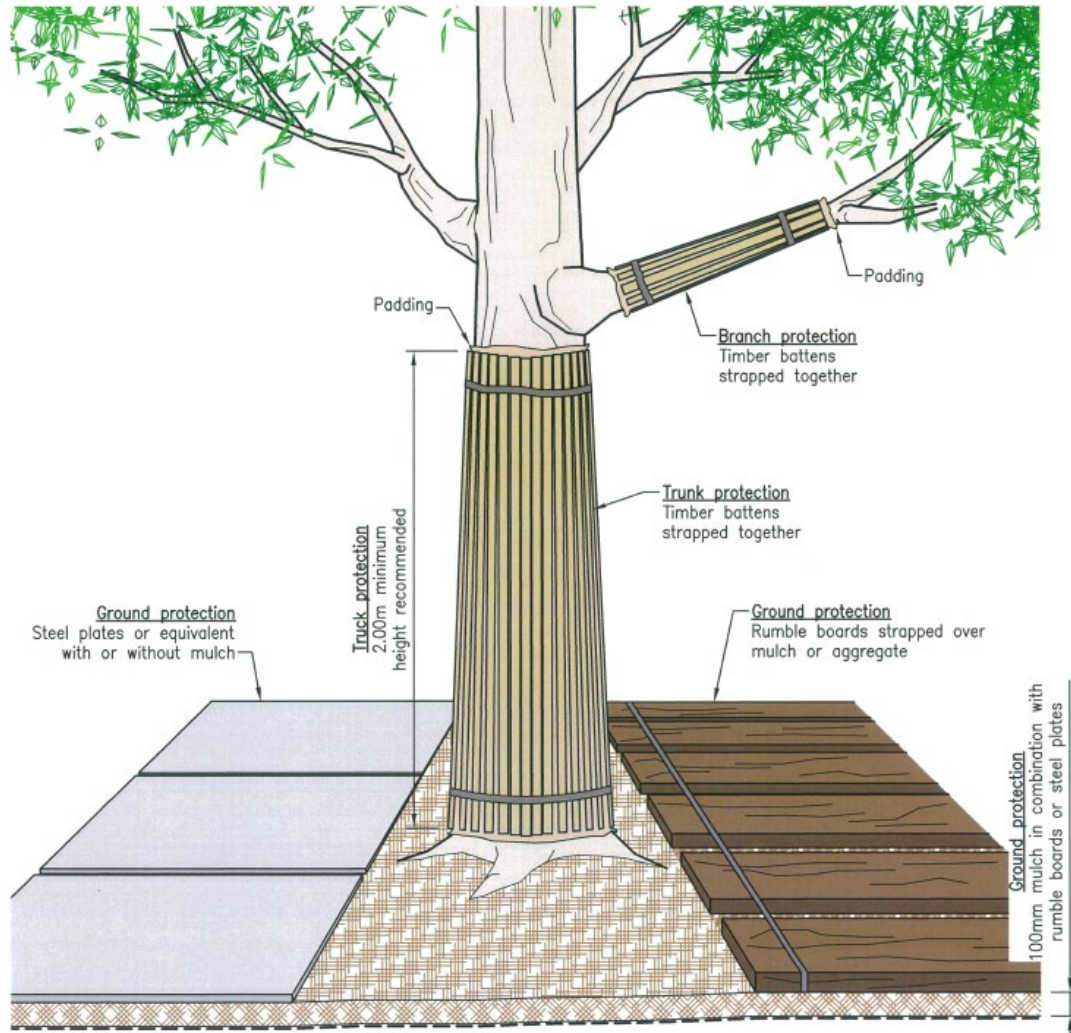
Project Arborist/Consulting Arborist should be engaged to review any changes to the Design Plans to ensure that clearance from all retained trees is maximised and that there is no inadvertent ill-effect caused to any retained trees within this area.

Project Arborist Requirements

1. Pre-Start Inspection and Audit of Tree Protection Fencing Before Works Commence
2. Any required Tree Works to be undertaken by a minimum AQF Level 3 Arborist under the Supervision of the Project Arborist (Min AQF Level 5). Tree Services Company to be a member of Queensland Arboricultural Association or Arboriculture Australia.
3. All works within the Tree Protection Zones of the retained vegetation to be supervised by the Project Arborist (Min AQF Level 5). Audit Reports to be completed and submitted by the Project Arborist. Any below ground incursion to be water excavated under low pressure, under the supervision of the Project Arborist.
4. All works to be excluded from the Structural Root Zone (SRZ) and supervised if located within Tree Protection Zone.
5. The Project Arborist to be consulted if changes to plans are made that affect any retained vegetation.
6. At the Completion of works, Project Arborist to undertake a site assessment and an audit report compile of any further remedial actions required.



Tree Protection Fencing to be utilised



Where works will be undertaken close to and within Tree Protection Zones specific tree protection measures to be utilised as directed by the project Arborist.

General Comment

All construction work within the TPZ of any retained tree must be authorised & supervised by the Project Arborist.
The use of amended construction methodology and low-pressure water or air excavation along exposed TPZ perimeter/s and/or minor areas of proposed incursion (under Project Arborist supervision) will assist to ensure ground disturbance and damage to tree roots is minimised within the TPZ of affected trees.
Removal of the concreted surface must occur from above the existing surface. Removal work is to be carried out with a style batter bucket with the machinery operated in a backward direction toward the extremity. Due care must be taken to ensure that TPZs of adjacent trees are isolated and protected from vehicular entry and therefore soil compaction within the protected root zone (of retained trees).
Addition of new soil and replanting must be carried out with due care. There shall be no use of strip style excavation adjacent to or within the TPZ of any retained tree, e.g. for removal of top soil, installation of boundary fencing, future foundations, installation of services, kerb/roadside guttering etc.
Where fencing is to be replaced, it is preferable to use existing post holes when they located within TPZs. New pier holes to be water excavated under Arborist Supervision.
It is imperative that TPZ fencing or branch /stem and ground protection measures are installed for the protection of all retained trees prior to the commencement of the future Construction Phase, and that it remains insitu for the duration and until completion of proposed construction works.
TPZ fencing and other measures must be fixed so that they cannot be moved either by accidental physical impact or other inadvertent means. There shall be no entry within any TPZ by any construction crew or other persons during the construction phase without authorisation and/or attendance of the Project Arborist. That is, no storage of builders' materials, machinery, pedestrian traffic, disposal of waste paints, fuels etc.

Conclusion

For all retained trees, with due care, implementation of appropriate work methodology and isolation of all TPZs of retained trees from construction works, the potential for ill-effect to retained/affected trees can be minimised in accordance with guidelines of AS4970:2009 – Protection of trees on development sites.

The following must occur:

QSC approvals must be in place prior to the commencement of any tree work for future construction work. Approvals are required should the Project Arborist prescribe pruning such as crown clean, canopy lift and/or directional pruning.

Project Arborist must be appointed and engaged to guide the protection of protected trees from project commencement, i.e. during Design Planning and during the construction period until its completion.

- **All Arboricultural reports, TMPs, VMPs & approvals must be included in the CMP**
- Arborist briefing of all engaged persons on their commencement as well as diligent work practice must occur during all approved future construction work.
- Root disturbance must be minimised to prevent accidental injury, compression and the creation of exposure points to allow future entry of pests and pathogens.
- **All work within any TPZ must be supervised by the Project Arborist.**

Please see the refer to the Recommendation Guidelines for tree protection measures to be implemented during the construction process.

The Project Arborist must be consulted at any time entry into a TPZ (of a retained tree) is required during the construction phase, if work is likely to affect a retained tree or immediately if it suffers accidental damage.

Site Audit Reports to certify that all work within the TPZ of protected trees are most likely to be conditioned in DA Approval documentation; these reports are also likely to be required for inclusion in DA sealing documentation. **NB:** As both written and photographic records are required for supervised work, these reports cannot be provided retrospectively.

All work within TPZs must be carried out with due care to avoid mechanical impact with retained tree/s during the construction phase. Where present existing strip footings or installed pier locations are to be utilised for any replacement of existing fence structures; alternatively, any removal of existing fence structures and new replacement work is to be carried out as detailed above, i.e. new fence foundations should utilise post and rail design with no concreted footing

unless authorised by the Project Arborist. Sleeving should be installed to provide an impervious barrier between exposed TPZ perimeter/s and new concreted areas to prevent chemical leeching into the RPA of retained trees.

Reactionary processes, such as the emergence of deadwood, dieback etc. are likely to occur as a result of disturbance and/or injury to any retained tree on a construction site. Amended design plans and construction methodology can serve to avoid or minimise the likely emergence of such issues and therefore their associated future OH&S issues to the future occupants of the new dwellings and or pedestrian or vehicular traffic within the vicinity of retained tree/s.

To minimise the likelihood of future neighbourhood concerns in relation to any proposed construction, due care and compliance with best Arboricultural practice is critical to mitigating or averting unnecessary concern and/or issues which may be raised by others.

Please see further notes providing additional explanatory detail in relation to construction within the surrounds of retained trees as well as optimal function of tree roots and their importance to the Useful Life Expectancy (ULE) and retention of trees on development sites in Appendices of this report.

Any pruning is to be carried out by authorised, qualified and insured Arboricultural Practitioners only. Practitioner Arborists are to have an up-to-date record of training, hold appropriate current insurances and membership of a recognised Arboricultural association such as QAA, *Arboriculture Australia* or internationally recognised Arboricultural association

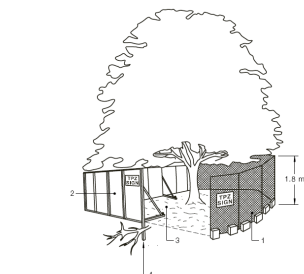
It is strongly recommended that application of aged forest style mulch be made over the ground surface area within the TPZs to assist tree/s to cope with planned works. Mulch will also to provide a natural ongoing (slow release) source of nutrients for affected tree/s. Depending on the extent of proposed disturbance within TPZs and specifically, the RPAs, it is likely that there will be some reactive response by affected tree/s, such as the emergence of deadwood and /or dieback. Further advice for remedial pruning to address such issues should be sought from the Project Arborist should they arise as the construction phase progresses.

Tree Protection Measures and Signage

Note 1: TPZ perimeter fencing should be grouped where perimeters overlap and appropriate

Note 2: Signage is to be installed in accordance with Australian Standard AS 4970-2009 – Protection of trees on development sites as illustrated below.

Figure 1: Protective Fencing¹



LEGEND:
1. Chain wire mesh panels with shade cloth (if required) attached, held in place with concrete feet.
2. Alternative plywood or wooden paling fence panels. This fencing material also prevents building materials or soil entering the TPZ.
3. Mulch installation across surface of TPZ (at the discretion of the project arborist). No excavation, construction activity, grade changes, surface treatment or storage of materials of any kind is permitted within the TPZ.
4. Bracing is permissible within the TPZ. Installation of supports should avoid damaging roots.

Figure 2: Examples of trunk, branch and ground protection²

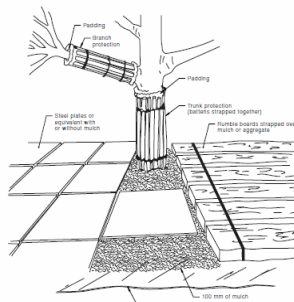


Figure 3: Tree Protection Zone Signage³



Figure 4-7: Low Pressure Ground Excavation and Watercutting

Figure 4



Figure 5



Figure 6



Figure 7



Figure 8-9: Example of fauna friendly rigid style temporary fencing (See Appendix 1, Note 1)

Figure 8



Figure 9



¹ Australian Standard AS 4970 - 2009 - Protection of trees on development sites, p16, Figure 3

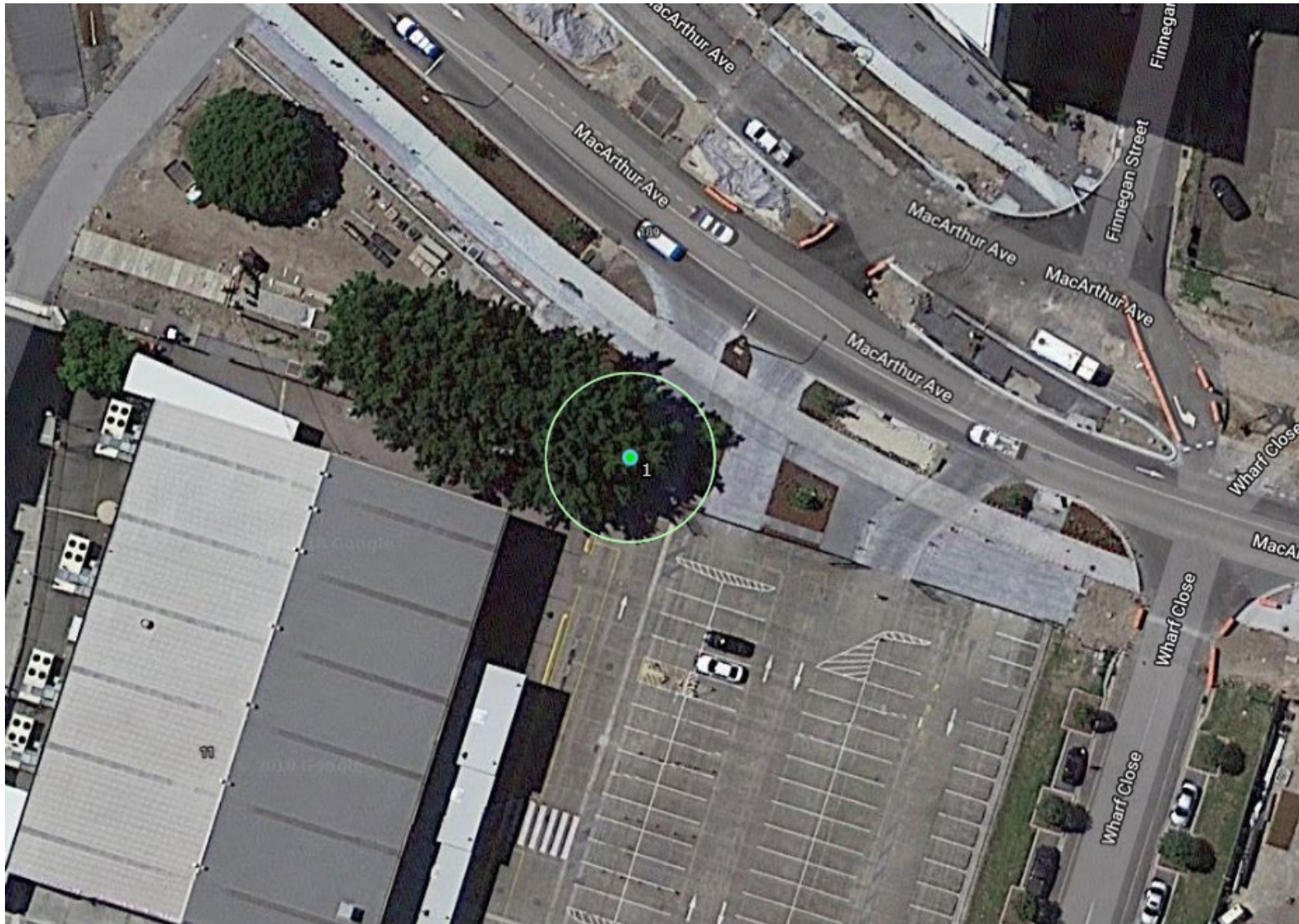
² Australian Standard AS 4970 - 2009 - Protection of trees on development sites, p17

³ Australian Standard AS 4970 - 2009 - Protection of trees on development sites, p29, Figure C1

Draft -Tree Management Plan (TMP) - Works progress: Development Phase

Stage	Tasks	Specific Outcomes
Pre-construction Phase		
Prepare and finalise Arboricultural Impact Assessments for submission to Council	Project Arborist to be appointed Review tree details in all approved Arboricultural reports following any new issue of plans	Submit Arboricultural reports including Arboricultural Impact Assessment for final Council Approval
Project Arborist to conduct Prestart Meeting with all representatives involved in construction	Prior to meeting: TPZs to be mulched and TPZ temporary protection/fencing installed <u>Arboricultural Report, TMP & QSG approval copies to be included in CMP</u> and made available to onsite crews	Prestart Certification and approvals in place & available onsite with CMP
Commencement - Construction Phase		
Initial Site Preparation	Project Arborist to supervise all work within TPZs including tree work, construction work & removal of slipway. Construction crew or others are not to remove any part of a tree! Project Arborist to supervise water cutting Retain all clean removed topsoil. Piled soil or mulch must not be stockpiled within TPZ of identified trees. Arborist prestart site inspection.	Compliance Certification of Arboricultural works for lodgement to Council Arborist certification of TPZ measures.
Prestart Toolbox Meeting	All relevant onsite crews to be briefed by Project Arborist prior to commencement of <u>each</u> work phase. Project Arborist <u>must</u> be notified and onsite at all times when construction works are within or very close to TPZ. Note: Onsite attendance of Project Arborist is a condition for issue of Arboricultural Site Audit Statement/s.	Arborist Site Audit Reporting system to be in place. Copies of Arboricultural Report to be retained onsite. <u>Arboricultural Site Audit Statement/s will not be issued retrospectively</u>
Construction Phase		
Site Establishment	Project Arborist to monitor tree health during establishment phase including bulk earthworks, changes in hydrology etc.	Instigate remedial tree care measures if required
Construction work	Site Manager to liaise with and ensure Project Arborist is advised in time to allow them to be present for all work carried out within TPZ area including any work likely to affect identified tree/s. Any deviation/s from approved plans to be approved by Project Arborist. Project Arborist to provide ongoing Site Audit Certification of all work within TPZ	Any remedial tree works to be carried out by qualified arborists under supervision of Project Arborist. Project Arborist is responsible for issue of Arborist Site Audit Reports.
Practical Completion	Project Arborist to carryout review of tree health and vigour and advise on TPZ fencing.	On Project Arborist approval, carryout removal of remaining temporary tree protection measures
Post Construction Phase		
Final Arborist inspection	Carryout tree health review and provide recommendations for required tree care.	Issue of final Arborist Site Audit Compliance Statement for inclusion in final DA documentation and sealing.

Tree Location:



Tree Information

Tree No.	Scientific Name	Common Name	DBH (mm)	TPZ (m)	Height (m)	Spread (m)	Health	Form	Comments
1	<i>Ficus hillii var Hillii</i>	Hills Fig	8.8	730	12	17	F	T	Deadwood in crown

Tree Detail & Removal / Retention Table

Tree No.	Scientific Name	Common Name	DBH (mm)	TPZ (m)	Incursion	Recommendations
1	<i>Ficus hillii var Hillii</i>	Hills Fig	8.8	730	Major	Retain and Protect - Amended construction to included suspended slab with no excavation within Tree Protection Zone

Legend:

m: meter

mm: millimetre

m/s: multi-stemmed

Health

G: Food

F: Fair

P: Poor

D: Dead

Form

G: Good

F: Fair

P: Poor

T: Typical

Var: various

Hgt: Height

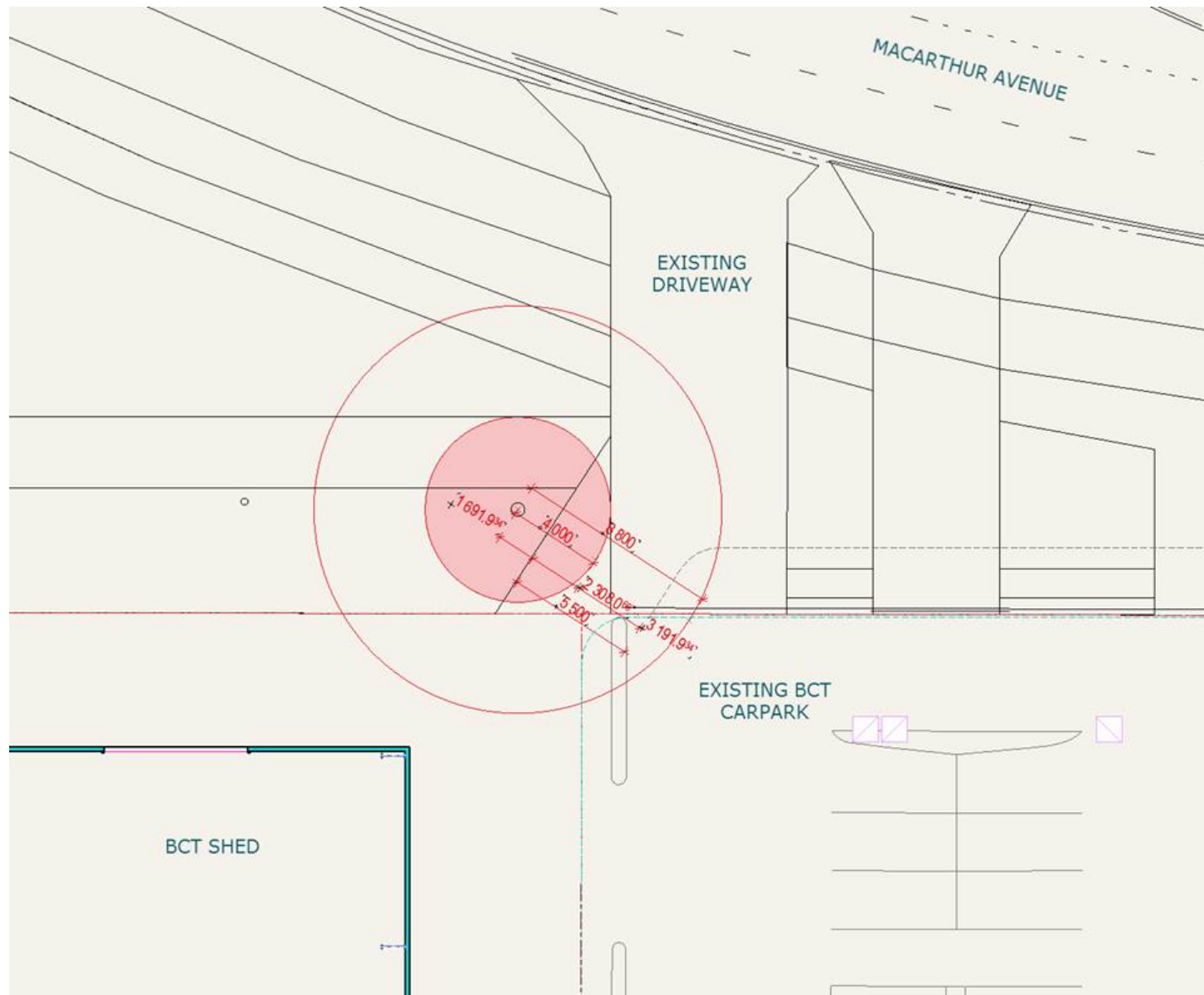
Spr: Spread

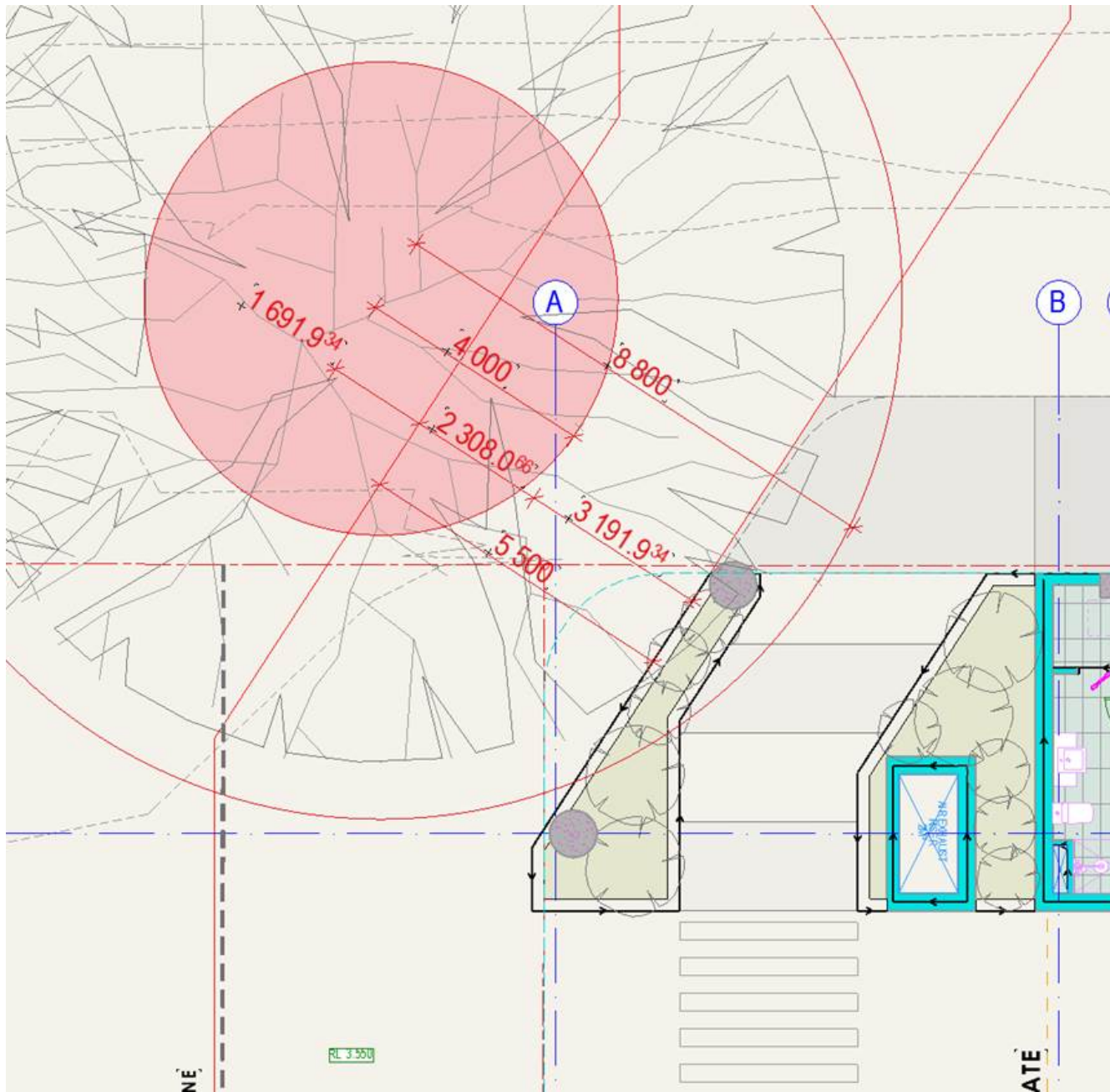
Cat: Category

DBH - Diameter at Breast Height measured at 1.4m aboveground level. DBH is the circumference divided by π. * Measurement taken by Standard issue DBH Tape.

TPZ - Tree Protection Zone TPZ = DBH x 12 (The radius of the TPZ is calculated for each tree by multiplying its DBH x 12) Note: TPZ - minimum area is 2.0m / maximum area is 15m Please Note: The TPZ figure is expressed as a radius measurement which is to be taken from the centre of the stem at ground level and applied in an outwards direction towards the extremities of the branches for the entire circumference of the tree/s.

Plans:





Photos



Subject Tree

All comments and recommendations in this report have been determined in accordance with Australian Standards AS 4373-2007- Pruning of amenity trees and AS 4970 – Protection of trees on development sites. All recommended tree work should be carried out in accordance with these standards.

Please do not hesitate to contact the writer should any further clarification of this report be required.

Yours faithfully,



Andrew Rankine

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Appendix 1: General Notes for the protection of trees close to construction zone

The following notes form part of the recommendations for the protection of trees identified in the report above and are a general guide for the protection of any other retained tree which may be affected by proposed building works on the property.

Note 1: Tree Protection Zone (TPZ)⁴

Exclusion zone- should be established along the TPZ perimeter detailed Tables of this report and cordoned off with a physical barrier of ridged chain mesh fence, 1.8m in height, which is securely anchored. These fences is to prevent any damage to the complete tree including root system (SRZ), stem and branch structure as well as the crown or canopy.

The physical location of the Tree Protection Zone may, in some instances, be altered to take into account site specific circumstances where the root structure of the tree is not symmetrical. Such circumstances may include, but are not limited to instances of the location of extended tension roots on a site with a rising/falling gradient or the development of tree roots in response to the presence of a physical barrier and will be determined in consultation with the project/consulting arborist⁵. The exclusion zone is also to prevent dumping of extraneous material, accidental damage by machinery including excavators, cranes and vehicles, site buildings or stacking of builders' materials. This fence will also ensure machinery does not come into contact with tree/s. Ensure machinery exhaust systems face away from tree/s.

This fence shall not be moved unless authorised by project/consulting arborist.

No excavation or placement of fill, site offices or storage containers shall occur within the TPZ. Materials which will contaminate the soil, e.g. concrete mixing, diesel oil, paint or other chemical and vehicle washing waste should not be discharged within the TPZ. Care should be taken if removing trees in close proximity to a TPZ and protected tree/s so as to minimise any disturbance of roots within the protected area of those trees. No disturbance of roots within the Structural Root Zone (SRZ) of a protected tree/s is to occur and any removal of adjacent trees likely to cause such disturbance shall be supervised by the project/consulting arborist. Any removal of soil in close proximity to the TPZ will be taken in an outward direction away from the tree stem. A batter bucket only should be used so as to avoid any accidental pulling and cracking or breaking of roots and damage to roots of adjacent retained trees which maybe tangled with those of trees to be removed. When removal of stumps in close proximity to retained trees is required, such removal should be carried out by grinding, not excavation (Refer Appendix 1, Note 4).

Encroachment within TPZ is considered⁶:

- Minor if encroachment is less than 10% of the TPZ
- Major if encroachment is greater than 10% or inside the SRZ

The Tree Protection Zone (exclusion zone) and mulching of this area will:

- Help prevent soil compaction and minimise root damage
- Reduce soil moisture loss and reduce weed growth
- Promote root generation and increase soil organic matter and available nutrients to tree
- Stimulate soil microflora and microfauna activity and assist the survival of affected tree/s by maintaining and ensuring optimum health and structural stability so as to maximize its ability to resist pest and pathogen attack and cope with a changed local environment.

Signs: Signs are to be erected to clearly explain the importance of the tree and to warn people of the fines they face for any form of tree vandalism. (Refer Appendix 1, Note 2).

⁴ Refer Aust. Std AS 4970-2009, Section 3

⁵ Refer Aust. Std AS 4970-2009, 3.3.4 TPZ Encroachment considerations p12

⁶ Refer Aust. Std AS 4970-2009, 3.3.4 TPZ Encroachment considerations p11

Please note:

Consideration of the effect on the longterm health and stability of the tree must be made if any encroachment of earth or construction works associated with the Building Envelope (BE) into the TPZ or SRZ is to occur. The extent of such incursion is to be determined in consultation with the consulting arborist and may be subject to approval by the regulating authority. Such intrusion must not exceed recommendations outlined in Aust. Std. 4970-2009.

Site Compliance Audit Statements prepared by the project arborist maybe required to be completed prior to, during and on completion of all construction works for sealing of the Development Approval. Project /Consulting Arborist must be in attendance at time of works for the issue of Compliance Audit Statements.

All work is to be carried out in accordance with Aust. Std 4970-2009 – Protection of trees on development sites.

INDICATIVE STAGES IN THE DEVELOPMENT AND THE TREE MANAGEMENT PROCESS**Planning: Tree management process**

Stage in development	Matters for consideration	Actions and certification
Site acquisition	Legal constraints	
Detail surveys	Council plans and policies Planning instruments and controls Heritage Threatened species	Existing trees accurately plotted on survey plan
Preliminary tree assessment	Hazard/risks Tree retention value	Evaluate trees suitable for retention and mark on plan Provide preliminary arboricultural report and indicative TPZs to guide development layout
Preliminary development design	Condition of trees Proximity to buildings Location of services Roads Level changes Building operations space Long-term management	Planning selection of trees for retention Design review by proponent Design modifications to minimize impact to trees

Tree Management Plan (TMP) – Works process: Development Phase**Pre-construction Phase**

Stage	Tasks	Specific Outcomes
Prepare and finalise Arboricultural Impact Assessments for submission to Council	Review Arboricultural Impact Assessment tree details and any new issue of plans Project Arborist & Fauna Spotter to be appointed	Submit Arboricultural Impact Assessments for final Council Approval and Fauna Spotter Report.
Project Arborist to conduct Prestart Meeting with all representatives involved in construction	Prior to meeting: tag trees, paint symbols on trees: ● tree retention X tree removal Tree mark up completed, mulch TPZs and install TPZ temporary protection/fencing All Arboricultural Report copies to be available including any TMP and Fauna Spotter Reports	Prestart Certification and approvals in place.

Commencement – Construction Phase

Stage	Tasks	Specific Outcomes
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Initial Site Preparation	Carry out approved tree works including tree removals and pruning works. All stumps to be left at ground level if root entanglement is present particularly where trees to be removed are located within any TPZ of retained tree/s. Retain all removed topsoil for reuse in onsite gardens where possible. Arborist prestart site inspection.	Compliance Certification of arboricultural works for lodgment to Council. Arborist certification of TPZ measures.
Prestart Toolbox Meeting	All relevant onsite crews to be briefed by Project Arborist prior to commencement of each work phase. Project Arborist to be onsite at all times when construction works are within or very close to any TPZ. Note: Onsite attendance of Project Arborist is a condition for issue of Arboricultural Site Audit Statement/s.	Arborist Site Audit Reporting system to be in place. Copies of all Arboricultural Report/s to be retained onsite.

Construction Phase

Stage	Tasks	Specific Outcomes
Site Establishment Phase	Project Arborist to monitor tree health during establishment phase including bulk earthworks, changes in hydrology etc.	Instigate remedial tree care measures if required
Construction Work	Site Manager to liaise with and ensure Project Arborist is advised in time to allow them to be present for all work carried out within TPZ areas including any work likely to affect retained trees. Any deviation/s from approved plans to be reviewed and approved by Project Arborist	Any remedial tree works to be carried out by qualified arborists under supervision of Project Arborist. Project Arborist is responsible for issue of Arborist Site Audit Reports.
Practical Completion	Project Arborist to carryout review of tree health and vigour of all retained trees near to or within construction site and advise on TPZ fencing. All replacement planting of tree stock is to be carried out as per Approved Landscape Plan using NATSPEC certified stock.	Carryout approved removal of remaining temporary tree protection measures

Post Construction Phase

Stage	Tasks	Specific Outcomes
Final Arborist inspection	Carryout tree health review and provide recommendations for required tree care.	Issue of final Arborist Site Audit Compliance Statement for inclusion in final DA documentation and sealing.

Note 2: Australian Standard AS 4970 – 2009 – Protection of trees on development sites

Figure 10: Protective Fencing

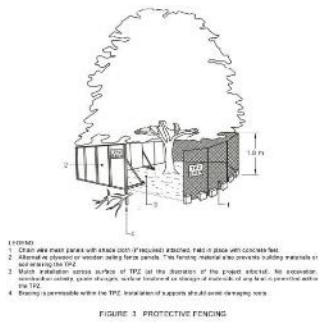
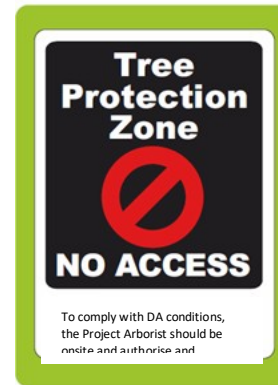


Figure 11: Tree Protection Zone signage



*Based on BCC and other guidelines

Figure 12: Fauna friendly style temporary fencing

Installation of a fauna friendly temporary fence

- A space of at least 50cm underneath any style of fencing will allow animals to pass beneath.
- Gaps left at corners will allow animals that follow the fence a place to pass through.
- Many native animals can easily climb wooden fences and chain wire.

For fences constructed to be permanent fixtures:

- A wider top rail on the fence can become an animal walkway.
- Incorporation of trees, sturdy shrubs and/or logs propped up against the fence (preferably on both sides) will provide shelter and climbing opportunities.
- Consider the use of hedges or bushy native plants as a privacy screen or hedge rather than a fence.

Note 3: Mulch/Watering/Fertilising

The exclusion TPZ including the Structural Root Zone (SRZ) should be mulched to a depth of 75mm using well composted forest blend or clean and aged reserved site mulch ensuring mulch used does not contain fines and it complies with AS 4454 -Compost, soil conditioners & mulches. Reserved site mulch should be stored in windrows at a height no greater than 2m to avoid spontaneous combustion. If site constraints do not allow for onsite storage of green waste, it may be spread across TPZ at the discretion of the project arborist. If applying green mulch, please seek further advice project arborist as it must be treated to compensate for nitrogen drawdown. Irrigation to a minimum depth of 400 mm of the area within the exclusion fenced area (TPZ) should occur immediately after mulching. Sufficient water should be applied to achieve field capacity. A liquid fertilizer should be applied after irrigation as prescribed by the consulting arborist. The project/consulting arborist will advise on frequency of application. Repeat application of mulch maybe necessary if TPZ is in place in excess of 12 months. Watering regime should be established according to prevailing weather conditions or as prescribed by the consulting arborist.

All work is to be carried out in accordance with Aust. Std 4970-2009 – Protection of trees on development sites.

Note 4: Root Damage

Roots outside TPZ are to be exposed using an 'Air Spear' or by hand digging. Any mechanical digging should be carried out using a batter bucket and digging should occur outside the TPZ and in the direction of the major lateral

roots, i.e. in the direction away from the stem of the tree. All roots requiring removal should be cut by sharp clean implements i.e. large lateral roots to be cut with a chainsaw, smaller roots to be cut with a sharp handsaw and hair roots to be cut with sharp secateurs. Roots smaller than 25mm diameter should be pruned back to a side branch. Roots larger than 25mm should be cut after consultation with a qualified Arborist. Root hormone should be applied to aid the regrowth of roots and the site should be back filled with good quality organic soil. A general purpose fungicide such as Fongarid® should be applied to damaged roots. All roots to be pruned roots should be pruned with a final cut to undamaged wood. Tree/s to be removed, including all stumps, from within a TPZ must be removed in a manner that avoids damaging or disturbing roots of trees to be retained. All care should be taken to prevent the compaction of soil surrounding the root system. (Refer section 4.5.4, p 18 Aust. Std 4970-2009)

All root pruning is to be carried out in accordance with Aust. Std 4970-2009 – Protection of trees on development sites.

Note 5: Decompaction

Where soil compaction is present, decompaction of the area around the stem of the tree should be carried out using an air spear. Decompect the soil in offset concentric circles approximately one metre apart. Carry out soil tests and apply appropriate treatment such as vertical mulch columns, slow release fertilizer or other prescribed treatment, through the created decompaction holes where prescribed by project/consulting arborist.

All work is to be carried out in accordance with Aust. Std 4970-2009 – Protection of trees on development sites.

Note 6: Inspection

Inspection- *During the development stages* any activity which results in damage to or compaction of the tree's root system should be inspected and monitored on an ongoing basis by project/consulting arborist. Where damage occurs it should be reported to the supervising arborist immediately and remedial measures taken as prescribed. Site audits should be carried out by the consulting or supervising arborist on a regular basis or as prescribed by the regulatory authority.

Inspection- *On completion of construction phase*, prior to public access, all trees within the vicinity of the construction area should be inspected by the project or consulting arborist and crown cleaning to remove deadwood and other arboricultural work as maybe specified should be carried out.

Site Compliance Audit Statements prepared by the project arborist maybe required to be completed prior to, during and on completion of all construction works for sealing of the Development Approval.

All work is to be carried out in accordance with Aust. Std 4970-2009 – Protection of trees on development sites.

Note 7: Pier construction (Building or fence)

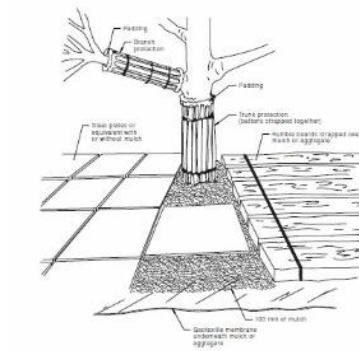
Where construction works or likely compaction may occur within the TPZ or SRZ the following measures as detailed in 3.3.4 of the Australian Standard 4970-2009 should be taken including:

- Minimise compaction of soil within drip zone of the tree
 - Over engineer building plans to allow for relocation of piers
 - Hand dig pier holes to expose major lateral roots.
Note: If major lateral roots are exposed, pier hole is to be relocated
 - Pier installation to be sleeved to prevent leaching of concrete materials into adjacent soil within the RPZ
 - All root pruning to be carried out as per Note 3 above
 - Decompaction and aeration of root area as per Note 4 above
 - Mulch and water drip zone to field capacity according to weather conditions as per Note 2
- Please Note: Design Plans incorporating any encroachment must be made in accordance with AS 4970-2009 and in consultation with project/consulting arborist. Encroachment is considered as:-
- Minor if encroachment is less than 10% of the TPZ
 - Major if encroachment is greater than 10% or inside the SRZ

All work is to be carried out in accordance with Aust. Std 4970-2009 – Protection of trees on development sites.

Note 8: Tree protection measures including ground, stem/trunk and branch structure when TPZ fence modification is required. (Refer AS 4970-2009, p16, 4.5.1 (General), p17, 4.5.2 (Stem/Trunk & branch), p17, 4.5.3 (Ground) and p18, 4.5.4 (Root)).

Figure 13: Examples of trunk, branch and ground



8.1 Ground protection

The purpose of ground protection is to prevent root damage and soil compaction within the TPZ. Measures may include installation of a permeable membrane such as geotextile fabric beneath a layer of mulch or crushed rock below rumble boards. Refer Figure 13 and AS 4970-2009, p17. These measures may be applied to root zones beyond the TPZ.

During the planning phase, consideration for site access should include routing of vehicular and pedestrian traffic to avoid areas in close proximity to retained trees or area/s of future landscaping so as to minimise compaction of soil. Such protection measures may include temporary bridging or laying down of temporary surfacing.

Where excavation of top soil cannot be avoided and/or cut and fill necessitates soil replacement, composition of replacement medium should be coarser or more porous than the underlying material to ensure adequate supply of air, nutrients and water to the tree/s. Planning should be cognisant of both present and future tree needs. All such work should be planned and carried out in consultation with the consulting arborist. (Refer Australian Standard AS 4970-2009: 4.5.3 Ground protection p17 & 18 & Appendix B3.4, p27).

8.2 Stem/Trunk and Branch protection

Stem and branch protection may also be required where approved work is to occur inside the TPZ barrier fencing. Such protection barriers should be installed to a minimum height of 2m to prevent damage to the tree structure. All damage should be reported to the Project or Consulting Arborist (experienced & min qual. AQF Level V/Diploma Arb.)⁷

The following extract from British Standard BS 5837:2005 (referred to in AS4970) is provided as a guide to illustrate appropriate methodology when considering installation of services by tunneling.

“Low-invasive vehicular access in proximity to trees⁸

Where the construction of hard surface access cannot be avoided within the root protection area, a no-dig design should be used to avoid root loss due to excavation. In addition, the structure of the hard surface should be designed to avoid localized compaction, by evenly distributing the carried weight over the track width and wheelbase of any vehicles that will use the access. Such designs might include the use of a three-dimensional cellular confinement system as an integral component of the sub-base, to act as a load suspension layer. Driveways and roadways constructed according to this principle can be designed to be suitable for most types of traffic. Where this type of

⁷ Aust. Std AS 4970-2009 – Protection of trees on development sites

⁸ British Standard BS 5837:2005 s 11.7.1

access is proposed, site-specific and specialist advice should be sought from an engineer and an arboriculturist in order to ensure that it is fit for purpose.”

Note 9: Installation of underground services within TPZ

All services should be routed outside the TPZ. If underground services must be routed within the TPZ, they should be installed by directional drilling or in manually excavated trenches. See following notes

The directional drilling bore should be at least 600 mm deep. The project arborist should assess the likely impacts of boring and bore pits on retained trees.

For manual excavation of trenches the project arborist should advise on roots to be retained and should monitor the works. Manual excavation may include the use of pneumatic and hydraulic tools. Refer Aust. Std 4970-2009 Clause 4.5.3. and Aust. Std 4970-2009 – Protection of trees on development sites

The following extract from British Standard BS 5837:2005 (referred to in AS 4970) is provided to illustrate appropriate methodology when considering installation of services by tunneling

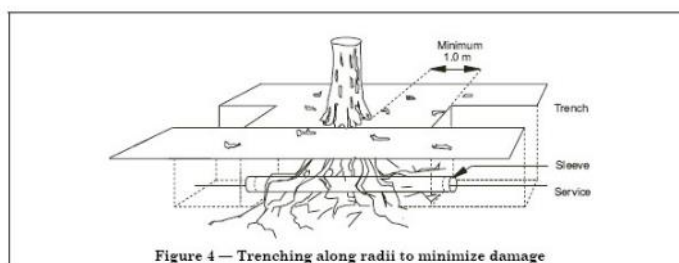
Underground and above ground services - **Note: AS 4970: TPZ includes Root Protection Area (RPA)** *Trenching for the installation of underground services severs any roots present and may change the local soil hydrology in a way that adversely affects the health of the tree. For this reason, particular care should be taken in the routing and methods of installation of all underground services. Wherever possible, they should be kept together and trenchless techniques used. At all times where services are to pass within the RPA, detailed plans showing the proposed routing should be drawn up in conjunction with an arboriculturist. Such plans should also show the levels and access space needed for installing the services and be accompanied by arboricultural method statements (AMS). © BSI 26 September 2005, s 11.7.1.*

As an alternative to trenchless techniques, a possible solution is to hand excavate a narrow trench passing directly towards a tree along a radius to not closer than 1 m from the trunk, tunnel straight beneath the tree, preferably not less than 750 mm deep, and exit on the opposite side along another radius (see Figure 4).

Provided the trench is kept as narrow as possible, the amount of root severance will be minimal, and will be far less than if a trench passes close beside the tree. It may be necessary to make provision to facilitate future servicing and repair without further damage to the tree roots s 11.7.2.

Consideration should be given to the routing of above ground services in order to avoid the need for detrimental and repetitive pruning. In this regard the current and future crown size of the tree should be assessed. Tree branches can be pruned back with care (see BS 3998) to provide space. s 11.7.3, as shown in following Figure 14: Trenching along radii to minimise damage.

Figure 14: Trenching along radii to minimise damage



Note 10: Scaffolding

Where scaffolding is required it should be erected outside the TPZ. Where it is essential for scaffolding to be erected within the TPZ, branch removal should be minimized. This can be achieved by designing scaffolding to avoid

branches or tying back branches. Where pruning is unavoidable it must be specified by the project arborist in accordance with AS 4373.

NOTE: Pruning works may require approval by determining authority.

Ground below the scaffolding should be protected by boarding (e.g. scaffold board or plywood sheeting) as shown in Figure 5. Where access is required, a board walk or other surface material should be installed to minimize soil compaction. Boarding should be placed over a layer of mulch and impervious sheeting to prevent soil contamination. The boarding should be left in place until the scaffolding is removed⁹.

Note 11: Weed removal

All weeds within TPZ should be removed by hand without soil disturbance or should be controlled with appropriate use of herbicide¹⁰.

Note 12: 'Green Style' Surfacing.

Green style surfacing is porous in nature, i.e. water permeable, and designed to allow good air and water flow to the root zone of vegetation including trees. This product can be filled and/or laid on a shallow non- fines bed and is designed to disperse weight from vehicular or high pedestrian traffic to minimise compaction of soil. Several products are now marketed in Australia and further information is available through links listed below. Please note, no individual product is specifically recommended as selection of appropriate surfacing style will be dependent upon final design layout and site specific requirements. Further information may be accessed by clicking on the following links:

Atlantis

Footpaths and driveways:

http://www.atlantiscorp.com.au/brochures/Turf_Cell_Brochure.pdf Boral - Hydrapave:

<http://www.boral.com.au/BrandStories/hydrapave.asp> Boral's Hydrapave™ - a unique 'green' paving solution

Adbri Masonry

Footpaths and driveways link: <http://www.infolink.com.au/c/Adbri-Masonry/Semi-Permeable-Paving-Solutions-available-from-Adbri-Masonry-n864396>

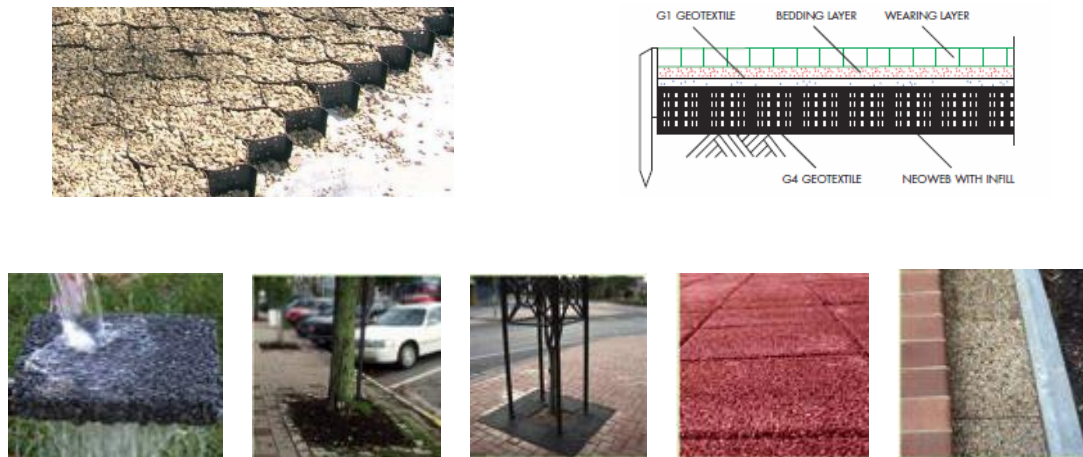
'No Dig' Construction

Please request detailed further explanatory notes and information about the application of 'No dig' construction techniques. Briefly, 'no dig' construction methodology allows for the installation of hardscape, water permeable surfacing suitable for the installation of footpaths and driveways within sensitive vegetation areas in most instances. Intrusion within the Tree Protection Zone (TPZ) including removal of topsoil and disturbance to important feeder and structural tree roots is largely avoided providing an environmentally sound alternative for the retention of important vegetation and preservation of localised natural water flows within the development site.

⁹ Aust. Std AS 4970-2009 – Protection of trees on development sites

¹⁰ Aust. Std AS 4970-2009 – Protection of trees on development sites

Figure 15: 'No dig' style installation techniques



Additional References:

<http://permapave.com.au/specs/brochures/Pavers-Tech-Data.pdf>
www.civilsandlintels.co.uk/pdfs_new/Treeguard%20Brochure.pdf
www.boddingtons-ltd.com/civil/tree-root-protection.htm
www.boddingtons.com.au/PDF/Bodcell-Tree-Root%20Protection.pdf
<http://www.geofabrics.com.au/products.asp?id=89>

<http://permapave.com.au/products/pavers.htm>
www.civilsandlintels.co.uk
www.boddingtons.com.au results

Soil cell structures

Figure 16: Soil cell structures¹¹



¹¹ www.citygreen.com/products/

Figure 17: Structural Soil¹²

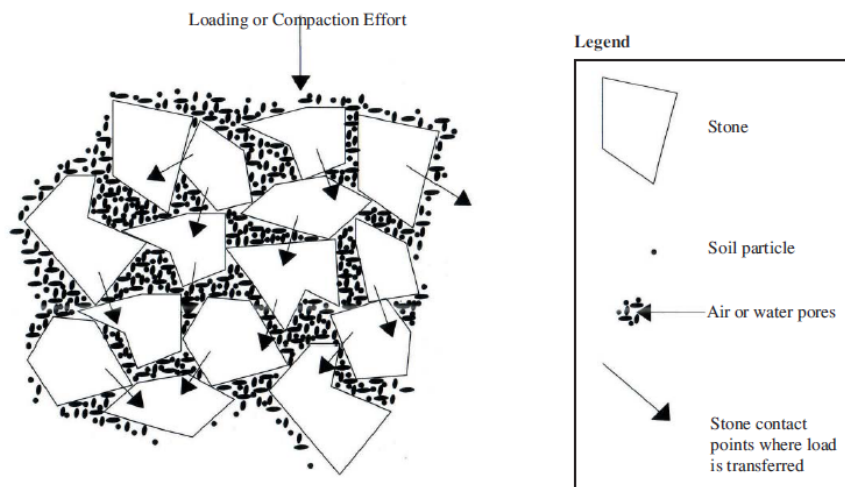


Fig.1.7 Conceptual diagram of CU-Structural Soil™ including stone-on-stone compaction and soil in interstitial spaces used as a base course for pavements.

Note 13: Trip Hazard Prevention - Expansion Joints

'TripStop' is UV and Ozone stabilised and Lead and Cadmium free extrusion that is installed in the concrete during the pour. Its uniquely designed double 'hinge' allows the concrete segments to raise and lower when the earth moves. This ensures that the segments do not displace and create tripping hazards.

Figure 18: Trip Hazard Prevention - Expansion Joints¹³



¹² Online Reference: <http://www.amereq.com/images/cusoil.pdf>

¹³ www.tripstop.net/en/index.php?option=com_content&task=view&id=72&Itemid=470

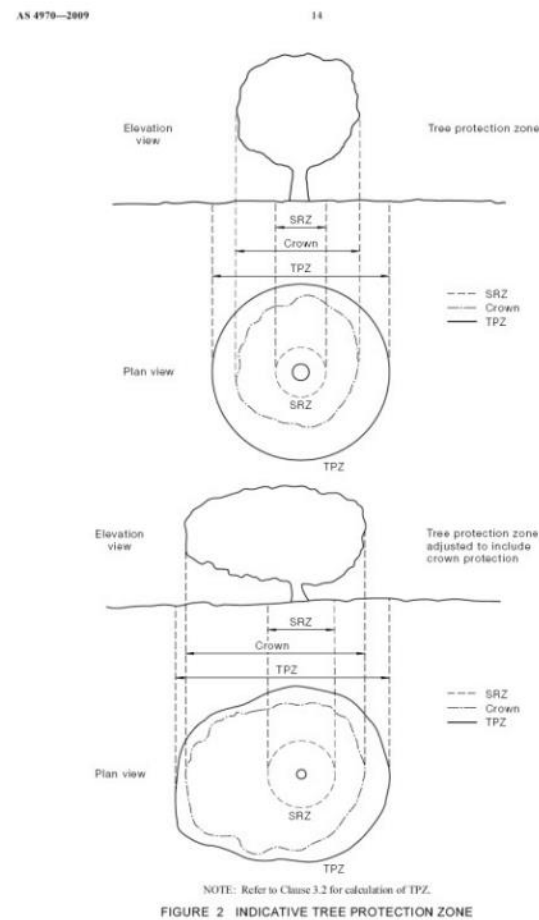
Note 14: Indicative Tree Protection Zone

Please Note:

AS4970-2009, s3: The radius of the TPZ is calculated for each tree by multiplying its DBH $\times$ 12. DBH = Diameter @ Breast Height measured @ 1.4m from ground level).

Please refer to the Standard and following Explanatory Notes for further detail.

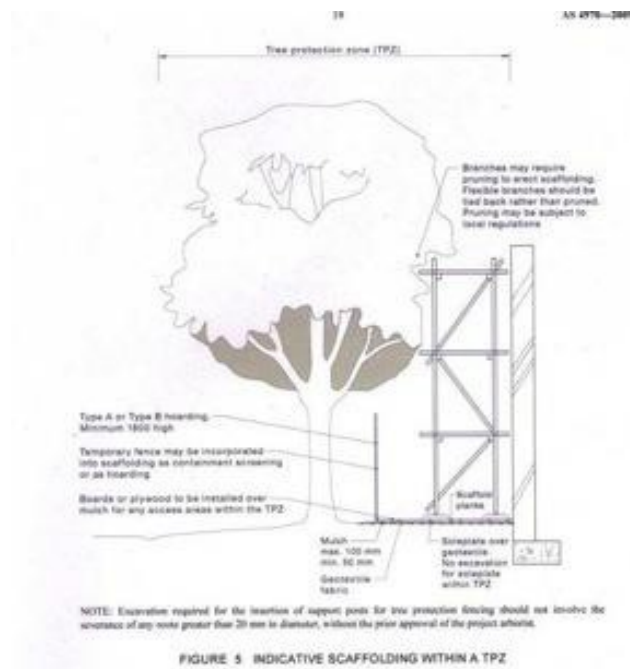
Figure 19: Indicative Tree Protection Zone, AS 4970-2009¹⁴.



¹⁴ Australian Standard AS 4970 – 2009, Figure 2

Note 15: Indicative Scaffolding within a TPZ

Figure 20: Indicative Scaffolding within a TPZ: AS 4970-2009¹⁵

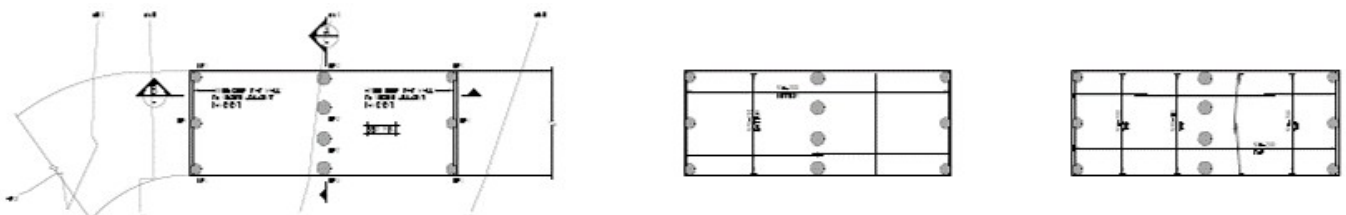


Note 16: Footpath & Roadway construction within a TPZ

Construction methodology must be over engineered and above grade with minimum excavation on a fill base of granular material using concrete sections to bridge the root zone of retained tree/s.

Please Note: If concrete is to be utilised it should be sleeved if contact is made with the soil to prevent chemical leaching into soil. Diameter of piers should be minimised to reduce intrusion beneath ground level.

Figure 21: Roadway construction bridging TPZ



¹⁵ Australian Standard AS 4970 - 2009 Figure 5

Figure 22: Footpath construction within and bridging TPZ

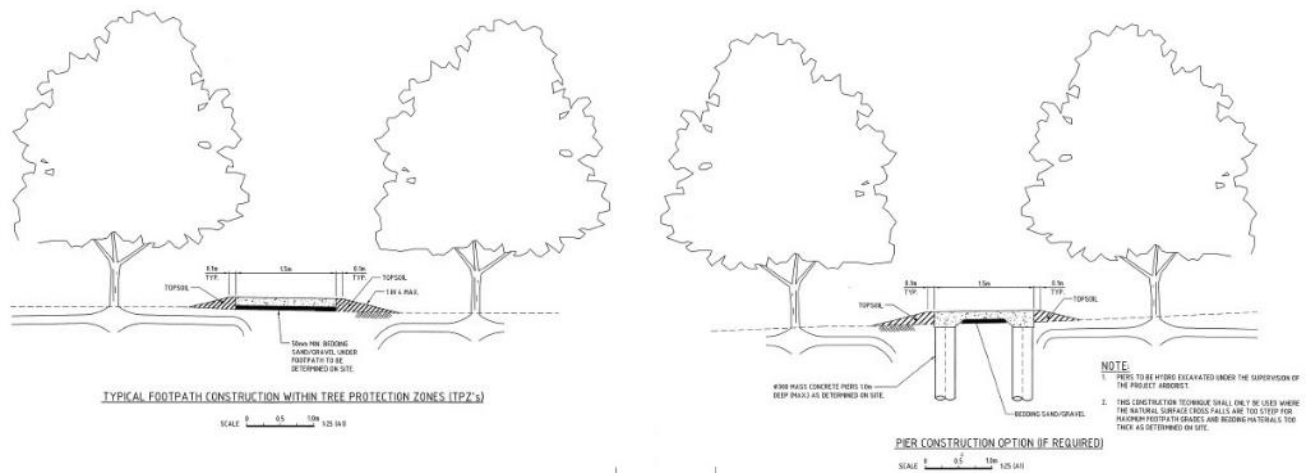
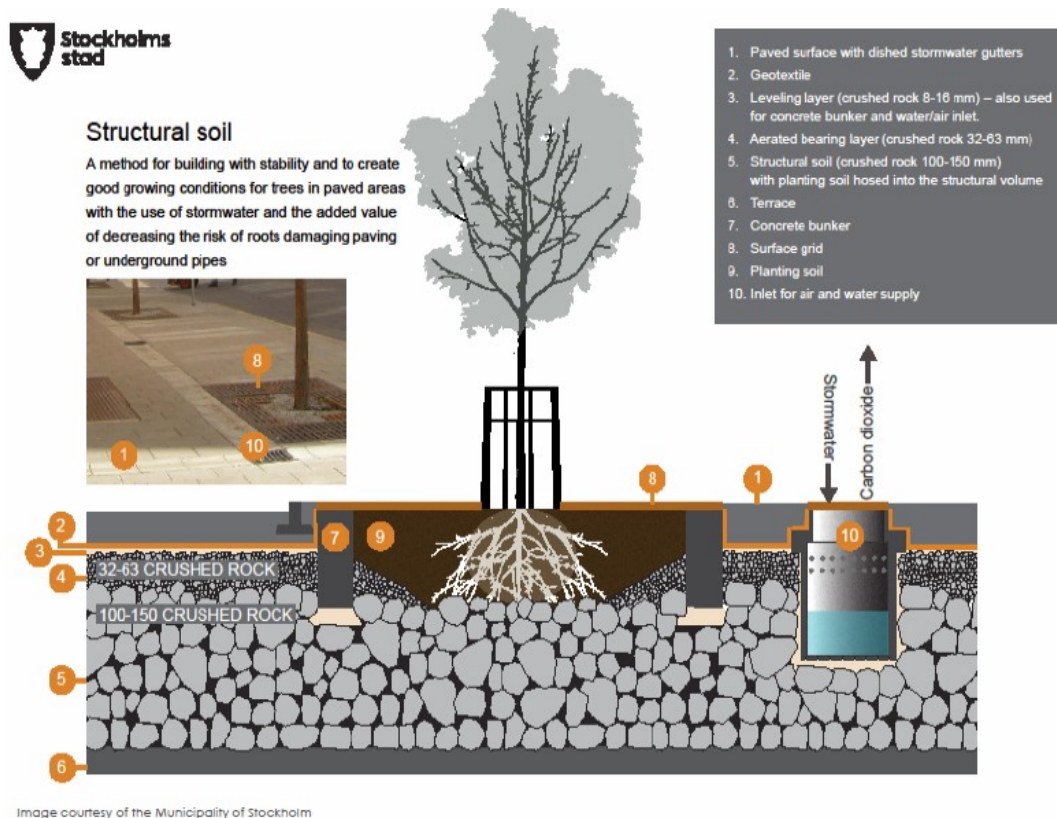


Figure 23: Road and footpath construction within and bridging TPZ¹⁶



¹⁶ Jaluzot, Anne, Trees and Design Action Group UTD2 Presentation, Melbourne, 23.02.2016

General Note: Trees & construction within TPZs for new buildings/driveways/fences etc.

To ensure the need for soil excavation and therefore disturbance within the TPZ of retained trees is minimised, construction of the new driveways, dwellings/carports etc. must utilise above ground level methodology, i.e. must include over-engineered design using raised foundations / suspended slab supported by sleeved piers. Raising of these structures above natural ground level to reduce the need for excavation of soil within the TPZ of tree/s and will also serve to reduce the potential overall weight load exerted by future new infrastructure over the affected TPZ area.

Further, there must be no use of strip footings between the tree stem and alignment of the new installations. Care must be taken to minimise disturbance to the existing natural hydrology and nutrient resource flows currently available to retained trees in order to avoid causing a rain shadow effect over RPA/s. All ground surface treatments must be 'Green Style' to reduce soil compaction and to promote water and air penetration into the 'below ground' subsoil to allow adequate gaseous exchange to occur. (Refer App. 1, General Note 12, p.46)

All work associated with the installation of the new driveway, fence / footpath / built structures adjacent retained trees must be carried out with due care under the supervision of the Project Arborist to ensure that disturbance within TPZs and/or any damage to tree roots is kept to an absolute minimum.

If sleeved pier and raise beam design is approved, excavation of soil during pier installation must be carried out under the supervision of the Project Arborist. All soil disturbance is to be carried out by hand or using low pressure excavation methodology to allow flexibility of pier location should major tree roots be exposed. Over-engineering of Design Plans will allow for such alteration of pier hole sites.

Driveway access & crossovers

In the first instance, following DA Approval and prior to the commencement of any construction, installation of the new accessways should be carried out so as to prevent compaction of soil and compression injury to roots. Layered coarse gravel could also serve to provide temporary access and assist to disperse the weight of vehicles etc.

TPZ perimeter fencing or alternative stem and branch protective barriers should then be established prior to the commencement of construction work.

Care must be taken during any removal of soil adjacent to the TPZs. If removal of existing hard surfacing is carried out using mechanical means such as an excavator, the machine is to use a batter bucket and be operated from above existing hard surface, in an outwards direction toward the extremity, i.e. in a direction away from the tree stem.

In the instance of TPZ fencing, rigid steel mesh barrier fencing, 1.8m in height should be installed along the new driveway alignment and continue along the TPZ perimeter as directed by the Project Arborist. Once established, there must be no alteration or relocation of the TPZ perimeter fencing unless such movement is authorised and supervised by the Project Arborist. Once Arborist reports are prepared for the project, any further issues of plans are to be assessed by the Project Arborist prior to finalisation to ensure that any alterations to planned construction works do not inadvertently cause an adverse effect on the health and/or structural integrity of trees of concern. No installation of services within TPZs is to occur unless further arboricultural advice is sought. Alternate installation methodology can include soil excavation under low air or water pressure to allow threading of conduits below exposed roots.

With the exception of established planting, no landscaping works within TPZs should be carried out so as to avoid causing additional stress as tree/s of concern compete for available soil moisture and nutrients. Leaving TPZs free of additional planting will also serve to maximise the available soil volume/area available to tree/s.

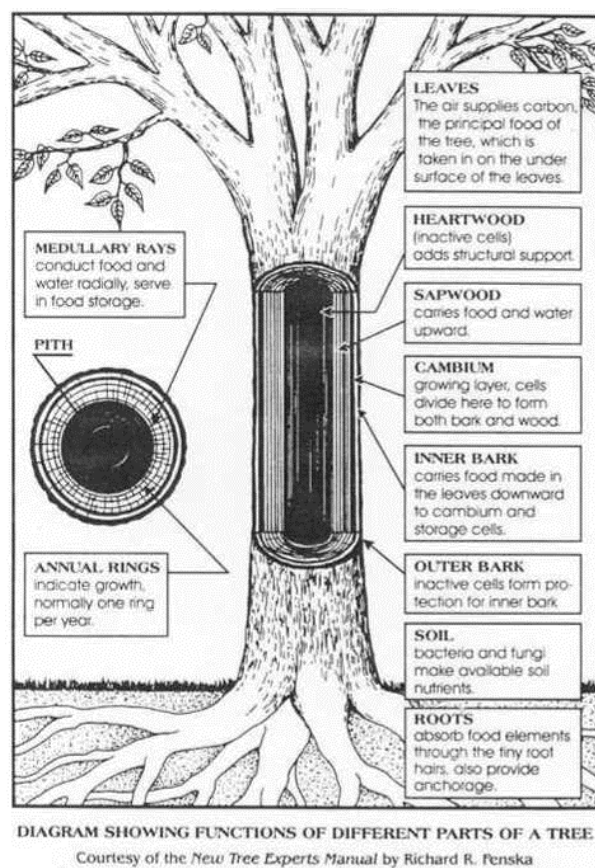
It is strongly recommended that application of aged forest style mulch be made over the ground surface area within the TPZs to assist tree/s to cope with planned works. Mulch will also to provide a natural ongoing (slow release) source of nutrients for affected tree/s. Depending on the extent of proposed disturbance within TPZs and

specifically, the RPAs, it is likely that there will be some reactive response by affected tree/s, such as the emergence of deadwood and /or dieback. Further advice for remedial pruning to address such issues should be sought from the Project Arborist should they arise as the construction phase progresses.

Please note: Application to relevant council and approvals must be in place prior to the commencement of any construction work. Approvals may be required should the Project Arborist prescribed pruning such as crown clean, canopy lift and/or directional pruning. **Any pruning is to be carried out by authorised, qualified and insured Arboricultural Practitioners only.**

Any pruning is to be carried out by authorised, qualified and insured Arboricultural Practitioners only as indiscriminate, arbitrary or excessive removal or damage to a retained tree is likely to result in diminished Useful Life expectancy of a tree as well as inadvertent increase in the OH&S risk profile over its target zone/ area the potential failure zone. (Refer Figure 24¹⁷ below)

Figure 24: Functions of different parts of a tree

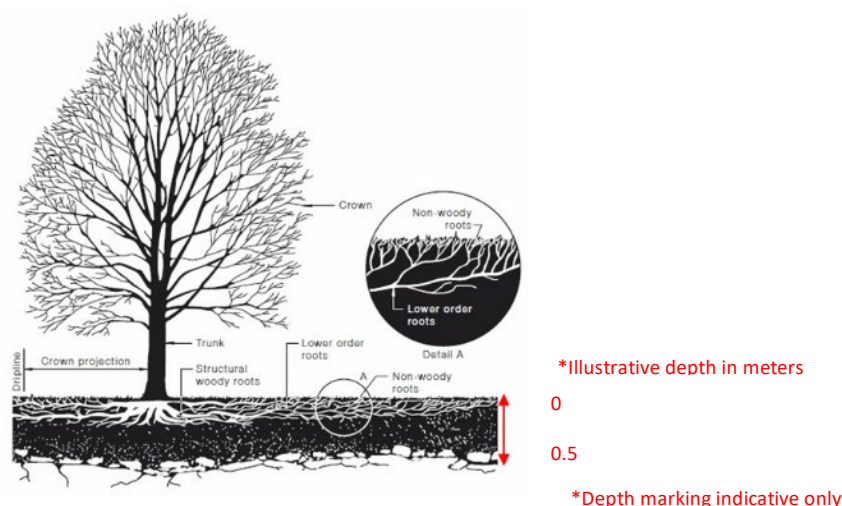


¹⁷ Online Source: Penska, Richard R., *New Tree Experts Manual*, <http://images.wikia.com/nature/images/5/5a/Thepartsofatree.jpg>

Appendix 2: Normal Function of a tree

Background Note: The following diagrams and explanatory notes are useful to illustrate the structure of a tree in a normal growing environment. This information is taken from AS4970-2009-Protection of trees on development sites which has been released subsequently to AS4373-2007- Pruning of amenity trees.

Figure 25: Structure of a tree in a normal growing environment¹⁸



“Leaves

The main function of leaves is photosynthesis, that is, the production of sugars. The sugars produced by the leaves (and any other green tissue) are the source of chemical energy for all living cells in the entire plant and as such are essential for the normal functioning and survival of the tree. Anything that directly or indirectly damages the leaves will interfere with photosynthesis.

Trunks and branches

Branches and trunks are composed of many tissues with specialized functions including the bark (protection), phloem (transport of sugars from the leaves), vascular cambium (growth of new transport tissues), sapwood (transport of water and nutrients from the roots), heartwood (strength and structural support) and rays (internal transport and storage of sugars). Damage to branches or trunks may allow infection by plant pathogens (disease causing organisms), disrupt the movement of vital materials and structurally weaken the tree.

Roots

The main functions of roots include the uptake of water and nutrients, anchorage, storage of sugar reserves and the production of some plant hormones required by the shoots. In order for roots to function, they must be supplied with oxygen from the soil. The root system of trees consists of several ‘types’ of roots found in different parts of the soil and is generally much more extensive than commonly thought. The importance of roots is easily overlooked because they are not visible, that is ‘out of sight, out of mind’. Damage to the root system is a common cause of tree decline and death and is the most common form of damage associated with development sites.

Root systems consist of three main parts:

1. The structural woody roots (anchorage, storage and transport);
2. Lower order roots (anchorage, storage and transport); and
3. Non-woody roots (absorption of water and nutrients, extension, synthesis of amino acids and growth regulators) (see Figure B1).

In addition to lateral root spread being underestimated, root depth in trees has also been grossly exaggerated. Deep root systems or taproots are the exception rather than the rule.

Most roots of most trees are found in the very top of the soil. The vast majority of these roots are small non-woody absorbing roots which grow upward into the very surface layers of the soil and leaf litter. This delicate, non-woody system, because of its proximity to the surface, is very vulnerable to injury.”

¹⁸ Aust. Std 4970-2009 – Protection of trees on development sites, p26. Figure B1.

Explanatory Note: The importance of gas exchange in soils

The fact that tree roots require oxygen to function is often misunderstood. Accessibility to available oxygen and water within the soil structure is dependent on the integrity of soil structure within their surrounds; when soils are compacted there is little space between soil aggregates with soil volume and total pore space, especially macropore space diminished. In turn, good soil oxygenation and gas exchange¹⁹ levels allow for successful function of tree roots. Oxygen levels in soils will typically decrease as soil depth increases and /or soils are heavily compacted.

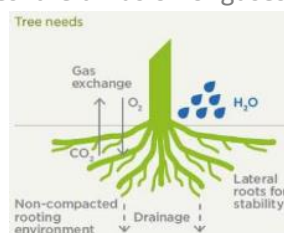
Macropore is the term used to describe the relatively large space between soil particles that is usually air filled and allows for water movement and root penetration. Micropore is the term used to describe the space between soil particles that is relatively small and likely to be water filled.

Compaction results from loads or stress forces applied to the soil as well as shear forces. When soil within the root zone of a plant, including a tree, is compacted through either pedestrian or vehicular traffic, or by the heavy weight of stored materials or machinery, the ability of water and oxygen to penetrate the soil around the roots of living plants is compromised. Whilst tree roots are typically found in the top 600mm of the soil horizon, vehicle traffic, in particular may cause significant compaction at depths of 150–200 mm (the area in which most absorbing roots are located). (Refer Tree Function Note above).

The degree of soil compaction will depend on weight of vehicles, number of movements, soil moisture levels and clay content. Soil handling, stockpiling and transporting also tend to lead to the breakdown of soil structure and thus to soil compaction. Vibration, as a result of frequent traffic or adjacent construction activities, will also cause compaction of soil.

Contrary to the commonly held myth that all trees have tap roots, tree roots are typically located within the top 600mm of soil. Just as leaves perform the vital function of photosynthesis, tree roots are vital for the primary functions of anchorage, storage, absorption and conduction. Larger tree roots fulfil the main functions of anchorage, storage and conduction and smaller more fibrous tree roots, which grow primarily at the end of the main woody roots, fulfil a vital role in absorbing oxygen, essential mineral elements and moisture from the soil, often through a symbiotic relationship with soil borne fungi referred to as Mycorrhizae; the extent of root loss has the potential to jeopardise any or all of these main functions and most importantly may compromise the structural integrity of an established tree and its associated potential OH&S risk of failure occurring; any OH&S risk of potential failure in a high use area such as public roads, is noteworthy for all the wrong reasons and should be of major concern and avoided at all times. (Refer Appendix 2, Tree Function Note).

Figure 26: Gas exchange in woody tissues: the diffusion of gases into and out of a particular region²⁰



¹⁹Londsdale, David, Principles of Tree Hazard Assessment and Management Tree Hazard Assessment & Management TSO (The Stationery Shop, PO Box 29, Norwich, NR3 1GN)

²⁰Jaluzot, Anne, Trees and Design Action Group UTD2 Presentation, Melbourne, 23.02.2016

Appendix 3: Explanatory Notes and Terminology

Criteria for tree retention and removal

Assessment and recommendations for tree removal or retention including trees located on development sites has been made in consideration of the following definitions and criteria from British Standard: BS 5837:2005²¹ which are referred to on p2 of the Australian Standard AS 4970-2009:

Criteria for tree removal

Category R: Those in such condition that any existing value would be lost within 10 years and which should, in the current context, be removed for reasons of sound arboricultural management

Criteria:

- Trees that have a serious, irremediable, structural defect, such that their early loss is expected due to collapse, including those that will become unviable after removal of other R category trees (i.e. where, for whatever reason, the loss of companion shelter cannot be mitigated by pruning)
 - Trees that are dead or are showing signs of significant, immediate, and irreversible overall decline
 - Trees infected with pathogens of significance to the health and/or safety of other trees nearby (e.g. disease) or very low quality trees suppressing adjacent trees of better quality
- NOTE: Habitat reinstatement may be appropriate (e.g. R category tree when used as a habitat tree)

Considerations for tree retention on a development site may include the following criteria and be identified as such in this report:

Category A:

Definition: Those of high quality and value: in such a condition as to be able to make a substantial contribution (a minimum of 40 years is suggested)

Criteria:

- *Mainly arboricultural values*
Tree that are particularly good examples of their species, especially if rare or unusual, or essential components of groups, or of formal or semi-formal arboricultural features (e.g. that dominant and /or principal trees within an avenue).
- *Mainly landscape values*
Trees, groups or woodlands /scrublands which provide a definite screening or softening effect to the locality in relation to views into or out of the site, or those of particular visual importance (e.g. avenues or other arboricultural features assessed as groups).
- *Mainly cultural values, including conservation*
Tree, groups or woodlands of significant conservation, historical, commemorative or other value (e.g. veteran trees or wood-pasture).

Category B

Definition: Those of moderate quality and value: those in such a condition as to make a significant contribution (a minimum of 20 years is suggested)

Criteria:

- *Mainly arboricultural values*
Trees that might be included in the high category but are downgraded because of impaired condition (e.g. presence of remediable defects including unsympathetic past management and minor storm damage).
- *Mainly landscape values*
Trees present in numbers, usually as groups or woodlands, such as that they form distinct landscape rating than they might as individuals but which are not, individually, essentially components of formal, or semiformal arboricultural features (e.g. trees of moderate quality within an avenue that includes better. A category specimens) or, trees situated mainly internally to the site, therefore individually having little visual

²¹ British Standard: BS 5837:2005 - Trees in relation to construction – recommendations.

impact on the wider locality.

- *Mainly cultural values, including conservation*
Trees with clearly identifiable conservation or other cultural benefits.

Category C:

Definition: Those of low quality and value: currently in adequate condition to remain until new planting could be established (a minimum of 10 years is suggested), or young trees with a stem diameter below 150mm. Criteria:

- *Mainly arboricultural values*
Trees not qualifying in higher categories
- *Mainly landscape values*
Trees present in groups or woodlands, but without this conferring on them significantly greater landscape value, and/or trees offering low or only temporary screening benefit
- *Mainly cultural values, including conservation*
Trees with very limited conservation or other cultural benefits

Note: Whilst C category trees will usually not be retained where they would impose a significant constraint in development, young trees with a stem diameter of less than 150mm should be considered for relocation should they be suitable.

For the purposes of this report hazard and risk have been determined as follows:

Hazard²²

Situation, condition or thing that may be dangerous: (1) In tree management, a tree or tree part that is likely to fail and cause damage or injury, and the likelihood exceeds an acceptable level of risk. (2) In tree care or forestry operations, the presence of a condition or situation that may cause harm or injury to workers.

Hazard and Risk²³

Hazard is 'Disposition of a thing, a condition or a situation to produce injury', whereas risk is 'the chance of something adverse happening'. Risk is the probability that harm may occur both magnitude of hazard and the probability of occurrence can to some extent be quantified and then combined so as to provide a risk assessment. Hazard and risk or target and target zone and maybe assessed in this report in relative terms to a person, persons, property or infrastructure.

Probability²⁴

The confidence that some event will happen, measured or estimated on a scale of 0 to 1. Zero probability means improbability, a probability of 1 means certainty, a probability of 1/2 is sometimes called fifty-fifty chance or an even chance.

There are rules of addition and multiplication in probability theory. In tree-failure risk assessment the probability that the three components will combine in a common outcome is the product of their independent probabilities²⁵.

Targets (Target Zone)²⁶

In tree risk assessment (with slight misuse of normal meaning) persons or property or things of value which might be harmed by mechanical failure of the tree or by objects falling from it.

Target²⁷

People, property or activities that could be injured, damaged or disrupted by tree failure.

²² Glossary of Arboricultural Terms, International Society of Arboriculture

²³ Lonsdale, David. Principles of Tree Hazard Assessment and Management: Published TWO, 2009

²⁴ Collins Australian Mathematics Dictionary. Collins Dove. Reprinted 1994

²⁵ Quantified Tree Risk Assessment used in the management of amenity trees. Ellison, Michael J.

²⁶ Quantified Tree Risk Assessment used in the management of amenity trees. Ellison, Michael J.

²⁷ Glossary of Arboricultural Terms, International Society of Arboriculture

Australian Standards

Australian Standards which may apply when working on a development site within a development site may include the following:

- AS - 4970:2009 - Protection of trees
- AS - 1319:1994 - Safety signs for the occupational environment
- AS - 2303:2015 - Tree stock for landscape
- AS - 4373:2007 - Pruning of amenity trees
- AS - 4454: 2012 - Composts, soil conditioners and mulches
- AS - 4687:2007 - Temporary fencing and hoardings
- AS - 4419:2003 - Soils for landscaping and garden use

Preliminary Tree Assessment²⁸

The preliminary assessment of the trees should take place at the beginning of the project, once any site surveys have been completed. The purpose of this assessment is to provide quantitative and qualitative information on the trees. All trees included in the site survey should be numbered and assessed by the project arborist as the basis for deciding which trees are suitable for retention.)

Preliminary Arboricultural Report²⁹

Tree protection is most effective when considered at the earliest stage of development planning. The process will require reports at different stages. The most crucial reports are the Preliminary Arboricultural Report and the Arboricultural Impact Assessment.

The preliminary report is not intended to be the comprehensive tree protection report. This information is to be used by planners, architects and designers, in conjunction with any planning controls and other legislation, to develop the design layout in such a way that trees selected for retention are provided with enough space. The preliminary arboricultural report should guide the development layout.

Arboricultural Impact Assessment³⁰

The arboricultural impact assessment will be prepared once the final layout is complete. The report will identify trees to be removed, retained or transplanted. The report will identify possible impacts on trees to be retained. The report will explain design and construction methods proposed to minimize impacts on retained trees where there is encroachment into the calculated TPZ (refer to Clause 3.3.2 of Aust. Std 4970-2009). It will recommend measures necessary to protect the trees throughout all demolition and construction stages. Review of architectural, services and landscape plans should be included to provide an accurate impact assessment. If these plans are not available for review, it should be clearly stated in the report. Specification of tree protection measures will be included in construction documentation (refer to Section 4 of Aust. Std 4970-2009).

The report will include a tree protection plan (drawing) showing the TPZs for trees being retained taking into account the matters referred to in Section 3 of Aust. Std 4970-2009 and other protection measures. Groups of trees with overlapping TPZs may be included within a single protection area. A copy of this plan will form part of the development plans.

The tree protection plan should be included in subsequent construction documentation. The location of tree protection measures should also be shown on other documents such as demolition, bulk earth works, construction and landscape plans.

PLANNING

²⁸ Aust. Std 4970-2009 – Protection of trees on development sites, 2.3.2

²⁹ Aust. Std 4970-2009 – Protection of trees on development sites, 2.3.3

³⁰ Aust. Std 4970-2009 – Protection of trees on development sites, s2.3.5

Site survey

A detailed topographical survey should be made showing all existing site features.

NOTE: This should be made by a registered surveyor.

The survey plans should include:

- a) location of all individual trees or groups of trees and other vegetation;
- b) location of trees on land adjacent to the development site that may be impacted by the development;
- c) crown spread, measured and drawn to scale, defining the actual crown spread;
- d) other features, such as streams, creeks, watercourses, buildings and above and below ground services; and
- e) spot heights of ground level throughout the development site and specifically including level at the base of individual trees as a basis for evaluating changes in soil level around retained trees.

Notes³¹

- Before commencing this survey, advice should be sought from the project arborist to confirm relevant items for inclusion in the survey.
- Other vegetation may need to be surveyed to meet specific provisions of the determining authority or legislation.

Tree Protection Plan³²

The approved tree protection plan must be available onsite prior to the commencement of and during works. The tree protection plan will identify key stages where monitoring and certification will be required.

A pre-construction meeting should be attended by the site manager, the project arborist and contractors to introduce the tree protection plan and its requirements.

TREE PROTECTION ZONES

Crown protection³³

Tree crowns may be injured by machinery such as excavators, drilling rigs, cranes, trucks, hoarding installation and scaffolding. The TPZ may need to include additional protection of the above ground parts of the tree.

Where crown protection is required, it will usually be located at least one metre outside the perimeter of the crown (see Figure 2). The erection of scaffolding may require an additional setback from the edge of the crown.

Crown protection may include pruning, tying-back of branches or other measures. If pruning is required, requirements are specified in AS 4373 and should be undertaken before the establishment of the TPZ. NOTE: Pruning may require approval from the determining authority

Root protection zone (RPZ)³⁴

A specified area below ground and at a given distance from the trunk set aside for the protection of tree roots to provide for the viability and stability of a tree to be retained where it is potentially subject to damage by development.

NOTE: Establishment of these areas may include root investigation and mapping, root pruning and installation of root barriers or other protection measures at the edge of the RPZ to prevent conflict between roots and works.

Structural root zone (SRZ)³⁵

³¹ Aust. Std 4970-2009 – Protection of trees on development sites, s2.3, s2.3.1

³² Aust. Std 4970-2009 – Protection of trees on development sites, s5.2

³³ Aust. Std 4970-2009 – Protection of trees on development sites, s3.3.6

³⁴ Aust. Std 4970-2009 – Protection of trees on development sites

³⁵ Aust. Std 4970-2009 – Protection of trees on development sites, s1.4.5

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. 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.

Tree protection zone (TPZ)

A specified area above and below ground and 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 stability of a tree to be retained where it is potentially subject to damage by development³⁶.

The tree protection zone (TPZ) is the principal means of protecting trees on development sites. The TPZ is a combination of the root area and crown area requiring protection. It is an area isolated from construction disturbance, so that the tree remains viable. The TPZ incorporates the structural root zone (SRZ) (refer to Clause 3.3.5)³⁷.

TPZ Encroachment considerations

Encroachment within TPZ is considered³⁸:-

- Minor if encroachment is less than 10% of the TPZ
- Major if encroachment is greater than 10% or inside the SRZ

Trunk and branch protection

Where necessary, install protection to the trunk and branches of trees as shown in Figure 4. The materials and positioning of protection are to be specified by the project arborist. A minimum height of 2m is recommended. Do not attach temporary powerlines, stays, guys and the like to the tree. Do not drive nails into the trunks or branches.

Ground protection³⁹

If temporary access for machinery is required within the TPZ ground protection measures will be required. The purpose of ground protection is to prevent root damage and soil compaction within the TPZ. Measures may include a permeable membrane such as geotextile fabric beneath a layer of mulch or crushed rock below rumble boards as per Figure 4. These measures may be applied to root zones beyond the TPZ.

Explanatory Note:

Assessment terminology:

Diameter at Breast Height - DBH⁴⁰

The nominal trunk diameter at 1.4 m above ground level determined from the circumference of the trunk divided by pi (π) (see Appendix A).

Height

Estimate measure of tree height unless specified

Spread

Distance of the total canopy measured in a straight north south line at ground level

³⁶ Aust. Std 4970-2009 – Protection of trees on development sites s1.4.7

³⁷ Aust. Std 4970-2009 – Protection of trees on development sites s3.1

³⁸ Refer Aust. Std AS 4970-2009, 3.3.4 TPZ Encroachment considerations p11

³⁹ Aust. Std 4970-2009 – Protection of trees on development sites, s 4.5.2

⁴⁰ Aust. Std 4970-2009 – Protection of trees on development sites s1.4.3

Health

Vigour of a tree as evidenced by general appearance of crown density, leaf colour, presence of epicormic shoots, ability to withstand disease invasion including pathogens and presence of dieback in crown at the time of inspection. Vigour may vary according to seasonal weather patterns and rainfall received. Classifications are Excellent, Good, Fair and Poor.

Form or Condition

A tree can be in a state of good health but poor condition or form as determined by current site conditions such as location and affecting factors such as proximity to other trees and surrounding infrastructure, soils, structural defects all of which are not direct factors of the state of the tree's health. Factors affecting the form that the tree has taken as a result of its location within a woodlot or scrubland setting and its present ability to survive as a result of its exposure on removal of surrounding trees within that previous community. Classifications are Good, Fair, Declining, Poor and Hazardous.

Classification and Tree description

AGE:

SAPLING

Species to 2 years

JUVENILE

Juvenile tree between 2 – 5 years

SEMI-MATURE

Tree is still growing

MATURE

Species has reached expected size and /or has begun to reproduce.

(Tree maybe classified as mature after it has reached near stable size or biomass above and below ground and maybe considered mature for > 90% of its lifespan)

SENESCENT

Over mature and signs are present of irreversible decline and decreasing biomass

HEALTH:

EXCELLENT

Exceptional specimen. Crown full and balanced. Foliage is entire with good colour. Minimal or no pathogen damage.

GOOD

Crown is full (can be unbalanced). Foliage is entire with good colour. Minimal or no pathogen damage.

FAIR

Tree has < 30% deadwood. Canopy can be unbalanced. Foliage generally with good colour, may be some discolouration present. Minor pathogen damage present (Typical for species in location)

POOR

Tree has >30% deadwood. Foliage may be discoloured or distorted and stress symptoms maybe apparent which could lead to decline of tree.

DEAD

Tree is dead.

FORM:

EXCELLENT

Excellent branch attachment, no structural defects. Trunk sound. No damage to roots and good root buttressing present

GOOD

Good branch attachment and or no minor structural defects. Trunk sound or minor damage. No damage to roots and or good buttressing.

FAIR

Some minor structural defects and or minor damage to trunk. Bark may be missing & cavities could be present. Minor damage to roots.

POOR

Major structural defects and or trunk damage and or girdling or damaged roots that are problematic.

HAZARDOUS

Tree poses immediate hazard potential that should be rectified as soon as possible.

PRIORITY CLASSIFICATION AND PROCESS DESCRIPTION

No.s	1	2	3
Definition	HIGH	PRIORITY	MAINTENANCE
Action Required	Immediate	12 months – 2 years	3 years / as per maintenance programming
Description	<i>Tree is dead, dying or poses immediate hazard potential to people or property.</i>	<i>May represent minor hazard potential to people or property [e.g. Deadwood, trip hazard] or may present damage to property.]</i>	<i>Preventative maintenance to anticipate and minimise potential for future hazard to people or property. May be routine maintenance</i>

Definition	Process Description
Removal	Complete tree removal leaving stump as close as possible to ground level. Recommended process will include chipping of all foliage limbs and timber and reinstatement of work site. Recommendation typically based on tree being assessed as representing a health and safety concern [Dead, dying, structurally unsound, unstable, poor form]
Remove and grind	Complete tree removal to include grinding of stump to a depth of 75 millimetres unless otherwise specified. Recommended process will include chipping of all foliage limbs and timber and reinstatement of work site. Stump site will be cleaned of all grinding debris and sawdust and backfilled with premium topsoil free from weeds.
Crown Clean (Deadwood)	Removal of all major/significant deadwood and dead branches up to [and including] 30 millimetres in diameter in trees overhanging pedestrian or vehicular areas or removal of dead branches > 50mm diameter in canopy of trees located in parkland or similar area unless otherwise specified.
Crown Clean (General pruning)	Recommended pruning process will include removal of broken, crossing, rubbing, diseased, stressed or dying branches or limbs with poor attachment. Additional work process may include pruning to define leaders, balance the crown, reduce weight load, or clear the tree from obstructions. In summary, to rectify, as far as is possible, any structural defects and eliminate undesirable growth or deadwood.
Crown Reduction (Canopy reduction)	Recommended pruning process may include light and general pruning typically to encompass removal of up to 15% but no more than 25% of the leaf-bearing crown. By definition the unique shape and form of the tree will not be altered or compromised by the pruning process. Typically, the consulting arborist will nominate the reduction percentage [%] appropriate to species, condition and assessment. Unless otherwise specified the default reduction shall not exceed 25% of the total canopy, nor leave the canopy with unbalanced form.
Crown Raising (Canopy lift)	Pruning processes may involve the raising of the tree's lower canopy to a height specified in metres. Typically, the process is performed to provide for pedestrian and or vehicular clearance and unless otherwise specified the default parameters will be to provide 2 metres clearance from ground level or as specified by local or state government regulation. From time to time pruning requirements may be altered to accommodate various site specific requirements as advised by the consulting arborist accordingly.
Crown Restoration	Pruning process will encompass crown restoration and remedial works where the tree has been previously lopped or otherwise damaged. Not feasible when tree has extensive decay and should only be considered when there is evidence of healthy re- growth. When performed correctly the process of remedial pruning will most likely take several years to complete.
Hanger Limb	Pruning process may be restricted to the removal of any hanger/s or dangerous/dead/dying limbs and will typically involve the removal of a single limb. In some instances, removal of an individual limb may be necessary to accommodate an obstruction and the consulting arborist will advise accordingly.
Directional Pruning	Pruning process will be restricted to pruning canopy away from buildings/service wires/property boundary and will typically be performed to avoid future growth in these areas. Where appropriate future growth will be directed away from obstruction by selected pruning so as to encourage the development of the growth of new leaders.

Boundary Pruning	In every situation EVERY EFFORT should be made to obtain the relevant authorisation to perform pruning to standard - AS 4373-2007 Pruning of amenity trees - so as to avoid "lopping" limbs to the immediate boundary. As with directional pruning optimum results will be achieved when it's feasible to eliminate undesirable growth and direct future growth. If authority to enter and work in neighbouring property is not forthcoming recommended pruning will be restricted to access for pruning works on client's property and work standards will be correspondingly comprised. Removal of significant foliage or branch structure which will severely compromise the longterm health or stability of a tree is contrary to AS 4373-2007 - Pruning of amenity trees and is never considered an appropriate solution. Please refer to the consulting arborist for further advice.
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USEFUL LIFE EXPECTANCY (ULE)

Scale: 0 yrs 5yrs 5 – 20yrs 21 – 50yrs >50yrs

Useful Life Expectancy: Central theme is that in a planning context the length of time a tree can be expected to be usefully retained is the most important consideration. ULE is a guide or measure of tree life expectancy and how trees could be expected to be retained safely and usefully in normal circumstances [i.e. when not subject to abnormal or adverse conditions such as mechanical interference such as property development or impact by machinery etc]. It is based on a number of obvious management assumptions and the fundamental principles of usefulness in the landscape.

General Terms

AS 4373 – 2007 Pruning of amenity trees

The intention of this Standard is to encourage pruning practices and procedures that reduce the risk of hazard development, branch failure, pathogen infection and premature tree death.

AS 4970 – 2009 Protection of trees on development sites

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.

Amenity trees⁴¹

Trees with recreational, functional, environmental, ecological, social, health or aesthetic value rather than for production purposes.

Aerial Inspection

Arborist inspection within upper tree canopy carried out by climber/arborist

Arborist⁴²

The person with training to AQF Level 3 in Arboriculture, or above, or equivalent recognized and relevant experience that enables the person to perform the tasks required by Standard 4373-2007.

Consulting Arborist

A person with training to AQF Diploma V in Arboriculture, or above or equivalent recognized and relevant experience in excess of five years which enables the consultant to prepare arborist reports as required by local council or other government or regulatory authority including courts of law.

Tree worker⁴³

A worker who through related training (minimum AQF Level-2 in arboriculture) or equivalent recognized and relevant on-the-job experience, has demonstrated competence in pruning according to Standard.4373-2007.

⁴¹ Aust. Std AS4373-2007 – Pruning of amenity trees.

⁴² Aust. Std AS4373-2007 – Pruning of amenity trees

⁴³ Aust. Std 4970-2009 – Protection of trees on development sites

Work⁴⁴

Any physical activity in relation to land that is specified by the determining authority.

PRUNING TERMINOLOGY

Pruning to Australian Standard 4373-2007- Pruning of amenity trees

Please refer to the Standard for detail.

Briefly tree works should be carried out as follows:

- For branch removal - a final cut shall be made as close as possible to the branch collar without cutting into the branch collar or leaving a protruding stub.
- Trees should be pruned to maintain their natural habit with the exception of specific types of pruning⁴⁵.
- When pruning a tree, as little as possible should be removed. For each tree or group of similar trees, the amount to be removed shall be specified prior to commencement of work. Consideration should be given to the species, health, age, condition and location of the tree as well as reason for pruning, location of foliage to be removed and size of cuts. Care should be taken to avoid excessive pruning. Generally, pruning works should not exceed 15% of the total tree. For branch removal, a final cut shall be made as close as possible to the branch collar without cutting into the branch collar or leaving a protruding stub. As a general rule no branch greater in size than 30% of the size of the leader should be removed.
- Climbing spikes should only be used if the tree is to be removed or in the event of an emergency.

Lopping and topping

Lopping⁴⁶ and topping⁴⁷ are unacceptable practices for the following reasons:

- a) They increase the rate of shoot production and elongation.
- b) The resulting regrowth is weakly attached and becomes prone to failure or collapse.
- c) The stubs may decay.
- d) The natural habit of the tree is destroyed.
- e) They may reduce the lifespan of the tree.
- f) They predispose trees to fungal infections and insect attack.

*Lopping*⁴⁸: The practice of cutting branches or stems between branch unions or internodes.

Tree Works to remove in excess of 50% of the tree canopy and/or structure including pruning which is not to the collar resulting in exposed stubs. 'Lopping' is poor pruning practice and is contrary to Australian and International Pruning Standard 4373-1996

It is generally accepted that 'lopping' will shorten the length of a tree's life and may lead to the decline and ultimate death of a tree.

Topping / heading back / lopping involves cutting back to a stub, bud or a lateral branch not large enough to assume apical dominance. Severe heading causes branch dieback, decay and sprout production from the cut ends, resulting in a potentially dangerous situation once the sprouts become large and heavy. Topping or heading back is not recommended pruning practice. No more than 25% of the tree canopy should be removed in any one year. In most cases much less pruning is required⁴⁹.

*Topping*⁵⁰: Reducing the height of a tree through the practice of lopping.

⁴⁴ Aust. Std 4970-2009 – Protection of trees on development sites, s1.4.9

⁴⁵ Pruning to Australian Standard 4373-2007- Pruning of amenity trees, Sections 7, 8 and 0

⁴⁶ Aust. Std 4373-2007 - Clause 3.31

⁴⁷ Aust. Std 4373-2007 - Clause 3.44

⁴⁸ Aust. Std AS4373-2007 – Pruning of amenity trees

⁴⁹ ISA Arborist' Certification Study Guide 2001

⁵⁰ Aust. Std AS4373-2007 – Pruning of amenity trees

Root Pruning

Roots are responsible for the uptake of nutrients and water and for anchoring and supporting the tree in the ground. The pruning of roots may place the tree under stress, allow entry of pathogens, including root-rotting fungi and may destabilize the tree.

Specialist advice from a person with a minimum AQF Level 4 in arboriculture should be sought before any root pruning occurs. Where possible, the root to be pruned should be located and exposed using minimally destructive techniques such as hand-digging, compressed air or water-jetting, or non-destructive techniques such as ground penetrating radar. All cuts shall be clean cuts made with sharp tools such as secateurs, pruners, handsaws, chainsaws or specialized root pruning equipment.

The effects of root pruning are not always predictable⁵¹. All root pruning shall be carried out in accordance with AS 4970-2009 – Protection of trees on development sites

REPORT TERMINOLOGY AND DEFINITIONS

The following definitions are stated in the *Glossary of Arboricultural Terms, International Society of Arboriculture 2011*, unless otherwise stated.

Abiotic: plant ailment caused by non-living, environmental or man-made agents

Barrier Zone: chemically defended tissue formed by the still living cambium, after a tree is wounded or invaded by pathogens to inhibit the spread of decay into new annual growth rings. Wall 4 in CODIT model. Contrast with reaction zone

Bifurcation: Natural division of a branch or stem into two or more stems or parts

Biotic: pertaining to non-human living organism/ biotic agent: a living organism capable of causing disease/ biotic disorder: disorder caused by a living organism

Bracket: British English term for fruiting body of a decay fungus. See *Conk*.

Codominant Structure: Stems or trunks of about the same size originating from the same position from the main stem⁵². When the stem bark ridge turns upward the union is strong; when the ridge turns inward the union is weak, a likely point of failure in storm or windy weather conditions or where increasing weight causes undue stress on the defective union⁵³.

CODIT: acronym for Compartmentalisation Of Decay In Trees (refer Compartmentalisation)

Compartmentalisation: Dynamic tree defence process involving protection features that resist the spread of pathogens and decay causing organisms⁵⁴. Natural defense process in trees by which chemical and physical boundaries are created that act to limit the spread of disease and decay organisms.

Compaction: Results from loads or stress forces applied to the soil as well as shear forces. Both foot traffic and vehicle traffic exert both forces on soils. Vehicle traffic may cause significant compaction at depths of 150–200 mm (the area in which most absorbing roots are located). The degree of compaction will depend on weight of vehicles, number of movements, soil moisture levels and clay content. Soil handling, stockpiling and transporting also tend to

⁵¹ Aust. Std AS4373-2007 – Pruning of amenity trees

⁵² s3.9, p6, Aust. Std AS4373-2007 – Pruning of amenity trees

⁵³ Aust. & International Pruning Std 4373-1996/Draft May 29th, 2006

⁵⁴ Aust. Std AS4373-2007 – Pruning of amenity trees

lead to the breakdown of soil structure and thus to compaction. Vibration as a result of frequent traffic or adjacent construction activities will also compact soils⁵⁵.

Compression wood: (1) in mechanics, the action of forces to squeeze, crush or push together any material (s) or substance(s); contrast with tension. (2) the ability of an internal combustion engine to contain or pressurized a combustible fuel - air mixture.

Conk: Fruiting body or nonfruiting body (sterile conk) of a fungus. Often associated with decay.

Crown: Portion of the tree consisting of branches and leaves and any part of the trunk from which branches arise⁵⁶.

Crown damage: The canopy of trees can be directly or indirectly damaged. Incorrect techniques of pruning such as lopping or flush cutting may produce wounds that are susceptible to infection by wood decay organisms. Similarly, mechanical damage to branches by machinery, etc. will also create wounds. Trees automatically respond to wounding and in doing so use stored sugars. Any wound places an additional load on trees that will inevitably be stressed during construction⁵⁷.

Damping: Damping occurs where energy is dissipated. In trees, damping occurs naturally in three main ways with aerodynamic damping of the leaves, internal damping in the wood and root zones, and with mass damping of the branches⁵⁸.

Deadwood: Dead branches within canopy of tree⁵⁹ Deadwood is a naturally occurring feature of most tree species and comprises dead or decaying branches within the canopy of a tree. Deadwood may have habitat value and require removal only according to the considered risk of its location, i.e. high use pedestrian area or damage to adjacent infrastructure.

Removal of deadwood is generally recommended only where it represents an unacceptable level of hazard. Consideration of the need for deadwood removal should take into account the occupancy of the target zone, i.e. high use pedestrian area or presence of infrastructure, possible damage to the tree during its removal as well as its conservation for habitat value. In some instances, retention of a reduced tree structure for habitat purposes maybe considered appropriate, especially when hollows are present.

Further reference: Principles of Tree Hazard Assessment. Lonsdale, David. TSO, 2009

Dead wooding: (Crown cleaning): The removal of dead branches⁶⁰. Recommendation to remove deadwood is for removal of all dead branches within tree canopy > 30mm diameter in trees which overhang pedestrian or vehicular areas and removal of all dead branches within tree canopy > 50mm diameter if trees are located in a Parkland or similar area.

Decay: The process of degradation of woody tissues by micro-organisms⁶¹.

Desiccation: Severe drying out. Dehydration.

Drip Line: Is the imaginary perimeter line at soil surface level which is directly below the outermost edge of the tree's foliage or canopy.

Epicormic bud : Latent or adventitious bud located at the cambium and concealed by the bark⁶².

⁵⁵ Aust. Std 4970-2009 – Protection of trees on development sites

⁵⁶ Aust. Std AS4373-2007 – Pruning of amenity trees

⁵⁷ Aust. Std 4970-2009 – Protection of trees on development sites, sB3.2

⁵⁸ James, Ken. The Bark, Arboriculture Australia, Vol 13, p5, Number 2, Winter 2011

⁵⁹ Aust. & International Pruning Std 4373-1996/Draft May 29th, 2006

⁶⁰ Aust. Std AS4373-2007 – Pruning of amenity trees

⁶¹ Aust. Std AS4373-2007 – Pruning of amenity trees

⁶² Aust. Std AS4373-2007 – Pruning of amenity trees

Epicormic shoots: Shoots produced from epicormic buds at the cambium of trunks or branches⁶³

Field Capacity: Maximum soil moisture content following the drainage of water due to the force of gravity.

Included bark: Inwardly formed bark within the junction of branches or codominant stems⁶⁴

Kino: Dark red to brown resin-like substance produced by trees in the genera Eucalyptus, Pterocarpus and Butea and related genera. Kino forms in the barrier zones. Large kino veins form in some tree in response to injury and infection⁶⁵.

Leaves: The main function of leaves is photosynthesis, that is, the production of sugars and oxygen. The sugars produced by the leaves (and any other green tissue) are the source of chemical energy for all living cells in the entire plant and as such are essential for the normal functioning and survival of the tree. Anything that directly or indirectly damages the leaves will interfere with photosynthesis⁶⁶.

Non-woody part of tree: 'organs that increase the surface area of vascular plants, thereby capturing more solar energy for photosynthesis'. ... maybe classified as microphylls (usually spine-shaped leaves with a single vein) or megaphylls (leaves with a highly branched vascular system)⁶⁷. Needles and leaves are major energy trapping organs of a tree. Flowers are modified leaves as they fit the definition of an organ⁶⁸.

Macropore: Relatively larger space between soil particles that is usually air-filled and allows for water movement and root penetration. Contrast with micropore.

Micropore: Space between soil particles that is relatively small and likely to be water filled

Mortality Spiral: Sequence of stressful events or conditions causing the decline and eventual death of a tree. Once in a mortality spiral trees are more likely to succumb to any further or additional stress factors such as drought, pest infestation or disease. (See definition Stress)

Necrosis: Localised death of tissue in a living organism

Occlusion (See wound): Shut in or out⁶⁹. Occlusion is the process of trees forming callus and clearwood over wounds⁷⁰

Pathogen: A disease-causing organism⁷¹

Pipe: Mud filled channel extending upwards from root/ stem zone of tree

Phototropism: Influence of light on the direction of plant growth. Tendency of plants to grow towards light.

Phloem: Plant vascular tissue that transports photosynthates and growth regulators. Situated on the inside of the bark, just outside the cambium. Is bidirectional (transports up and down). Contrast with xylem.

⁶³ Aust. Std AS4373-2007 – Pruning of amenity trees

⁶⁴ Aust. Std AS4373-2007 – Pruning of amenity trees

⁶⁵ Shigo, Alex A.: A new Tree Biology Dictionary 1986 Durham, New Hampshire 03824

⁶⁶ Aust. Std 4970-2009 – Protection of trees on development sites

⁶⁷ Campbell Reece Meyers, Biology (Aust. ed. 2006), 7th ed.. Pearson Benjamin Cummings

⁶⁸ Shigo, Alex A.: (2003), Modern Arboriculture Durham, New Hampshire 03824-3105, USA

⁶⁹ Collins English Dictionary

⁷⁰ O'Hara Kevin, Journal of Forestry, April/May 2007

⁷¹ Aust. Std AS4373-2007 – Pruning of amenity trees

Photosynthesis: Process in green plants (and in algae and some bacteria) by which light energy is used to form glucose (chemical energy) from water and carbon dioxide.

Reaction wood: Wood forming in leaning or crooked stems or on lower or upper sides of branches as a means of counteracting the effects of gravity. See compression wood and tension wood

Shrub: A woody plant similar to a tree except it is usually several-stemmed and smaller than a tree⁷².

Stem / Trunk: Organ which supports branches, leaves, flowers and fruit; may also be referred to as 'the trunk'⁷³.

Stress: In Plant Health Care, (1) a factor that negatively affects the health of a plant; a factor that stimulates a response. (2) in mechanics, a force per unit area⁷⁴.

Stress – acute: Disorder or disease that occurs suddenly and over a short period of time

Stress – chronic: Disorder or disease occurring over a longer time.

Tree: Long lived woody perennial plant greater than (or usually greater than) 3 m in height with one or relatively few main stems or trunks^{75,76}. A tree has 3 major organs – roots, stem and leaves⁷⁷

Vigor: Ability of a tree to sustain its life processes. The term 'vigour' in this document is synonymous with commonly used terms such as 'health' and 'vitality'⁷⁸. Inherent genetic capacity of a plant to deal with stress.

Vitality: Ability of plant to deal effectively with stress.

Watersprouts/ Epicormic growth (Usually multiple shoots): Shoots produced from epicormic buds at the cambium of trunks or branches⁷⁹. Grows 'from the stub ends and only grows from the outermost living tissue layer of that year's growth. They are weakly attached and prone to falling out or being blown off with the risk increasing markedly as they increase in size. When epicormic shoots arise from stub ends that are decaying, the chances of them falling out are significantly greater'⁸⁰.

Wound: An opening that is created when the bark is cut, removed or injured⁸¹.

NOTE: Pruning a live branch always creates a wound, even when the cut is properly made.

Xylem: Main water and mineral-conducting (unidirectional, up only) tissue in trees and other plants. Provides structural support. Arises (inward) from the cambium and becomes wood after lignifying. Contrasted with phloem.

SPECIES AND VEGETATION CLASSIFICATIONS:

Ecological Significance: Species which contributes to local biodiversity. Tree may also provide habitat value to local community, i.e. food source and shelter for local native fauna. A tree of high ecological value may refer to an

⁷² Shigo, Alex A.: *A new Tree Biology Dictionary* 1986 Durham, New Hampshire 03824

⁷³ Aust. Std AS4373-2007 – Pruning of amenity trees

⁷⁴ Aust. Std 4970-2009 – Protection of trees on development sites

⁷⁵ Aust. Std AS4373-2007 – Pruning of amenity trees

⁷⁶ Aust. Std 4970-2009 – Protection of trees on development sites

⁷⁷ Shigo, Alex A.: (2003), *Modern Arboriculture* Durham, New Hampshire 03824-3105, USA

⁷⁸ 1.4.8 Vigour Aust. Std 4970-2009 – Protection of trees on development sites

⁷⁹ Aust. Std AS4373-2007 – Pruning of amenity trees

⁸⁰ Qld Arboricultural Association

⁸¹ Aust. Std AS4373-2007 – Pruning of amenity trees

endemic species located in a significant landscape location such as Riparian Zone or form part of a wildlife corridor. Please refer to local council laws and orders.

Endemic Species: Species native to local area

Exotic Species: Non-native or indigenous to a region. Maybe invasive. Contrast with introduced species, native species and naturalized species⁸². Term maybe used to describe a species introduced to Australia from another country.

Indigenous Species: Species native to Australia.

Introduced species: Organisms not native to a region. Contrast with exotic species, native species and naturalized species⁸³.

Landscape Significance: Species significant to area including amenity, habitat and biodiversity value to property Please refer to local council laws and orders.

Native species: Plants indigenous to a region. Naturally occurring and not introduced by man. Contrast with exotic species, introduced species and naturalized species⁸⁴.

Naturalized species: Non-native species that has become established in a region and propagates without human assistance. Contrast with exotic species, introduced species and native species⁸⁵.

Protected Vegetation: Vegetation designated as protected by applicable local government authority or Queensland State legislature laws. Permission must be sought from the relevant authority prior to the commencement of specified tree works.

Riparian Zone Vegetation: Currently all marine plants in Queensland are afforded protection under the provisions of the Fisheries Act 1994 and, as part of the recent integration of provisions under this act, by the Sustainable Planning Act 2009 (SPA).

Special Significance: Tree which may represent but is not limited to historical, aboriginal or protected local, state or federal significance that may fall outside of local council tree laws. Such trees may include those listed for heritage, endangered ecological community or as threatened species. Classifications are Low, Moderate and High.

Streetscape Significance: Species providing visual significance within street and local area Please refer to local council laws and orders.

Weed Species: Species designated by relevant local government authority and/or Department of Primary Industries & Fisheries Queensland.

⁸² Glossary of Arboricultural Terms, ISA 2008

⁸³ Glossary of Arboricultural Terms, ISA 2008

⁸⁴ Glossary of Arboricultural Terms, ISA 2008

⁸⁵ Glossary of Arboricultural Terms, ISA 2008

Appendix 4: Company Detail



Independent Arboricultural Services

Independent Arboricultural Services, incorporated in May 2007, offers a completely independent arborist consulting and reporting service. Its directors and associated consultants bring extensive arboricultural knowledge gained over many years to this company. All staff hold Level V (Diploma of Arboriculture/Horticulture) to University qualifications. Specialised advice when required, such as provision of survey mapping or engineering advice and certification is sourced from reputable professional providers according to site requirements as per Australian Standard 4970-2009.

Statement of Goal

It is the goal of Independent Arboricultural Services to strive for continued improvement through the use of world's best arboricultural practice supported by ongoing education and exposure to leading industry experts and research throughout the world.

Mission Statement

It is the mission of Independent Arboricultural Services to provide timely, relevant and actionable consulting advice and practice based on the latest available and best scientific arboricultural knowledge.

Environmental Statement

Independent Arboricultural Services supports long term environmental sustainability sustainable sourced paper and ensuring all inks cartridges are recycled where possible.

Independent Arboricultural Services actively seeks to maintain a positive carbon footprint status and to that end is committed to protecting and preserving the environment, continuing to carry out tree planting, transplanting and replacement planting where practical, having planted in excess of 4000 trees in the first 2 years after its inception in May 2007 alone. Arboricultural recommendations involving the removal of tree/s will include replanting at a minimum ratio of 2 trees for any tree removed where possible. All arboricultural recommendations are made in accordance with world's best arboricultural practice and within the Australian Standards AS 4373-2007 Pruning of amenity trees and AS 4970 – Protection of trees on development sites so as to ensure optimal outcomes for all living trees.

Independent Arboricultural Services acknowledges the benefits of healthy trees with good vigour and vitality and actively promotes better understanding in the general community of the contribution that trees make to reducing greenhouse gasses, the contribution of trees to better water retention and the prevention of soil erosion, the ability of trees to provide protection to infrastructure by diffusing strong winds in weather events and the contribution of trees to general liveability within the urban environment.

It is an acknowledged fact that air temperature beneath a tree canopy is in excess of 5° Celsius lower than the surrounding ambient air temperature thereby reducing reliance on greenhouse gas producing airconditioners and coal fired power sources.

Independent Arboricultural Services - Disclaimer

Please Note – The material contained in this document has been prepared on an independent basis free of any bias and represents the honest opinion of the consulting arborist.

Tissue or soil samples have not been collected nor submitted for testing unless otherwise stated. Excavation is limited to minor earthworks and we submit this assessment on the basis that all data is based on visual inspection of the tree/s and its/their location, species, health and condition at the time of writing unless otherwise stated. Measurements and tree locations noted in this report are approximate and have not been determined by survey unless information and analysis has been provided by the consultant or such information is otherwise noted. Please request a more detailed arborist report if further information and analysis is required. Depending on site requirements, specific alternate specialist advice including engineering consultancy and certification maybe required in combination with this assessment. This assessment contains arborist advice and associated general information only and does not purport to provide other site specific specialist advice such as engineering certification unless arrangement to source such advice for inclusion in this assessment has been requested and authorised.

This report containing opinions, advice and recommendations based on information and data gathered from site inspections carried out by personnel from Independent Arboricultural Services as well as information provided by the client and/or its representatives, is to be relied on by the client in that context. It is assumed that all such information provided to Independent Arboricultural Services is correct. All recommended arboricultural works detailed in this assessment including pruning of tree canopy or roots, tree removal, tree transplantation or other associated works including stump grinding or the application of any prescribed treatment shall be carried out in accordance with applicable standards including Australian Standards AS 4373-2007- Pruning of amenity trees and AS 4970-2009- Protection of trees on development sites.

This report is subject to copyright laws and no part of it may be reproduced or used without the express written permission of the client or Independent Arboricultural Services, nor shall it be conveyed to the public through advertising, public relations, news, sales or other media without the written consent of the consultant and no responsibility will be accepted by Independent Arboricultural Services should such unauthorised use of this report be made. The consultant shall not be required to give testimony or to attend court by reason of this report unless subsequent contractual arrangements have been made including payment of additional fees for such services.

The invoice for this report will be issued to the person or entity as per the address advised at the time of confirmation of appointment. Assessment in this report is based on plans provided at the time of confirmation of engagement and report preparation. Additional time required for re-assessment of report detail due to subsequent re-issue of plans after report preparation will be subject to an additional fee which will be charged at our hourly rate. This report shall not be conveyed to any third party including regulatory authority/s until full payment of this invoice is received by Independent Arboricultural Services and a finalised report has been issued unless agreement to do so has been granted.

Factors including the absence of historical records or local knowledge, recognition of the variability of the integrity of a tree as a naturally living organism as well as the impact of conditions within its surrounds to which it maybe subject including the impacts of mechanical force and the occurrence of weather events, do not allow an arborist to guarantee the age of a tree, or the length of time a tree/s may live or such time as it /they may fail. There is no warranty or guarantee, expressed or implied that the problems or deficiencies of the plants or property in question may not arise in the future.