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Arboricultural Impact Assessment

61-65 Lucas Avenue
MOOREBANK NSW 2170

requested by
A & K Engineering Group

prepared by
Russell Kingdom
Qualified AQF5

20/06/2017

Principal:Russell Kingdom
Fully Insured: Public Liability $20M, Professional Indemnity $5M & Personal Accident.
Advanced Treescape Consulting is committed to providing a safe working environment for its employees in accordance with The Occupational Health & Safety Act NSW 2000.

INSTITUTE OF AUSTRALIAN CONSULTING ARBORICULTURISTS
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1.0 Proposal

A & K Engineering Group has commissioned Advanced Treescape Consulting to prepare an Arboricultural Impact Assessment at 61-65 Lucas Avenue, Moorebank. This site is located in the City of Liverpool Local Government Area where there is a Tree Preservation Order in force.

It is proposed to build residential development.

The subject site was inspected on 29/05/2017. The plans supplied are from 'Studio Rhizome'. The site plan in Appendix 1 illustrates the location of all surveyed trees.

This assessment has been carried out by Russell Kingdom: Graduate Diploma of Horticulture, Diploma of Horticulture, Diploma in Horticulture/Arboriculture - AQF5 (see Appendix 12).

2.0 Scope of Report

Assess the trees on site and the impact of the proposed development on the trees to be retained then make recommendations to ensure the impact on the retained trees is acceptable and complies with AS 4970-2009 Protection of Trees on Development Sites (Australian Standard®, 2009).

3.0 Site Inspection

The property faces the east and is a residential developed block. The land is basically flat.

This site has mainly exotic trees located on it. There were two Eucalypts located at the front of the site as well as street trees.

The soil texture was observed to be clay-based Blacktown soils[1]. *Blacktown soil limitations are* moderately reactive highly plastic subsoil, low soil fertility and poor soil drainage.

Drainage characteristics are considered to be good.

3.1 Site Assessment

- The microclimate is considered good as all trees appear to have reached their genetic potential.
- There are no re-reflected heat load issues.
- There are no sunlight level issues.
- There is no irrigation visible on the site.
- The site is exposed to all winds.

[1] (Chapman, et al., 2002)

4.0 Method of Assessment

An objective visual inspection was made from the ground of the health and condition of the trees based on the *Visual Tree Assessment* (VTA) technique described by (Mattheck, et al., 1994). The Tree Schedule (provided in Appendix 3) was based upon:

- Estimation of tree heights by Silva Clinomaster/Heightmeter™ plus visual estimates of canopy spreads.
- Distances of trees, etc. are measured using a Leica Disto™ D2 Laser Distance Meter.
- All photographs that appear in this report are unaltered originals which were taken during site inspection (see Appendix 2).
- Hazard ratings for all trees (see Appendix 4) refer to Failure Potential, Size of Defective Part & Target Rating = Hazard Rating is out of 12.
- Significance Rating (see '5.0 Tree Schedule'; '5.1 Assessment of VTA, Recommendations of Impact & Tree Protection Measures required by Proposed Plans' and Appendix 3).
- Calculation of Tree Protection Zones (TPZ) and Structural Root Zones (SRZ) using AS 4970-2009 *Protection of Trees on Development Sites* (Australian Standard®, 2009) (see Appendix 6 and 7).
- The application of TPZs and SRZs using AS 4970-2009 *Protection of Trees on Development Sites* (Australian Standard®, 2009) (see Appendix 8 and 9).
- Glossary (see Appendix 11).
- Trees were numbered with aluminium tags for easy identification.

It should be noted that this objective assessment and related VTA assessments are based upon health and condition that were observed at the time of inspection.

The recommendations of this report regarding retention, works or removal are based upon Safe & Useful Life Expectancy (SULE – see Appendix 10) and hazard ratings being applied.

This information has guided the conclusions in this report.

5.0 Tree Schedule

Appendix 3 summarises existing trees upon the site in terms of species, height and canopy spread, structural condition, health, hazard rating and SULE.

Appendix 4 provides explanations of abbreviations and assessment criteria.

The trees contained within the Tree Schedule (see Appendix 3) range from having short to long SULEs. These trees also have a broad range of hazard ratings which limits the retention of such trees within development sites.

5.1 Assessment of VTA, Recommendations of Impact & Tree Protection Measures required by Proposed Plans

Accepted tree management practices recommend removal of trees where SULE ratings are 3 (or listed as dead), and/or where hazard ratings are high [where ratings adapted from Matheny and Clark range from low=3 to dangerous=12] (Matheny, et al., 1994). A detailed explanation of SULE ratings is provided in Appendix 10. Height/Diameter Ratio should not exceed 1:30 (Mattheck, et al., 1994).

For Tree Protection Zones for each of the following trees refer to Clause 6.0 or Appendix 6 and 7. It should be noted that distance stated is a radius, not a diameter. AS 4970 states that an intrusion for the TPZ of less than 10% is considered minor. No intrusion into the TPZ is to exceed 20% of total TPZ area.

Note that:

1. **= VTA Assessment**
2. **= Impact of proposed plan**
3. **= TPZ Measures**

Tree 1: *Araucaria columnaris* (Cook Island Pine)

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 4.9m, with an SRZ of 2.5m. It is in good health and structural condition. Significance Rating: H. SULE: 2B.
2. This tree is located on the boundary. The proposed development will *not* be located within the full TPZ of this tree. Retain and protect.
3. TPZ fence is required as per Appendix 8.

Tree 2: *Eucalyptus moluccana* (Grey Box)

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 5.4m, with an SRZ of 2.8m. It is in good health and structural condition. This tree is unbalanced and has small deadwood. Significance Rating: H. SULE: 2B.
2. This is a street tree with powerlines to the north. This tree's full TPZ will not be impacted by the proposed development. Retain and protect.
3. TPZ fence is required as per Appendix 8.

Tree 3: *Eucalyptus robusta* (Swamp Mahogany)

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 3.4m, with an SRZ of 2.3m. It is in fair health and structural condition. This tree has tip die back, inclusive fork union and fungi in the roots. It has many surface roots and is a trip hazard. Significance Rating: M. SULE: 3B.
2. This tree's full TPZ will not be impacted by the proposed development. Retain and protect.
3. TPZ fence is required as per Appendix 8

Tree 4: *Syzygium luehmannii* (Riberry)

1. This tree fails the VTA (refer to Appendix 3 for details). It is not suitable to be considered for retention. Significance Rating: L. SULE: 3B.
2. This is a street tree. This tree's full TPZ will not be impacted by the proposed development. Retain and protect.
3. N/A.

Tree 5: *Callistemon viminalis* (Weeping Bottlebrush)

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 2.4m, with an SRZ of 2.1m. It is in good health and structural condition. This tree has epicormic shoots and has the crown raised. Significance Rating: L. SULE: 3B.
2. This is a street tree. This tree's full TPZ will not be impacted by the proposed development. Retain and protect.
3. TPZ fence is required as per Appendix 8.

Tree 6: *C. viminalis* (Weeping Bottlebrush)

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 2.0m, with an SRZ of 1.7m. It is in good health and structural condition. Significance Rating: L. SULE: 3B.
2. This is a street tree. This tree's full TPZ will not be impacted by the proposed development. Retain and protect.
3. TPZ fence is required as per Appendix 8.

Tree 7: *Mangifera indica* (Mango)

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 3.0m, with an SRZ of 2.3m. It is in good health and structural condition. This is a fruit tree. Significance Rating: M. SULE: 2B.
2. Removal is required to facilitate the proposed development plans.
3. N/A.

Tree 8: *Pittosporum undulatum* (Native Daphne)

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 2.4m, with an SRZ of 2.1m. It is in good health and structural condition. This tree has an inclusive fork union and small deadwood. Significance Rating: M. SULE: 2B.
2. This tree is located above the proposed basement entrance. Removal is required to facilitate the proposed development plans.
3. N/A.

Tree 9: *E. moluccana* (Grey Box)

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 5.4m, with an SRZ of 2.7m. It is in good health and fair structural condition. This tree has recent failure sites, small deadwood and the crown has been raised to the north. Significance Rating: H. SULE: 2B.
2. This tree is 4m to the boundary. The proposed basement is within the SRZ of this tree. This is an unacceptable impact of this tree. Removal is required to facilitate the proposed development plans.
3. N/A.

Tree 10: *E. moluccana* (Grey Box)

1. This tree fails the VTA (refer to Appendix 3 for details). It is not suitable to be considered for retention. Significance Rating: M. SULE: 3B.
2. This tree is 2m to the boundary.
3. N/A.

Tree 11: *Archontophoenix cunninghamiana* (Bangalow Palm)

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 3.0m**. It is in health and structural condition. Significance Rating: L. SULE: 2B.
2. This tree is <500mm to the fence. Removal is required to facilitate the proposed development plans.
3. N/A.

Tree 12: *A.cunninghamiana* (Bangalow Palm)

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 3.0m**. It is in health and structural condition. Significance Rating: L. SULE: 2B.
2. This tree is <500mm to the fence. Removal is required to facilitate the proposed development plans.
3. N/A.

Tree 13: *Melaleuca bracteata 'Gold'* (Melaleuca Revolution Gold)

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 2.0m, with an SRZ of 2.0m. It is in good health and structural condition. Significance Rating: L. SULE: 3B.
2. This tree is <400mm to the boundary and 1m to the pool. The removal of the pool will impact the SRZ of this tree. This will be an unacceptable impact. Removal of this tree is required to facilitate the proposed development plan.
3. N/A.

Tree 14: *Conifer sp.*

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 2.0m, with an SRZ of 1.5m. It is in fair health and good structural condition. Significance Rating: L. SULE: 3B.
2. This tree is 1m to the pool. The removal of the pool will impact the SRZ of this tree. This will be an unacceptable impact. Removal of this tree is required to facilitate the proposed development plan.
3. N/A.

Tree 15: *Murraya paniculata* (Orange Jessamine)

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 2.0m, with an SRZ of 1.5m. It is in good health and structural condition. Significance Rating: L. SULE: 3B.
2. This tree is <1m to the residence. The removal of the existing residence will impact the SRZ of this tree. This will be an unacceptable impact. Removal of this tree is required to facilitate the proposed development plan.
3. N/A.

Tree 16: *A. cunninghamiana* (Bangalow Palm)

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 2.0m**. It is in fair health and good structural condition. Significance Rating: L. SULE: 3B.
2. This tree is <1m to the residence. The removal of the existing residence will impact the SRZ of this tree. This will be an unacceptable impact. Removal of this tree is required to facilitate the proposed development plan.
3. N/A.

Tree 17: *A. cunninghamiana* (Bangalow Palm)

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 2.0m**. It is in fair health and good structural condition. Significance Rating: L. SULE: 3B.
2. This tree is <1m to the residence. The removal of the existing residence will impact the SRZ of this tree. This will be an unacceptable impact. Removal of this tree is required to facilitate the proposed development plan.
3. N/A.

Tree 18: *Cupressus macrocarpa 'Brunniana Aurea'* (Brunnings Golden Cypress)

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 2.0m, with an SRZ of 1.7m. It is in fair health and structural condition. This tree has been topped. Significance Rating: L. SULE: 3B.
2. This tree is ornamental and is located within the works zone. In can be replaced in the landscape plan. Removal of this tree is required to facilitate the proposed development plan.
3. N/A.

Tree 19: *C. macrocarpa 'Brunniana Aurea'* (Brunnings Golden Cypress)

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 2.0m, with an SRZ of 1.7m. It is in fair health and structural condition. This tree has been topped. Significance Rating: L. SULE: 3B.
2. This tree is ornamental and is located within the works zone. In can be replaced in the landscape plan. Removal of this tree is required to facilitate the proposed development plan.
3. N/A.

Tree 20: *C. macrocarpa 'Brunniana Aurea'* (Brunnings Golden Cypress)

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 2.0m, with an SRZ of 1.7m. It is in fair health and structural condition. This tree has been topped. Significance Rating: L. SULE: 3B.
2. This tree is ornamental and is located within the works zone. In can be replaced in the landscape plan. Removal of this tree is required to facilitate the proposed development plan.
3. N/A.

Tree 21: *A. cunninghamiana* (Bangalow Palm)

1. This tree fails the VTA. It is not suitable to be considered for retention. Significance Rating: L. SULE: 3B.
2. N/A.
3. N/A.

Tree 22: *C. viminalis* (Weeping Bottlebrush)

1. This tree passes the VTA. It is suitable to be considered for retention. This tree has a full TPZ of 2.5m, with an SRZ of 2.4m. It is in good health and fair structural condition. This tree has been lopped and has had the crown raised. Significance Rating: M. SULE: 2B.
2. This tree is 2.5m to the residence and domestic power lines are to the south. This tree is located within the works area. Removal of this tree is required to facilitate the proposed development plan. To be replaced in the landscape plan.
3. N/A.

**As stated in Section 3, clause 3.2, of AS 4970-2009 *Protection of Trees on Development Sites* (Australian Standard®, 2009), "The TPZ for palms or other monocots, cycads or tree ferns should not be less than 1m outside the crown projection".

In clause 3.35/Note 4 it states that "The RSRZ formula and graph do not apply to palms, other monocots, cycads and tree ferns".

5.2 Discussion

Trees 1 is a visually significant tree located just inside of the site boundary. The proposed works will not impact this tree's full TPZ. This tree is recommended for retention.

Tree 2, 3, 4, 5 & 6 are street trees which can be retained.

Tree 11 & 12 are *Archontophoenix cunninghamiana* (Bangalow Palm) trees will be impacted by the demolition of the existing house and pool. Their removal is required to facilitate the proposed development plans.

All other trees on the site are located within the proposed building footprint, which includes the basement car park.

Tree 9 is a *Eucalyptus moluccana* (Grey Box). This tree has had a recent crown failure. It also has its crown raised to the north. This tree lies within the proposed location of the belowground car park and would require removal. It is a community member of the Cumberland Plains Shale Woodland which is a Critically Endangered Ecological Community (EEC). Suitable replacement trees of the same species should be included in the landscape plan to ensure that there is no net loss of trees of this species on the site.

5.3 Tree Significance (Appendix 5)

- Tree 4, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 & 21 listed in this report are of low significance.
- Tree 3, 7, 8, 10 & 22 listed in this report are of medium significance.
- Tree 1, 2, 5, 6 & 9 listed in this report are of high significance.

6.0 Tree Protection Plan

a) Identify Further Potential Impacts on Trees by Proposed Plans

- It would be preferable that no fill soils be used in any TPZ unless approved by the Liverpool City Council.
- Soil cuts should be kept to a minimum near any TPZ unless approved by the Liverpool City Council.
- Services should not be located in or run through any TPZ unless approved by the Liverpool City Council.
- Site Office/Toilet, etc., are not to be located in any TPZ unless approved by the Liverpool City Council.
- Materials are to be stored away from any TPZ unless approved by the Liverpool City Council.
- Aeration of the soil is managed by the TPZ fencing.
- An area is to be set aside for tradespeople to wash down equipment away from any TPZ. The location of the wash down point should be approved by the Consultant Arboriculturist unless approved by the Liverpool City Council.

b) Tree Protection Zones using AS 4970-2009 (Australian Standard®, 2009)

DBH – Diameter at Breast Height (1.4 metres)
DGL – Diameter at Ground Level
TPZ = DBH (stem) x 12 (radius)
SRZ radius = $(D \times 50)^{0.42} \times 0.64$

See Appendix 6 and Appendix 7
Refer to Appendix 3 for TPZ and SRZ details

* Minimum TPZ is 2 metres – Maximum TPZ is 15 metres
\# Minimum SRZ is 1.5 metres

c) Tree Protection Works

- TPZ fences are to be erected around the retained trees (Tree 1, 2, 3, 4, 5 & 6) before construction commences (see Appendix 8 & 9).
- The distance from the tree trunk to the TPZ fence is specified in Appendix 3 and highlighted. N.B: This is a radius, not diameter.
- The TPZ fence is to be constructed of two (2) metres high temporary chain wire fencing. This is preferable to star pickets as it would require them to be hammered into the ground which could damage roots.
- This action will greatly reduce the stress on the trees. The TPZ fence should be left in place until the landscaping phase of construction begins.
- TPZ signage as per Appendix 8 to be attached to TPZ fencing.

d) Tree Works

Any tree work is to be carried out by a suitably qualified and insured Arborist (AQF 3) to AS 4373-2007 Pruning of Amenity Trees (Australian Standard®, 2007).

7.0 Tree Protection Stages

a) Works Prior to Demolition

TPZ fencing to be erected around retained trees as per Appendix 8.

b) Works During Demolition

There are no tree works to be carried out during demolition.

c) Earthworks

There will be earthworks to level the site. Any tree roots encountered within the works area need to be correctly terminated, which is cut by a hand saw and not smashed off with a backhoe bucket. Correctly terminating a root will ensure that the tree roots do not suffer from decay.

d) Construction Works

TPZ fencing to remain in place during construction.

e) Landscaping Phase

The TPZ fencing may be removed during the Landscaping Phase.

All trees removed should, where practicable, be replaced at the landscaping phase as part of the proposed Development Application (DA).

At the landscaping phase, the retained trees will not be impacted.

8.0 Conclusions

The proposed development will require the removal of all but 1 of the trees located within this site. This includes one tree which is a listed member of a Critically Endangered Ecological Community (EEC). With suitable same species replacement trees in the landscape plan, the number of EEC trees can be increased on the site which will be a positive outcome from this development.

9.0 Recommendations

Implement all recommendations contained in Clauses 5.1, 5.2, 6.0 & 7.0.

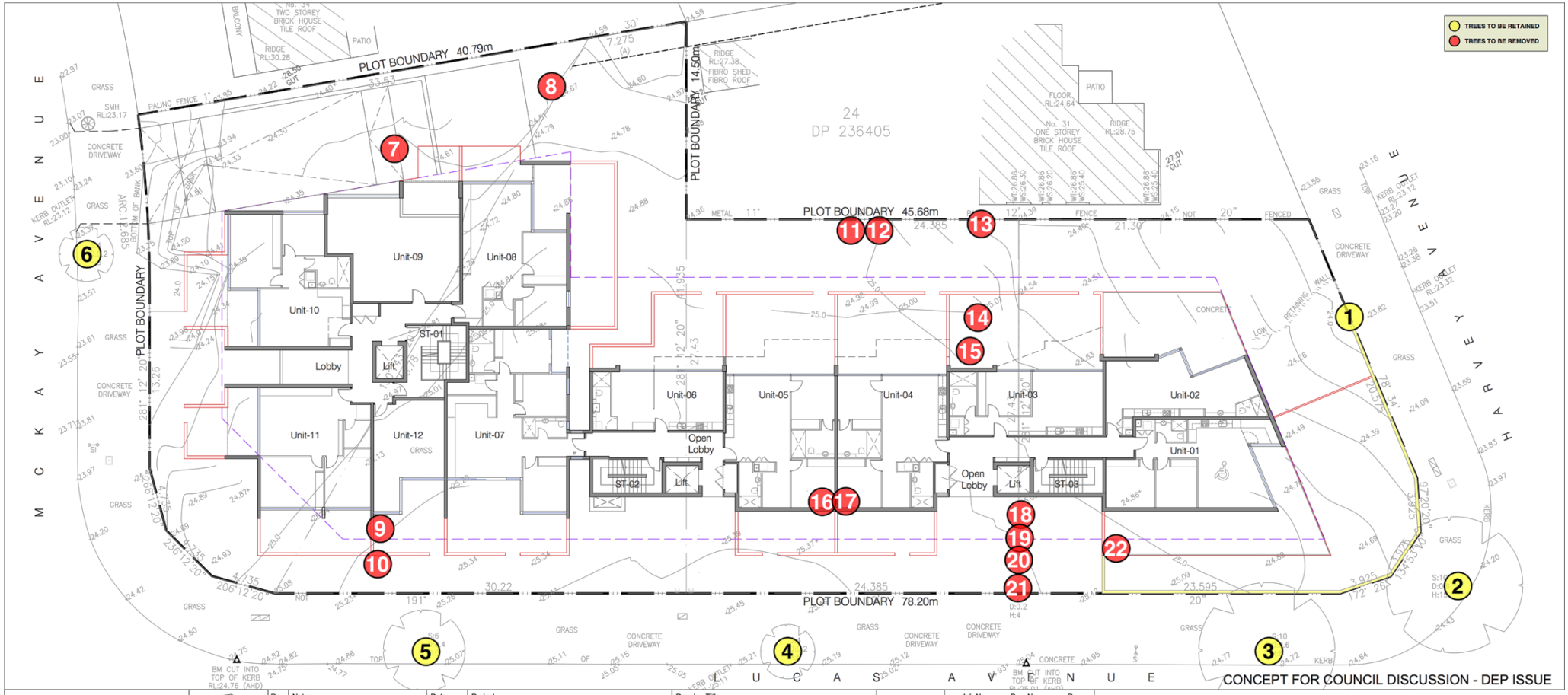
Reason: These recommendations have been developed in accordance with AS 4970-2009 to reduce the impact of the proposed development on the retained trees.

The trees to be removed have been assessed as being unsuitable to be considered for retention or they have an unacceptable impact from the proposed development.

Russell Kingdom
AQF5 Arboriculturist & Horticulturist

MIACA MAIH MAA
Graduate Diploma of Horticulture | Diploma of Horticulture | Diploma of Horticulture/Arboriculture

Appendix 1: Site Plan with Trees and Proposed Development



a&k engineering group	Studio Rhizome	Rev:	Notes:	Date:	Project:	Drawing Title:	Job No. / Dwg No. / Rev.
		A	Pre DA Issue	11.04.17	Proposed Five Storey Residential Flat Building 61-65 Lucus Av & 36 Mckay Av Moorebank NSW 2170	SITE PLAN (Sheet - 01)	16/007 002 OF 07 SHEETS B
		B	For Concept Landscape for DEP	22.05.17	Client: Mounir Tamer, Rabick Tamer, Fouad Hebous & Ahmed Tabbah	Drawn by: AK Date: 09.09.16 Scale: 1:200 @ A3	

Appendix 2: Photographs

Figure 1: Tree 4 - *S. luehmannii* (Riberry).

Figure 2: Tree 5 - *C. viminalis* (Weeping Bottlebrush).

Figure 3: Tree 6 - *C. viminalis* (Weeping Bottlebrush).

Figure 4: Tree 9 & 10 - *E. moluccana* (Grey Box).

Figure 5: Showing wounds in Tree 10.

Figure 6:Showing wounds in Tree 10.

Figure 7: Showing wounds in Tree 10.

Figure 8: Tree 18 & 19 - *C. macrocarpa 'Brunniana Aurea'* (Brunnings Golden Cypress).

Figure 9: Tree 11 & 12 - *A. cunninghamiana* (Bangalow Palm).

Figure 10: Tree 13 - *M. bracteata 'Gold'* (Melaleuca Revolution Gold).

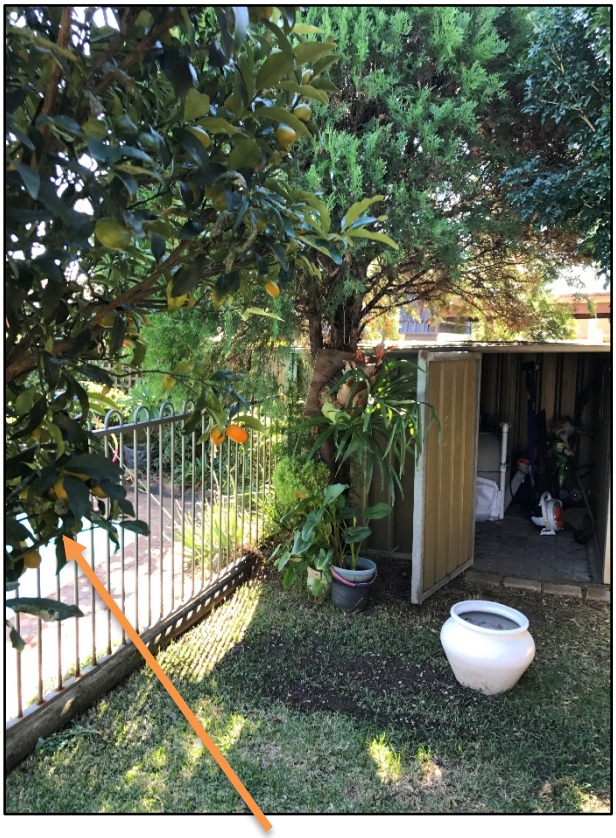


Figure 11: Tree 7 - *M. indica* (Mango).

Figure 12: Tree 15 - *M. paniculata* (Orange Jessamine).

Figure 13: Tree 18, 19 & 20 - *C. macrocarpa 'Brunniana Aurea'* (Brunnings Golden Cypress).

Figure 14: Tree 21 - *A. cunninghamiana* (Bangalow Palm).

Figure 15: Tree 22 - *C. viminalis* (Weeping Bottlebrush).

Figure 16: Tree 1 - *A. columnaris* (Cook Island Pine).

Figure 17: Showing Tree 2 -*E. moluccana* (Grey Box).

Figure 18: Showing surface roots of Tree 3, tripping hazard - *E. robusta* (Swamp Mahogany).

Figure 19: Another view of the surface roots of Tree 3, also showing fungi - *E. robusta* (Swamp Mahogany).

Figure 20: Close up of fungi in root of Tree 3 - *E. robusta* (Swamp Mahogany).

Appendix 3: Tree Schedule

ABBREVIATIONS: m-metres, **mm**-millimetres, **DBH**-trunk diameter @ 1.4m, **DGL**-trunk diameter at ground level, **VP**-very poor, **P**-poor, **F**-fair, **G**-good, **VG**-very good, **COT**-centre of trunk, **CD**-co-dominant trunk, **TD**-tri-dominant trunk, **QD**-4x trunk, **TL**-trunk lean, **TW**-trunk wound, **Insp**-inspect, **L**-longicorns, **E**-epicormic shoots, **K**-Kino, **FA**-forest architecture, **FR**-Forest Remnant, **dw**-deadwood small, **DW**-deadwood large, **TDB**-tip dieback, **PFS**-previous failure site, **RFS**-recent failure site, **BEW**-branch end weight, **MTU**-multi tree union, **MFU**-main fork union, **IFU**-inclusive fork union, **IMFU**-inclusive main fork union, **IMBU**-inclusive main branch union, **MBA**-Multiple branch attachments, **FB**-fruiting body, **BF**-bracket fungus, **U/C**-under canopy, **Decl**-declining, **B**-borers, **PD**-parrot damage, **LD**-leaf damage, **CMP**-chewing mouthpiece, **RW**-reaction wood, **H/D**-Height/Diameter ratio test (Mattheck, et al., 1994), **J**-juvenile, **YM**-young mature, **SM**-semi mature, **M**-mature, **OM**-over mature, **HFP**-high failure potential, **D**-dangerous, **VD**-very dangerous, **X**-no room to grow/unsuitable, **H**-habitat, **HB**-habitat box, **Rec.**-recommendation, **S**-save, **R**-remove, **T**-transplant, **C**-council determination, **W**-work needed to be carried out, **mon**-monitor, **TPO**-tree preservation order, **HV**-high voltage, **PL**-power lines, **VTA** (P-pass, F-fail) **Hazard Rating**-**3**=low hazard, **12**=dangerous, **N/A**-not applicable, **SULE**-safe & useful life expectancy.

TREE NO.	SPECIES	HEIGHT (m)	DBH (mm)	DGL (mm)	RADIUS OF FULL TPZ (m)	RADIUS OF FULL SRZ (m)	HEALTH/VIGOUR	STRUCTURAL CONDITION	CANOPY SPREAD (m) N S E W	AGE CLASS	COMMENTS	VTA	SIGNIFICANCE RATING	HAZARD RATING (3 - 12)	S.U.L.E	REC.
1	*Araucaria columnaris* (Cook Island Pine)	16	410	500	4.9	2.5	G	G	2 radial	M	On boundary.	P	H	4	2B	S
2	*Eucalyptus moluccana* (Grey Box)	15	450	650	5.4	2.8	G	G	2 4 6 6	M	PL to the north, unbalanced, dw, street tree.	P	H	4	2B	S
3	*Eucalyptus robusta* (Swamp Mahogany)	10	280	400	3.4	2.3	F	F	5 radial	M	TDB, IMFU, many surface roots, trip hazard, fungi in roots.	P	M	6	3B	S
4	*Syzygium luehmannii* (Riberry)	3	100	200	2.0	1.7	VP	F	1 radial	M	Street tree – Decl.	F	L	4	3B	S
5	*Callistemon viminalis* (Weeping Bottlebrush)	5	200	350	2.4	2.1	G	G	2 radial	M	Street tree, crown raised, E.	P	H	4	2B	S
6	*C. viminalis* (Weeping Bottlebrush)	5	TD 3x100 (170)	200	2.0	1.7	G	G	2 radial	M	Street tree.	P	H	4	2B	S
7	*Mangifera indica* (Mango)	5	250	400	3.0	2.3	G	G	3 radial	M	Fruit tree, exempt species, in building footprint (BFP).	P	M	4	2B	R
8	*Pittosporum undulatum* (Native Daphne)	6	200	340	2.4	2.1	G	G	3 radial	M	IFU, dw, in BFP.	P	M	4	2B	R
9	*E.moluccana* (Grey Box)	16	450	600	5.4	2.7	G	F	5 radial	M	RFSs, dw, 4m to boundary, crown raised to north, in BFP.	P	H	5	2B	R
10	*E. moluccana* (Grey Box)	14	400	550	4.8	2.6	P	P	2 6 4 6	M	E, canker in trunk, large wounds, 2m to boundary.	F	M	6	3B	R

ABBREVIATIONS: m-metres, **mm**-millimetres, **DBH**-trunk diameter @ 1.4m, **DGL**-trunk diameter at ground level, **VP**-very poor, **P**-poor, **F**-fair, **G**-good, **VG**-very good, **COT**-centre of trunk, **CD**-co-dominant trunk, **TD**-tri-dominant trunk, **QD**-4x trunk, **TL**-trunk lean, **TW**-trunk wound, **Insp**-inspect, **L**-longicorns, **E**-epicormic shoots, **K**-Kino, **FA**-forest architecture, **FR**-Forest Remnant, **dw**-deadwood small, **DW**-deadwood large, **TDB**-tip dieback, **PFS**-previous failure site, **RFS**-recent failure site, **BEW**-branch end weight, **MTU**-multi tree union, **MFU**-main fork union, **IFU**-inclusive fork union, **IMFU**-inclusive main fork union, **IMBU**-inclusive main branch union, **MBA**-Multiple branch attachments, **FB**-fruiting body, **BF**-bracket fungus, **U/C**-under canopy, **Decl**-declining, **B**-borers, **PD**-parrot damage, **LD**-leaf damage, **CMP**-chewing mouthpiece, **RW**-reaction wood, **H/D**-Height/Diameter ratio test (Mattheck, et al., 1994), **J**-juvenile, **YM**-young mature, **SM**-semi mature, **M**-mature, **OM**-over mature, **HFP**-high failure potential, **D**-dangerous, **VD**-very dangerous, **X**-no room to grow/unsuitable, **H**-habitat, **HB**-habitat box, **Rec.**-recommendation, **S**-save, **R**-remove, **T**-transplant, **C**-council determination, **W**-work needed to be carried out, **mon**-monitor, **TPO**-tree preservation order, **HV**-high voltage, **PL**-power lines, **VTA** (P-pass, F-fail) **Hazard Rating-3**=low hazard, **12**=dangerous, **N/A**-not applicable, **SULE**-safe & useful life expectancy.

TREE NO.	SPECIES	HEIGHT (m)	DBH (mm)	DGL (mm)	RADIUS OF FULL TPZ (m)	RADIUS OF FULL SRZ (m)	HEALTH/VIGOUR	STRUCTURAL CONDITION	CANOPY SPREAD (m) N S E W	AGE CLASS	COMMENTS	VTA	SIGNIFICANCE RATING	HAZARD RATING (3 - 12)	S.U.L.E	REC.
11	*Archontophoenix cunninghamiana* (Bangalow Palm)	6	150	300	3.0**	N/A	G	G	2 radial	M	<500mm to fence, in BFP.	P	L	4	2B	R
12	*A.cunninghamiana* (Bangalow Palm)	8	150	300	3.0**	N/A	G	G	2 radial	M	<500mm to fence, in BFP.	P	L	4	2B	R
13	*Melaleuca bracteata 'Gold'* (Melaleuca Revolution Gold)	4	50	100	2.0	2.0	G	G	1 radial	YM	<400mm to boundary, 1m to pool, in BFP.	P	L	4	3B	R
14	*Conifer sp.*	2	100	150	2.0	1.5	F	G	1 radial	YM	1m to pool, in BFP.	P	L	4	3B	R
15	*Murraya paniculata* (Orange Jessamine)	2	CD 2x50 (70)	100	2.0	1.5	G	G	1 radial	YM	<1m to residence, in BFP.	P	L	4	3B	R
16	*A. cunninghamiana* (Bangalow Palm)	3	100	200	2.0**	N/A	F	G	1 radial	YM	<1m to residence, in BFP.	P	L	4	3B	R
17	*A. cunninghamiana* (Bangalow Palm)	3	100	200	2.0**	N/A	F	G	1 radial	YM	<1m to residence, in BFP.	P	L	4	3B	R
18	*Cupressus macrocarpa 'Brunniana Aurea'* (Brunnings Golden Cypress)	2	<100	200	2.0	1.7	F	F	1 radial	YM	Topped, in BFP.	P	L	4	3B	R
19	*C. macrocarpa 'Brunniana Aurea'* (Brunnings Golden Cypress)	2	<100	200	2.0	1.7	F	F	1 radial	YM	Topped, in BFP.	P	L	4	3B	R
20	*C. macrocarpa 'Brunniana Aurea'* (Brunnings Golden Cypress)	2	<100	200	2.0	1.7	F	F	1 radial	YM	Topped, in BFP.	P	L	4	3B	R
21	*A. cunninghamiana* (Bangalow Palm)	2.5	80	200	2.0**	N/A	G	G	1 radial	J		P	L	3	2B	R

ABBREVIATIONS: m-metres, **mm**-millimetres, **DBH**-trunk diameter @ 1.4m, **DGL**-trunk diameter at ground level, **VP**-very poor, **P**-poor, **F**-fair, **G**-good, **VG**-very good, **COT**-centre of trunk, **CD**-co-dominant trunk, **TD**-tri-dominant trunk, **QD**-4x trunk, **TL**-trunk lean, **TW**-trunk wound, **Insp**-inspect, **L**-longicorns, **E**-epicormic shoots, **K**-Kino, **FA**-forest architecture, **FR**-Forest Remnant, **dw**-deadwood small, **DW**-deadwood large, **TDB**-tip dieback, **PFS**-previous failure site, **RFS**-recent failure site, **BEW**-branch end weight, **MTU**-multi tree union, **MFU**-main fork union, **IFU**-inclusive fork union, **IMFU**-inclusive main fork union, **IMBU**-inclusive main branch union, **MBA**-Multiple branch attachments, **FB**-fruiting body, **BF**-bracket fungus, **U/C**-under canopy, **Decl**-declining, **B**-borers, **PD**-parrot damage, **LD**-leaf damage, **CMP**-chewing mouthpiece, **RW**-reaction wood, **H/D**-Height/Diameter ratio test (Mattheck, et al., 1994), **J**-juvenile, **YM**-young mature, **SM**-semi mature, **M**-mature, **OM**-over mature, **HFP**-high failure potential, **D**-dangerous, **VD**-very dangerous, **X**-no room to grow/unsuitable, **H**-habitat, **HB**-habitat box, **Rec.**-recommendation, **S**-save, **R**-remove, **T**-transplant, **C**-council determination, **W**-work needed to be carried out, **mon**-monitor, **TPO**-tree preservation order, **HV**-high voltage, **PL**-power lines, **VTA** (P-pass, F-fail) **Hazard Rating-3**=low hazard, **12**=dangerous, **N/A**-not applicable, **SULE**-safe & useful life expectancy.

TREE NO.	SPECIES	HEIGHT (m)	DBH (mm)	DGL (mm)	RADIUS OF FULL TPZ (m)	RADIUS OF FULL SRZ (m)	HEALTH/VIGOUR	STRUCTURAL CONDITION	CANOPY SPREAD (m) N S E W	AGE CLASS	COMMENTS	VTA	SIGNIFICANCE RATING	HAZARD RATING (3 - 12)	S.U.L.E	REC.
22	*C. viminalis* (Weeping Bottlebrush)	4	TD 100 120 140 (210)	450	2.5	2.4	G	F	2 1 2 1	M	Lopped, PL to south (domestic), crown raised, 2.5m to residence, in BFP.	P	M	4	2B	R

**As stated in Section 3, clause 3.2, of AS 4970-2009 Protection of Trees on Development Sites (Australian Standard®, 2009), "The TPZ for palms or other monocots, cycads or tree ferns should not be less than 1m outside the crown projection".

In clause 3.35/Note 4 it states that "The RSRZ formula and graph do not apply to palms, other monocots, cycads and tree ferns".

Appendix 4: Notes on Tree Assessment

Key	Criteria	Comments
Tree No	Must relate to the number on your site diagram	
Species	Botanical name and common name of Tree	
Diameter of trunk	DBH Diameter at Breast Height (1.4 metres) DGL Diameter at Ground Level	
Height	In metres	
Spread	Average diameter of canopy in metres	
Crown Condition	Overall vigour and vitality 0 Dead 1 Severe decline (<20% canopy; major dead wood) 2 Declining (20-60% canopy density; twig and branch dieback) 3 Average/low vigour (60-90% canopy density; twig dieback) 4 Good (90-100% crown cover; little or no dieback or other problems) 5 Excellent (100% crown cover, no deadwood or other problems)	This requires knowledge of species.
Age class	Y Young = recently planted S Semi-mature (< 20% of life expectancy) M Mature (20-80% of life expectancy) O Over-mature (> 80% of life expectancy)	
Special Significance	A Aboriginal C Commemorative Ha Habitat Hi Historic M Memorial R Rare U Unique form O Other	This may require specialist knowledge.
Services/adjacent structures	Bs Bus stop Bu Building within 3m HVo High voltage open-wire construction HVb High Voltage bundled (ABC) LVo Low Voltage open-wire construction LVb Low Voltage bundled (ABC) Na No services above Nb No services below ground Si Signage Sl Street light T Transmission lines (>33KV) U Underground services O Other	More than one of these may apply.
Defects	B Borers C Cavity D Decay dw Deadwood E Epicormics FA Forest Architecture H/D Height/Diameter ratio I Inclusions L Lopped LDCMP Leaf damage by chewing mouthpiece insects M Mistletoe/Parasites MBA Multiple Branch Attachments PD Parrot Damage PFS Previous Failure Sites	More than one of these may apply. H/D if ratio is higher than 50:1 then tree is defective (Mattheck, et al., 1994).

Key	Criteria	Comments
	S Splits/cracks T Termites TL Trunk Lean TW Trunk Wound O Other	
Root zone	C Compaction D Damaged/wounded roots (eg by mowers) E Exposed roots Ga Tree in garden bed Gi Girdled roots Gr Grass Kb Kerb close to tree L+ Raised soil level L- Lowered soil level M Mulched Pa Paving/concrete/bitumen Pr Roots pruned O Other	More than one of these may apply.
Failure Potential	Identifies the most likely failure and rates the likelihood that the structural defect(s) will result in failure within the inspection period. 1. Low – defects are minor (e.g. dieback of twigs, small wounds with good wound wood development) 2. Medium – defects are present and obvious (e.g. cavity encompassing 10-25% of the circumference of the trunk) 3. High – numerous and or significant defects present (e.g. cavity encompassing 30-50% of the circumference of the trunk, major bark inclusions) 4. Severe – defects are very severe (e.g. heart rot fruiting bodies, cavity encompassing more than 50% of the trunk)	This requires specialist knowledge
Size of defective part	Rates the size of the part most likely to fail. The larger the part that fails, the greater the potential for damage. 1. most likely failure less than 150mm in diameter 2. Most likely failure 150-450mm in diameter 3. Most likely failure 450-750mm in diameter 4. Most likely failure more than 750mm in diameter	
Target Rating*	Rates the use and occupancy of the area that would be struck by the defective part 1. Occasional use (e.g. jogging/cycle track) 2. Intermittent use (e.g. picnic area, day use parking) 3. Frequent use, secondary structure (e.g. seasonal camping area, storage facilities) 4. Constant use, structures (e.g. year-round use for a number of hours each day, residences)	
Hazard rating*	Failure potential + size of part + target rating Add each of the above sections for a number out of 12	The final number identifies the degree of risk. The next step is to determine a management strategy. A rating in this column does not condemn a tree but may indicate the need for more investigation and a risk management strategy.

Appendix 5: Significance of a Tree, Assessment Rating System (STARS) (IACA)

In the development of this document IACA acknowledges the contribution and original concept of the Footprint Green Tree Significance & Retention Value Matrix, developed by Footprint Green Pty Ltd in June 2001.

The landscape significance of a tree is an essential criterion to establish the importance that a particular tree may have on a site. However, rating the significance of a tree becomes subjective and difficult to ascertain in a consistent and repetitive fashion due to assessor bias. It is, therefore, necessary to have a rating system utilising structured qualitative criteria to assist in determining the retention value for a tree. To assist this process all definitions for terms used in the Tree Significance - Assessment Criteria and Tree Retention Value - Priority Matrix, are taken from the IACA Dictionary for Managing Trees in Urban Environments 2009 (Draper, et al., 2009).

This rating system will assist in the planning processes for proposed works, above and below ground where trees are to be retained on or adjacent a development site. The system uses a scale of High, Medium and Low significance in the landscape. Once the landscape significance of an individual tree has been defined, the retention value can be determined.

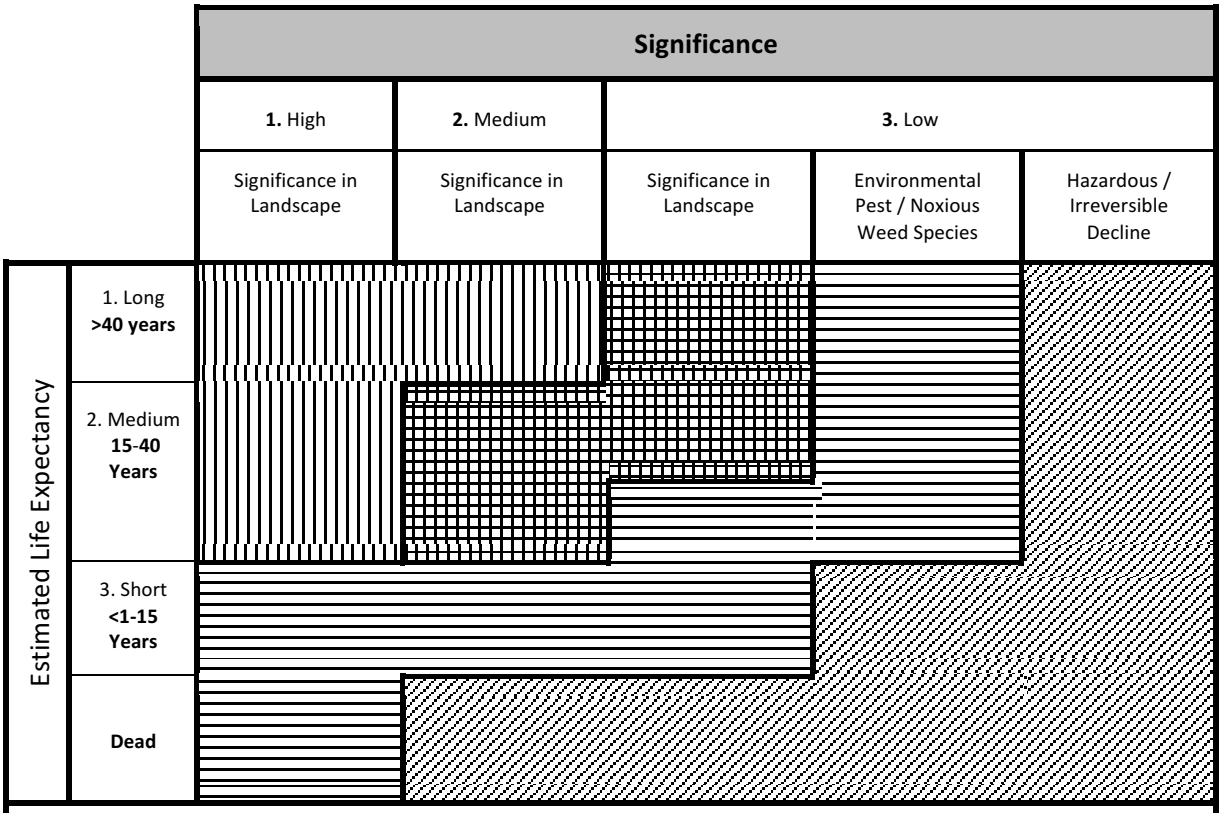
TREE SIGNIFICANCE - ASSESSMENT CRITERIA

1. **High Significance in landscape**
   - The tree is in good condition, or normal vigour and form typical of the species,
   - The tree is a remnant or is a planted locally indigenous specimen and/or is rare or uncommon in the local area or of botanical interest or of grand age.
   - The tree is listed as a Heritage Item, Threatened Species or part of a Threatened Community or listed on council's significant tree register.
   - The tree is visually prominent and visible from a considerable distance when viewed from most directions within the landscape by bulk and scale and makes a positive contribution to the local amenity.
   - The tree has been influenced by historic figures, events or part of the heritage development of the place.
   - The tree supports social and cultural sentiments or spiritual associations, reflected by the broader population or community group or has commemorative values. (ICOMOS)
   - The growing environment supports the tree to its full dimensions above and below ground without conflict or constraint.
2. **Medium Significance in landscape**
   - The tree is in fair-good condition, or normal or low vigour and form typical or atypical of the species.
   - The tree is a planted locally indigenous or a common species with its taxa readily planted in the local area.
   - The tree is visible from surrounding properties, although not visually prominent as partially obstructed by other vegetation or buildings when viewed from the street.
   - The tree provides a fair contribution to the visual character and amenity of the area.
   - The tree is moderately constrained by above or below ground influences of the built environment to reach full dimensions.
3. **Low Significance in landscape**
   - The tree is in fair-poor condition, or normal or low vigour and form typical or atypical of the species,
   - The tree is not visible or is partly from surrounding properties as obstructed by other vegetation or buildings.
   - The tree provides a minor contribution or has a negative impact on the visual character and amenity of the area.
   - The tree is severely constrained by above or below ground by influences of the built environment and therefore will not reach full dimensions; the tree is inappropriate to the site conditions.
   - The tree is listed as exempt under the provisions of the local Council Tree Preservation Order.
   - The tree has a wound or defect that has the potential to become structurally unsound.

The tree is to have a minimum of three (3) criteria in a category to be classified in that group.

Note: The assessment criteria are for individual trees only, however, can be applied to a monocultural stand in its entirety e.g. hedge.

TABLE 1.0 TREE RETENTION VALUE - PRIORITY MATRIX.



Legend for Matrix Assessment

Priority for Retention (High) - These trees are considered important for retention and should be retained and protected. Design modification or relocation of building/s should be considered to accommodate the setbacks as detailed in Table 2. Special construction works must be implemented e.g. pier and beam, etc if works are to proceed within the Tree Protection Zone.

Consider for Retention (Medium) - These trees may be retained and protected. These are considered less critical; however their retention should remain a priority with removal considered only if adversely affecting the proposed building/works and all other alternatives have been considered and exhausted.

Consider for Removal (Low) – These trees are not considered important for retention, nor require special works or design modification to be implemented for their retention.

Priority for Removal – These trees are considered hazardous, or in irreversible decline, or weeds and should be removed irrespective of development.

Appendix 6: Extract from AS 4970-2009 Protection of Trees on Development Sites (Australian Standard®, 2009), Section 3: Determining the Tree Protection Zones of the Selected Trees, 3.1 Tree Protection Zone (TPZ)

3.1 TREE PROTECTION ZONE (TPZ)

"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)."

3.2 DETERMINING THE TPZ

TPZ for Single Trunked Trees

The radius of the TPZ is calculated for each tree by multiplying its DBH x 12.

TPZ = DBH x 12

TPZ for Multiple Trunked Trees

The radius of the TPZ for multiple-trunked trees is calculated using the following formula:

$$\sqrt{(DBH_1)^2+(DBH_2)^2+(DBH_3)^2} = \text{total DBH x 12}$$

DBH = trunk diameter measured at 1.4 metres above ground.

Radius is measured from the centre of the stem at ground level.

A TPZ should not be less than 2 metres nor greater than 15 metres (except where crown protection is required).

The TPZ of palms, other monocots, cycads and tree ferns should not be less than 1 metre outside the crown projection.

AS 4970-2009
Refer to page 14 "FIGURE 2 INDICATIVE TREE PROTECTION ZONE" & page 24 "Appendix A – DIAMETER AT BREAST HEIGHT (DBH) (Informative)" in AS 4970-2009 *Protection of Trees on Development Sites* (Australian Standard®, 2009) for more information.

Appendix 7: Extract from AS 4970-2009 Protection of Trees on Development Sites (Australian Standard®, 2009), Section 3: Determining the Protection Zones of the Selected Trees, 3.3.5 Structural Root Zone (SRZ)

3.3.5 Structural root zone (SRZ)

"The SRZ is the area required for tree stability. A larger area is required to maintain a viable tree. The SRZ only needs to be calculated when a major encroachment into a TPZ is proposed. Root investigation may provide more information on the extent of these roots."

Determining the SRZ

Note: The SRZ for trees with trunk diameters less than 0.15 m will be 1.5 m.

AS 4970-2009
Refer to page 13 "FIGURE 1 STRUCTURAL ROOT ZONE CALCULATION" in AS 4970-2009 *Protection of Trees on Development Sites* (Australian Standard®, 2009) for more information.

TABLE 2.0 TPZ AND SRZ TABLE

DBH for TPZ (mm)	DGL for SRZ (mm)	TPZ (m)	SRZ (m)	DBH for TPZ (mm)	DGL for SRZ (mm)	TPZ (m)	SRZ (m)	DBH for TPZ (mm)	DGL for SRZ (mm)	TPZ (m)	SRZ (m)
100	100	2.0	1.5	500	500	6.0	2.5	900	900	10.8	3.2
110	110	2.0	1.5	510	510	6.1	2.5	910	910	10.9	3.2
120	120	2.0	1.5	520	520	6.2	2.5	920	920	11.0	3.2
130	130	2.0	1.5	530	530	6.4	2.5	930	930	11.2	3.2
140	140	2.0	1.5	540	540	6.5	2.6	940	940	11.3	3.2
150	150	2.0	1.5	550	550	6.6	2.6	950	950	11.4	3.2
160	160	2.0	1.5	560	560	6.7	2.6	960	960	11.5	3.3
170	170	2.0	1.6	570	570	6.8	2.6	970	970	11.6	3.3
180	180	2.2	1.6	580	580	7.0	2.6	980	980	11.8	3.3
190	190	2.3	1.7	590	590	7.1	2.7	990	990	11.9	3.3
200	200	2.4	1.7	600	600	7.2	2.7	1000	1000	12.0	3.3
210	210	2.5	1.7	610	610	7.3	2.7	1010	1010	12.1	3.3
220	220	2.6	1.8	620	620	7.4	2.7	1020	1020	12.2	3.3
230	230	2.8	1.8	630	630	7.6	2.7	1030	1030	12.4	3.4
240	240	2.9	1.8	640	640	7.7	2.7	1040	1040	12.5	3.4
250	250	3.0	1.9	650	650	7.8	2.8	1050	1050	12.6	3.4
260	260	3.1	1.9	660	660	7.9	2.8	1060	1060	12.7	3.4
270	270	3.2	1.9	670	670	8.0	2.8	1070	1070	12.8	3.4
280	280	3.4	1.9	680	680	8.2	2.8	1080	1080	13.0	3.4
290	290	3.5	2.0	690	690	8.3	2.8	1090	1090	13.1	3.4
300	300	3.6	2.0	700	700	8.4	2.9	1100	1100	13.2	3.4
310	310	3.7	2.0	710	710	8.5	2.9	1110	1110	13.3	3.5
320	320	3.8	2.1	720	720	8.6	2.9	1120	1120	13.4	3.5
330	330	4.0	2.1	730	730	8.8	2.9	1130	1130	13.6	3.5
340	340	4.1	2.1	740	740	8.9	2.9	1140	1140	13.7	3.5
350	350	4.2	2.1	750	750	9.0	2.9	1150	1150	13.8	3.5
360	360	4.3	2.1	760	760	9.1	3.0	1160	1160	13.9	3.5
370	370	4.4	2.2	770	770	9.2	3.0	1170	1170	14.0	3.5
380	380	4.6	2.2	780	780	9.4	3.0	1180	1180	14.2	3.6
390	390	4.7	2.2	790	790	9.5	3.0	1190	1190	14.3	3.6
400	400	4.8	2.3	800	800	9.6	3.0	1200	1200	14.4	3.6
410	410	4.9	2.3	810	810	9.7	3.0	1210	1210	14.5	3.6
420	420	5.0	2.3	820	820	9.8	3.0	1220	1220	14.6	3.6
430	430	5.2	2.3	830	830	10.0	3.1	1230	1230	14.8	3.6
440	440	5.3	2.3	840	840	10.1	3.1	1240	1240	14.9	3.6
450	450	5.4	2.4	850	850	10.2	3.1	1250	1250	15.0	3.6
460	460	5.5	2.4	860	860	10.3	3.1				
470	470	5.6	2.4	870	870	10.4	3.1				
480	480	5.8	2.4	880	880	10.6	3.1				
490	490	5.9	2.5	890	890	10.7	3.2				

Appendix 8: Tree Protection Zones – Standard Procedure

1.0 TREE PROTECTION ZONES - STANDARD PROCEDURE

1.1 The Protective fencing where required may delineate the ***TPZ*** and should be located as determined by the project Arborist either in accordance with the specific Council's guidelines or if no guidelines are given by the Council then using AS 4970-2009 *Protection of Trees on Development Sites* (Australian Standard®, 2009), Section 4, 4.3. *"Fencing should be erected before any machinery or materials are brought onto the site and before the commencement of works including demolition. Once erected, protective fencing must not be removed or altered without approval by the project arborist. The TPZ must be secured to restrict access. AS 4687 Temporary fencing and hoardings specifies applicable fencing requirements. Shade cloth or similar should be attached to reduce the transport of dust, other particulate matter and liquids into the protected area. Fence posts and supports should have a diameter greater than 20 mm and be located clear of roots. Existing perimeter fencing and other structures may be suitable as part of the protective fencing."*

Figure 03 Protective fencing shows examples of such fencing.

1.2 AS 4970-2009 *Protection of Trees on Development Sites* Section 4, Tree protection measures, 4.2 Activities restricted within the TPZ

"Activities generally excluded from the TPZ included but are not limited to-

(a) Machine excavation including trenching;
(b) Excavation for silt fencing
(c) Cultivation;
(d) Storage;
(e) Preparation of chemicals, including preparation of cement products;
(f) Parking of vehicles and plant;
(g) Refuelling;
(h) Dumping of waste;
(i) Wash down and cleaning of equipment;
(j) Placement of fill;
(k) Lighting of fires;
(l) Soil level changes;
(m) Temporary or permanent installation of utilities and signs, and
(n) Physical damage to the tree."

AS 4970-2009

Refer to page 15 "4.3 PROTECTIVE FENCING" & page 16 "FIGURE 3 PROTECTIVE FENCING" in AS 4970-2009 *Protection of Trees on Development Sites* (Australian Standard®, 2009) for more information.

1.3 Tree Protection signage is to be attached to each ***Tree Protection Zone*** and displayed from within the development site in accordance with AS 4970-2009 Protection of Trees on Development Sites (Australian Standard®, 2009), Section 4.4 – see example below.

Example of Tree Protection Zone signage

1.4 Where a tree is to be retained and a ***Tree Protection Zone*** cannot be adequately established due to restricted access e.g. tree located alongside an access way, the trunk and branches in the lower crown will be protected by wrapping 2 layers of hessian or carpet underfelt around the trunk and branches for a minimum of 2 m or as lower branches permit, then wire or rope secures 90x50x2000 mm hardwood battens together around the trunk (do not nail or screw to the trunk or branches). The number of battens to be used is as required to encircle the trunk and the planks are to extend to the base of the tree (AS 4970-2009 *Protection of Trees on Development Sites* (Australian Standard®, 2009) – see example below.

Example of Trunk Armour

1.5 If a tree is growing downslope from an excavation, a silt fence located along the contours of the site in the area immediately above the ***Tree Protection Zone*** fencing may need to be installed and regularly maintained to prevent burial and asphyxiation of the roots of the tree. To allow for the maintenance of both fences, the silt fence must be constructed separately to the tree protection fence and the 2 fences must be constructed independently of each other and standalone. To reduce competition with the tree the area within the ***Tree Protection Zone*** is to be kept free of weeds. These are best removed by the application of foliar herbicide with Glyphosate as the active constituent. This is the preferred method rather than removal by the cultivation of the soil within the dripline, to minimise root disturbance to the tree. The removal of woody weeds such as Privet should use the cut and paint method of herbicide application. Weeds are to be controlled within the ***Tree Protection Zone***, for the duration of the project.

1.6 The area of the Tree Protection Zone to be mulched to a depth of 50mm with the organic material being 75% leaf litter and 25% wood, and this being composted material. The depth of mulch and type as indicated, to be maintained for the duration of the project. Where deep excavation will expose the soil profile to drying out the root plate is to be protected by pegging jute matting across the ground surface 2 m back from the edge of the profile and 2 m down the face of the profile and is to be in one continuous sheet or layers up to 5 mm thick and overlapped 300 mm and pegged. Pegs are to be a minimum length of 200 mm and spaced at 500 mm increments in a grid pattern. Once installed mulch is to be placed on top of the jute matting previously described.

1.7 No services either temporary or permanent are to be located within the ***Tree Protection Zone***. If services are to be located within the ***Tree Protection Zone***, special details will need to be provided by a qualified Consulting Arboriculturist for the protection of the tree regarding the location of the service/s. Works within the TPZ should be hand dug or tunnelled.

1.8 A tree will not be fertilised during its protection within the ***Tree Protection Zone***, as this may hasten its decline if it were to decline. If a tree is to be fertilised this should be in consultation with a qualified Consulting Arboriculturist.

1.9 In the event of prolonged dry periods, or where a tree has been transplanted, or where excavation nearby, especially up slope, leads to drying out of a soil profile, or modification to ground water flow, or flows across an existing ground surface to the tree and its growing environment; deep root watering thoroughly at least twice a week is to be undertaken to irrigate the tree. The need for such watering is determined readily by observing the dryness of the soil surface within the dripline of the tree by scraping back some mulch. Mulch is to be reinstated afterwards. In the event of disrupted ground or surface water flows to the tree due to excavation, filling or construction, a reticulated irrigation system may be required to be installed within the ***Tree Protection Zone***. If an irrigation system is to be installed, consideration must be given to volume, frequency, and drainage of water delivered, and this should be in consultation with a qualified Consulting Arboriculturist.

AS 4970-2009

Refer to page 17 "4.5.2 Trunk and branch protection", "4.5.3 Ground protection" & "FIGURE 4 EXAMPLES OF TRUNK, BRANCH AND GROUND PROTECTION" in AS 4970-2009 *Protection of Trees on Development Sites* (Australian Standard®, 2009) for more information.

Appendix 9: Tree Protection on Construction Sites

1.0 TREE PROTECTION ON CONSTRUCTION SITES

Note: Individual protection measures to be applied where stated as applicable.

1.1.0 General notes
1.2.0 Cautionary notes for the protection of retained trees
1.3.0 Demolition of built structures - precautions to protect trees
1.4.0 Excavation and construction close to Tree Protection Zones

1.1.0 General notes

1.1.1 The application of any measures for the protection of trees on development sites is determined by the species characteristics of the subject tree, and the existing physical constraints of the growing environment on site both above and below ground.

1.1.2 This report considers where applicable, AS 4970-2009 Protection of Trees on Development Sites (Australian Standard®, 2009).

1.1.3 This report applies the ***Tree Protection Zone - Standard Procedure*** However, this does not restrict the author from applying additional or alternative conditions where it is deemed appropriate by the author for the protection of trees on development sites. Such additional or alternative conditions may be founded upon professional judgement based on:

- the experience of the Consulting Arboriculturist
- scientific research
- new technology
- industry best practice
- consideration of the individual tree species and its relative tolerance to development impacts
- the individual or cumulative factors present or proposed to impact upon the growing environment essential for the trees' survival

1.1.4 Where this report makes reference to the retention of subject trees it is for their incorporation into the landscaping works for the site, and they are to be documented on a Landscape Plan for the site.

1.2.0 Cautionary notes for the protection of retained trees

1.2.1 Installing underground services within TPZ

If an underground utility service is to be located within the area of the TPZ, AS 4970-2009 Protection of Trees on Development Sites (Australian Standard®, 2009), Section 4, 4.5.5 Installing underground services within TPZ provides the following:

"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.

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 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 Clause 4.5.3."

1.2.1.1 **Location of services Option B** (Driveway Construction)

If a service is to be located within the area of the dripline of a protected tree or within the Tree Protection Zone, and site conditions such as shallow bedrock or if mass rooting has occurred from multiple trees growing in close proximity to each other, the service trench is to be elevated and positioned above natural ground level within the new driveway structure. The existing driveway surface is to be scabbled and a reinforced concrete topping is to be provided with downturned thickened edges constructed under the kerb edging to prevent lateral movement. A suitable subgrade material to manufacturers' recommendations is to be utilised if and where appropriate. Construction is to occur in a manner so as not to cause damage to the subject trees root system. All works to be in accordance with engineers' details.

1.2.2 **Precautions in Respect of Temporary Work**

For Precautions in respect of temporary work, AS 4970-2009 *Protection of Trees on Development Sites* (Australian Standard®, 2009), Section 4, Tree protection measures, 4.5 Other tree protection measures, provides the following:

*"**4.5.3 Ground protection***

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."

4.5.6 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 minimised. This can be achieved by designing scaffolding to avoid branches or tying back branches. The ground below the scaffolding should be protected by boarding (e.g. scaffolding board or plywood sheeting) as shown in Figure 5. Where access is required, a boardwalk or other surface material should be installed to minimise 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 removed."

"Notes:

1 For trunk and branch protection use boards and padding that will prevent damage to bark. Boards are to be strapped to trees, not nailed or screwed.

2 Rumble boards should be a suitable thickness to prevent soil compaction and root damage."

AS 4970-2009

Refer to page 19 "FIGURE 5 INDICATIVE SCAFFOLDING WITHIN A TPZ" in AS 4970-2009 *Protection of Trees on Development Sites* (Australian Standard®, 2009) for more information.

1.3.0 **Demolition of Built Structures - Precautions to Protect Trees**

1.3.1 **Demolition of Existing Buildings**

The demolition of the buildings should be undertaken with access restricted to the driveway and the building platform for each of the existing buildings, or to areas of the land where no trees are growing within 6m of any tree to be retained. Where access or space for a safe working environment is restricted, or where the area of the 6m setback must be compromised, a 100 mm layer of Eucalyptus wood mulch must be laid over the area of encroachment. Where vehicular access is required across the mulch layer further root protection should be provided by laying a temporary pathway over the mulch. The temporary pathway should be constructed of a grated steel material capable of supporting the vehicles used during demolition e.g. similar to ramps used to load vehicles onto the backs of trucks. Trunks of trees are to be protected from vehicular damage as per section 1.2.2 above.

1.3.2 **Demolition of Landscape Structures**

The demolition of walls, driveways retaining walls, paths and pools etc. within 6 m of a tree to be retained should be undertaken manually using hand tools. Where a driveway is to be demolished being of concrete strip or slab type construction, it should be undertaken by working from the end of the driveway closest to the building back towards the street by utilising the driveway as a stable platform to prevent soil compaction. Where a concrete slab driveway passes less than 1 m from the base of a tree and the area beneath the driveway is to be undisturbed and incorporated into the landscape works for the site, the volume of space previously occupied by the driveway must be replaced with local top soil from the site or otherwise a loamy sand, to replace the mass of the concrete on the root plate which may be critical to the ballast and centre of mass for the stability of the tree. If the tree becomes unstable immediately contact the Consultant Arboriculturist.

1.3.3 **Removal of Existing Trees near Trees to be Retained**

Removal of a tree within 6 m of a tree to be retained should be undertaken only by cutting down such a tree without damaging the trees to be retained, and by grinding out its stump. Where possible the structural roots of 20 mm diameter or greater of the tree to be cut down should not be removed, minimise soil disturbance and reduce the impact on the roots of any tree to be retained nearby. Where structural roots are to be removed this should be undertaken manually by the use of non-motorized hand tools after the stump has been ground out when such roots are often easier to locate from the site of the stump from which they have been severed.

1.4.0 **Excavation and Construction close to Tree Protection Zones**

1.4.0.1 Where structural woody roots with a diameter of 20 mm or greater are to be pruned outside the area of the Tree Protection Zone, they are to be excavated manually first by using hand tools to determine their location. A Water knife or Airknife can be used as a mechanised alternative to locate such structural woody roots. Once located those roots to be severed are to be cut cleanly with a final cut to undamaged woody tissue and this will prevent tearing damage to the roots from excavation equipment which can extend beyond the point of excavation back towards the tree.

1.4.0.2 Where a large vigorous tree is to be retained near to a built structure, and dependent upon its taxa, age class and propensity for its roots system to regenerate, it may be prudent to install a root barrier immediately adjacent to the footing of the new building, or to deepen and strengthen the footings themselves to act as a root barrier, but for such structural advice an appropriately qualified chartered structural engineer should be consulted.

1.4.1 Root Location and Protection where Structures are to be Positioned near a Retained Tree

1.4.1.1 If walls or a driveway or other structures are to be constructed near a protected tree, careful excavation is to be undertaken manually by using non-motorized hand tools to determine the location of first order and lower order structural roots with a diameter of 20 mm (*structural woody roots*) or greater, without damaging them. Boundary walls or fences should use columns or posts within fill panels, or a wall to be constructed with suspended sections 100 mm clear above or beside any structural woody root or further as required, or any new wall to be built only to the depth of that existing. Structural woody roots to be further protected by utilising the construction techniques of pier or bridge footings, or screw piles between or over them with a minimum clearance above or beside of 100 mm, or further as required to allow for future and on-going growth.

1.4.1.2 Where a driveway or footpath is to pass by the tree a suspended slab is to be constructed or approved similar, to protect the roots that may be encountered at, near, or above ground, and may be constructed on gap graded fill. Where such a driveway or footpath is to be constructed the edge of the structure closest to the tree is to terminate no closer than 0.5 m from the closest edge of trunk, or further depending on the species and its likely further growth to allow for future development and expansion of the trunk, buttresses, and first order and lower order roots as may be advised by a Consultant Arboriculturist. The side of the driveway closest to a tree is to be edged with a concrete kerb of minimum dimensions of 150 x 150 mm, to prevent vehicular collision with the trunk. Here a *Water knife* or an *Airknife* can be used as a mechanised alternative to locate first order and lower order structural woody roots.

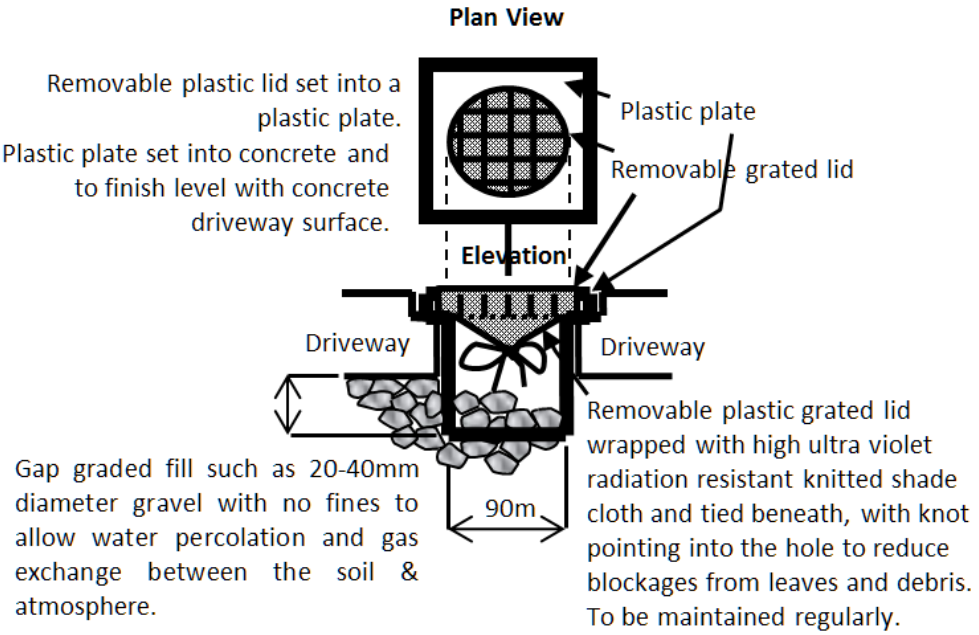
1.4.1.3 Alternatively a footpath or driveway may be constructed at ground level without any excavation, removing turf by raking, having sprayed with herbicide first if time permits. Here the path or driveway section is to extend for a distance past the tree equivalent to the lateral spread of the crown of that tree alongside the footpath, or driveway.

1.4.1.4 Watering / Gaseous exchange vents are to be installed in the area of the driveway that passes within the dripline of the tree or the prescribed ***Tree Protection Zone*** area and the number and location are to be determined by a Consultant Arboriculturist and the driveway design approved by a Certified Engineer. Exposed edges of the path are to be concealed with the finished level beside the path equivalent to the top of the path by minimal filling with a sandy soil and turf, or mulch, or a garden bed with minimal cultivation, or other landscape treatments as appropriate. (see image below)

1.4.2 **Root Protection where a Driveway close to a Tree is to be Demolished and a New Driveway Constructed in a Similar Location to a Previous Driveway.**

After demolition of an existing driveway as per 1.3.2, the level of the base for the new driveway should be located at the same existing level as that of the base of the previous driveway, and should extend for a distance past the tree equivalent to the lateral spread of the crown of that tree alongside the driveway. To prevent excavation from damaging the existing roots which may be located at, near or above the surface of the soil beneath the base of the previous driveway, the new driveway may need to be raised by constructing it on pier or bridge footings between or over them (see 1.4.2 for minimum clearances), or based on a gap graded fill and the driveway constructed with any exposed edges concealed to the top of the driveway by minimal filling with a sandy soil and turf, or mulch, or a garden bed with minimal cultivation, or other landscape treatments as appropriate. Where roots have grown to occupy the soil between the concrete strips of a concrete, stone or brick strip driveway, they and the soil may be excavated to the level of the base of the concrete strips, but where such roots have a diameter of 20 mm or greater, a Consulting Arboriculturist should be contacted prior to such works being undertaken. Where roots are to be severed, they are to be cut cleanly with a final cut to undamaged woody tissue.

Irrigation / Gaseous Exchange Vent



NOTE: Such vents can be installed in a grid pattern at 1 per 1 m^2 and their planning and construction utilised in consultation with an appropriate structural or civil engineer.

1.4.3 **Root Protection where a Footpath is to be Constructed close to a Tree.**

1.4.3.1 A footpath may be constructed at ground level without any excavation, by first killing with herbicide the plants to be removed from the pathway area, and then removing that plant material by cutting the trunks of woody shrubs to ground level and by raking all other plant material to expose the topsoil surface without organic matter. This will remove the need for physically disturbing the soil and the roots of the tree. The path section is to extend for a distance past each tree equivalent to the lateral spread of the crown of that tree where it extends alongside the footpath.

1.4.3.2 To prevent excavation from damaging the existing roots which may be located at, near, or above the surface of the soil, a gap graded fill as a fill material of a media as appropriate, to a depth of 100 mm above the soil surface, or above the top of the root of any tree to be retained, or above the soil surface may be utilised as a base treatment to construct the footpath. Any exposed edges to be concealed to the top of the edges of the footpath and tapering back to the base of the trunk of each tree by minimal filling at each trunk of no greater than 100 mm with a sandy soil and turf, or mulch, or a garden bed with minimal cultivation with ground covers, or other landscape treatments as appropriate. A Consultant Arboriculturist should be contacted prior to such works being undertaken or if any structural roots are considered appropriate to be severed being those roots of 20 mm diameter or greater.

1.4.4 **Structural Soil to Accommodate Load Bearing Conditions**

A structural soil should only be considered as a new media into which the trees could be planted if the planting was into a new area where the area surrounding was to be load bearing such as a footpath, driveway or road.

1.4.5 **Gap Graded Fill to Accommodate Compacted Sub Grade and Root Growth**

To further protect woody roots with a diameter of 20 mm or greater, a gap graded fill with no fines such as gravel 40 mm diameter should only be considered as a fill media above existing grade when soil levels are to be increased near existing trees and the roots can utilise the new media to develop on-going and future root growth and provide for gaseous exchange between the soil and the atmosphere.

Appendix 10: SULE

SULE (an acronym for **Safe** & **Useful Life Expectancy**). There are a number of SULE categories that indicate the safe useful life anticipated for each tree. Factors such as the location, age, condition and health of the tree are significant to determining this rating. Other influences such as the tree's effect on better specimens and the economics of managing the tree successfully in its location are also relevant to SULE (Barrell, 1993 - 2009).

SULE Categories and Subgroups

1 = Long SULE OF > 40 years

A	**B**	**C**
Structurally sound trees located in positions that can accommodate future growth.	Storm damaged or defective trees that could be made suitable for retention in the long term by remedial tree surgery.	Trees of special significance for historical, commemorative or rarity reasons that would warrant extraordinary efforts to secure their long-term retention.

2 = Medium SULE of 15-40 years

A	**B**	**C**	**D**
Trees that may only live between 15 and 40 more years.	Trees that may live for more than 40 years but would be removed to allow the safe development of more suitable individuals.	Trees that may live for more than 40 years but would be removed during the course of normal management for safety or nuisance reasons.	Storm damaged or defective trees that can be made suitable for retention in the medium term by remedial work.

3 = Short SULE of 1-15 years

A	**B**	**C**	**D**
Trees that may only live between 1 and 15 more years.	Trees that may live for more than 15 years but would be removed to allow the safe development of more suitable individuals.	Trees that may live for more than 15 years but would be removed during the course of normal management for safety or nuisance reasons.	Storm damaged or defective trees that require substantial remedial work to make safe, and are only suitable for retention in the short term.

Dead

A	**B**	**C**	**D**	**E**	**F**
Dead trees.	Dying or suppressed and declining trees through disease or inhospitable conditions.	Dangerous trees through instability or recent loss of adjacent trees.	Dangerous trees through structural defects including cavities, decay, included bark, wounds or poor form.	Damaged trees that are considered unsafe to retain.	Trees that will become dangerous after removal of other trees for the reasons given in (a) to (e).

The SULE rating given to any tree in this report assumes that reasonable maintenance will be provided by a qualified Arboriculturist (AQF 3) using the correct and acknowledged techniques. Retained trees are to be protected from root damage. Incorrect tree work practices can significantly accelerate tree decline and increase hazard potential.

Appendix 11: Glossary

All Glossary items adapted from Dictionary for Managing Trees in Urban Environments, Institute of Australian Consulting Arboriculturists (IACA) 2009. (Draper, et al., 2009), unless otherwise cited.

AGE OF TREES

Most trees have a stable biomass for the major proportion of their life. The estimation of the age of a tree is based on the knowledge of the expected lifespan of the taxa in situ divided into three distinct stages of measurable biomass, when the exact age of the tree from its date of cultivation or planting is unknown and can be categorized as Young, Mature and Over-mature (British Standard®, 1991) p.13 & (Harris, et al., 2004) p.262.

Young Tree aged less than <20% of life expectancy, in situ.

Mature Tree aged 20-80% of life expectancy, in situ.

Over-mature Tree aged greater than >80% of life expectancy, in situ, or senescent with or without reduced vigour, and declining gradually or rapidly but irreversibly to death.

CONDITION OF TREES

A tree's *crown form* and growth habit, as modified by its *environment* (aspect, suppression by other trees, soils), the *stability* and *viability* of the *root plate*, trunk and structural branches (first [1st] and possibly second [2nd] order branches), including structural defects such as wounds, cavities or hollows, *crooked* trunk or weak trunk/branch junctions and the effects of predation by pests and diseases. These may not be directly connected with *vigour* and it is possible for a tree to be of *normal vigour* but in *poor condition*. The condition can be categorised as *Good Condition*, *Fair Condition*, *Poor Condition* and *Dead*.

Good Condition Tree is of good habit, with crown form not severely restricted for space and light, physically free from the adverse effects of predation by pests and diseases, obvious instability or structural weaknesses, fungal, bacterial or insect infestation and is expected to continue to live in much the same condition as at the time of inspection provided conditions around it for its basic survival do not alter greatly. This may be independent of, or contributed to by vigour.

Fair Condition Tree is of good habit or misshapen, a form not severely restricted for space and light, has some physical indication of decline due to the early effects of predation by pests and diseases, fungal, bacterial, or insect infestation, or has suffered physical injury to itself that may be contributing to instability or structural weaknesses, or is faltering due to the modification of the environment essential for its basic survival. Such a tree may recover with remedial works where appropriate, or without intervention may stabilise or improve over time, or in response to the implementation of beneficial changes to its local environment. This may be independent of, or contributed to by vigour.

Poor Condition Tree is of good habit or misshapen, a form that may be severely restricted for space and light, exhibits symptoms of advanced and irreversible decline such as fungal, or bacterial infestation, major die-back in the branch and foliage crown, structural deterioration from insect damage e.g. termite infestation, or storm damage or lightning strike, ring barking from borer activity in the trunk, root damage or instability of the tree, or damage from physical wounding impacts or abrasion, or from altered local environmental conditions and has been unable to adapt to such changes and may decline further to death regardless of remedial works or other modifications to the local environment that would normally be sufficient to provide for its basic survival if in good to fair condition. Deterioration physically, often characterised by a gradual and continuous reduction in vigour but may be independent of a change in vigour, but characterised by a proportionate increase in susceptibility to, and predation by pests and diseases against which the tree cannot be sustained. Such conditions may also be evident in trees of advanced senescence due to normal phenological processes, without modifications to the growing environment or physical damage having been inflicted upon the tree. This may be independent of, or contributed to by vigour.

Senescent / Moribund The advanced state of decline, dying or nearly dead.

Dead Tree is no longer capable of performing any of the following processes or is exhibiting any of the following symptoms;

Processes Photosynthesis via its foliage crown (as indicated by the presence of moist, green or other coloured leaves); Osmosis (the ability of the root system to take up water); Turgidity (the ability of the plant to sustain moisture pressure in its cells); Epicormic shoots or epicormic strands in Eucalypts (the production of new shoots as a response to stress, generated from latent or adventitious buds or from a lignotuber);

Symptoms Permanent leaf loss; Permanent wilting (the loss of turgidity which is marked by desiccation of stems leaves and roots); Abscission of the epidermis (bark desiccates and peels off to the beginning of the sapwood).

Removed No longer present, or tree not able to be located or having been cut down and retained on a site, or having been taken away from a site prior to site inspection.

BRANCH

An elongated woody structure arising initially from the trunk to support leaves, flowers, fruit and the development of other branches. A branch may itself fork and continue to divide many times as successive orders of branches with the length and taper decreasing incrementally to the outer extremity of the crown. These may develop initially as a gradually tapering continuation of the trunk with minimal division as in a young tree or a tree of excurrent habit, or in a sapling, or may arise where the trunk terminates at or some distance from the root crown, dividing into first order branches to form and support the foliage crown. In an acaulescent tree, branches arise at or near the root crown. Similarly, branches may arise from a sprout mass from damaged roots, branches or trunk.

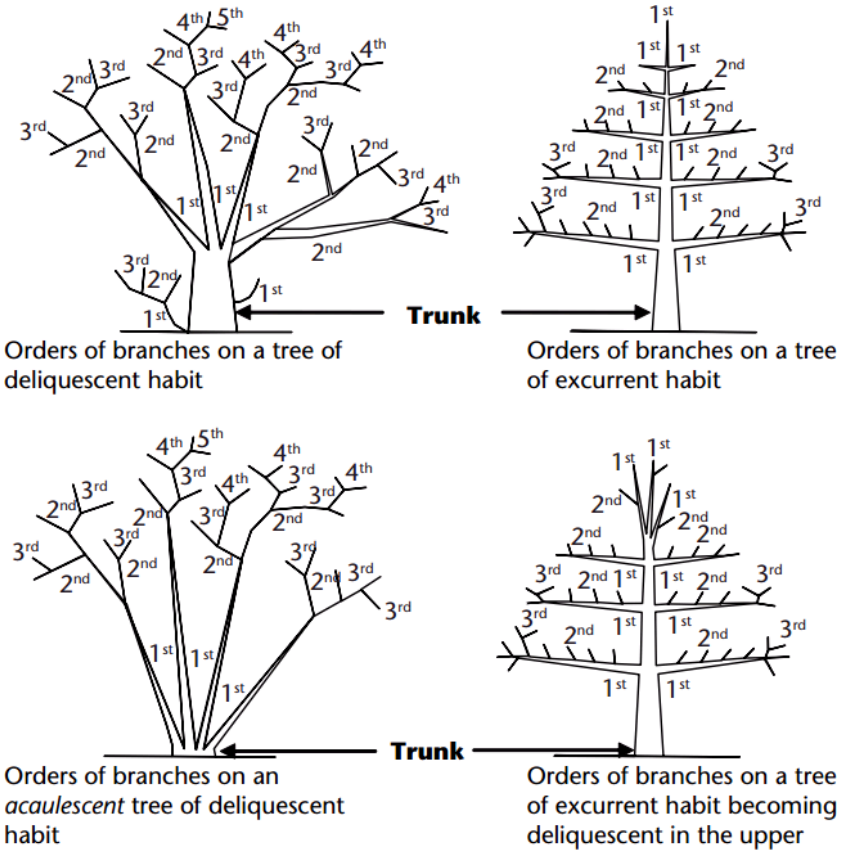


Figure 21 Orders of branches.

Orders of Branches The marked divisions between successively smaller branches (James, 2003)p. 168, commencing at the initial division where the trunk terminates on a deliquescent tree or from lateral branches on an excurrent tree. Successive branching is generally characterised by a gradual reduction in branch diameters at each division, and each gradation from the trunk can be categorised numerically, e.g. first order, second order, third order etc. (See Figure 21.)

Branch tear out Dislodging of a branch from its point of attachment where it is torn away from the branch collar snapping the branch tail causing a laceration, usually to the underside of the branch union of the branch or trunk to which it was attached forming a tear out wound.

Sudden branch drop The failure and collapse of live, usually horizontal branches, seemingly without any noticeable cause in calm hot, dry weather conditions generally after rain. Theorised to be caused by altered moisture content in the branch disturbing the longitudinal pre-stressing of the wood that normally helps support the load as formed by reaction wood in branches tending to horizontal (Lonsdale, 1999)p. 30, or incipient failure from the lengthening of existing internal cracks as the wood cools (Shigo, 1986) p. 248, or influenced by branch creep under its own weight and by wind (Mattheck, et al., 1994) p. 126, or fractures to vascular rays if pulled at right angles to their longitudinal orientation forming from subsidence cracks (Mattheck, et al., 1994)p. 169, or a combination of these factors. Such branch breakages usually occur at some distance from the branch collar leaving a stub. See also *Branch tear out*.

Canopy

1. Of multiple trees, the convergence, or merging in full or part, of the crowns of two or more trees due to their proximity, or where competition for light and space available in a forest environment is limited as each tree develops forming a continuous layer of foliage.
2. Used as a plural for the crown.
3. Sometimes synonymously used for the crown (USA).

Crown Of an individual tree all the parts arising above the trunk where it terminates by its division forming branches, e.g. the branches, leaves, flowers and fruit; or the t amount of foliage supported by t branches. The crown of any tre can be divided vertically into three sections and can be categorised as lower crown, mid crown and upper crown (Figure 8). For a leaning tree these can be divided evenly into crown sections of one-third from the base to apex. The volume of a crown can be categorised as the inner crown, outer crown and outer extremity of the crown.

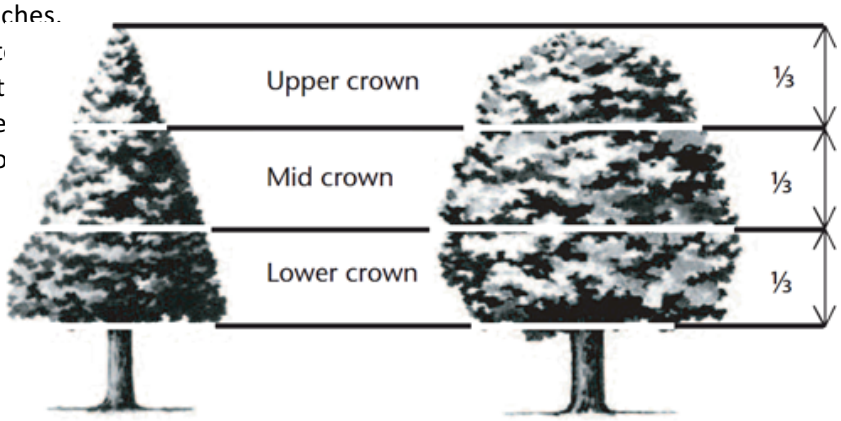


Figure 8 Crown sections.

Lower Crown The proximal or lowest section of a crown when divided vertically into one-third (⅓) increments.

Mid Crown The middle section of a crown when divided vertically into one-third (⅓) increments.

Upper Crown The distal or highest section of a crown when divided vertically into one-third (⅓) increments.

Crown Projection (CP) Area within the dripline or beneath the lateral extent of the crown (Geiger, 2004) p.2.

Dripline A line formed around the edge of a tree by the lateral extent of the crown. Such a line may be evident on the ground with some trees when exposed soil is displaced by rain shed from the crown.

CROWN FORM OF TREES

The shape of the crown of a tree as influenced by the availability or restriction of space and light, or other contributing factors within its growing environment. Crown Form may be determined for tree shape and habit generally as Dominant, Codominant, Intermediate, Emergent, Forest and Suppressed. The habit and shape of a crown may also be considered qualitatively and can be categorised as Good Form or Poor Form.

Good Form Tree of typical crown shape and habit with proportions representative of the taxa considering constraints such as origin e.g. indigenous or exotic, but does not appear to have been adversely influenced in its development by environmental factors in situ such as soil water availability, prevailing wind, or cultural practices such as lopping and competition for space and light.

Poor Form Tree of atypical crown shape and habit with proportions not representative of the species considering constraints and appears to have been adversely influenced in its development by environmental factors in situ such as soil water availability, prevailing wind, cultural practices such as lopping and competition for space and light; causing it to be misshapen or disfigured by disease or vandalism.

Crown Form Codominant Crowns of trees restricted for space and light on one or more sides and receiving light primarily from above e.g. constrained by another tree/s or a building.

Crown Form Dominant Crowns of trees generally not restricted for space and light receiving light from above and all sides.

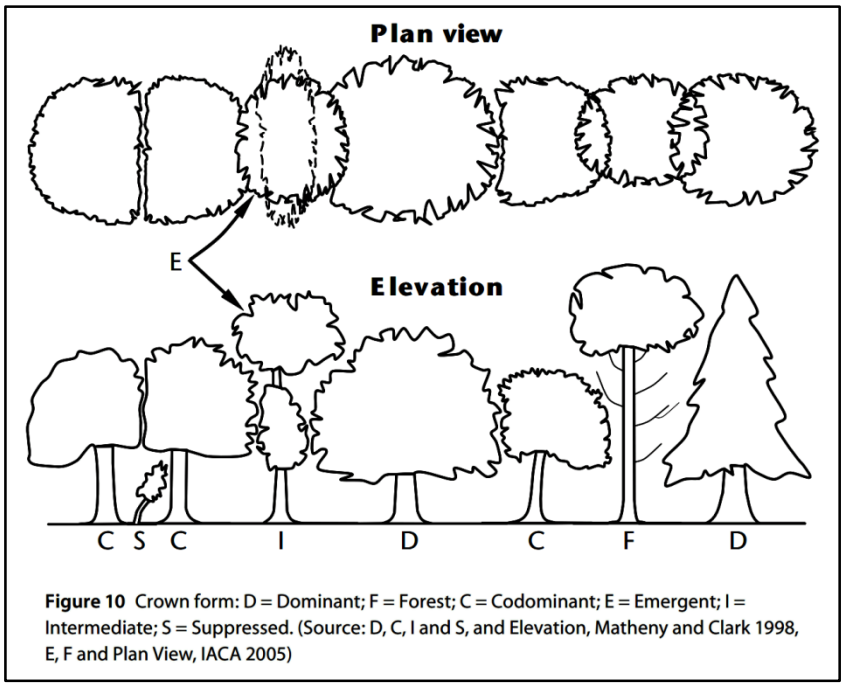


Figure 10 Crown form: D = Dominant; F = Forest; C = Codominant; E = Emergent; I = Intermediate; S = Suppressed. (Source: D, C, I and S, and Elevation, Matheny and Clark 1998, E, F and Plan View, IACA 2005)

Crown Form Emergent Crowns of trees restricted for space on most sides receiving most light from above until the upper crown grows to protrude above the canopy in a stand or forest environment. Such trees may be crown form dominant or transitional from crown form intermediate to crown form forest asserting both apical dominance and axillary dominance once free of constraints for space and light.

Crown Form Forest Crowns of trees restricted for space and light except from above forming tall trees with narrow spreading crowns with foliage restricted generally to the top of the tree. The trunk is usually erect, straight and continuous, tapering gradually, crown often excurrent, with first order branches becoming structural, supporting the live crown concentrated towards the top of the tree, and below this point other first order branches arising radially with each inferior and usually temporary, divergent and ranging from horizontal to ascending, often with internodes exaggerated due to competition for space and light in the lower crown.

Crown Form Intermediate Crowns of trees restricted for space on most sides with light primarily from above and on some sides only.

Crown Form Suppressed Crowns of trees generally not restricted for space but restricted for light by being overtopped by other trees and occupying an understorey position in the canopy and growing slowly.

DEADWOOD

Dead branches within a tree's crown and considered quantitatively as separate to crown cover and can be categorised as Small Deadwood and Large Deadwood according to diameter, length and subsequent risk potential. The amount of dead branches on a tree can be categorised as Low Volume Deadwood, Medium Volume Deadwood and High Volume Deadwood. See also Dieback.

Deadwooding Removing of dead branches by pruning. Such pruning may assist in the prevention of the spread of decay from dieback or for reasons of safety near an identifiable target.

Small Deadwood - dw A dead branch up to 10mm diameter and usually <2 metres long, generally considered of low-risk potential.

Large Deadwood - DW A dead branch >10mm diameter and usually >2 metres long, generally considered of high-risk potential.

DIEBACK

The death of some areas of the crown. Symptoms are leaf drop, bare twigs, dead branches and tree death, respectively. This can be caused by root damage, root disease, bacterial or fungal canker, severe bark damage, intensive grazing by insects, abrupt changes in growth conditions, drought, water-logging or over-maturity. Dieback often implies reduced resistance, stress or decline which may be temporary. Dieback can be categorised as Low Volume Dieback, Medium Volume Dieback and
High Volume Dieback.

High Volume Dieback Where >50% of the crown cover has died.

Medium Volume Dieback Where 10-50% of the crown cover has died.

Low Volume Dieback Where <10% of the crown cover has died. See also Dieback, High Volume Dieback and Medium Volume Dieback.

EPICORMIC SHOOTS

Juvenile shoots produced at branches or trunk from epicormic strands in some Eucalypts (Burrows, 2002) pp. 111-131, or sprouts produced from dormant or latent buds concealed beneath the bark in some trees. Production can be triggered by fire, pruning, wounding, or root damage but may also be as a result of stress or decline. Epicormic shoots can be categorised as Low Volume Epicormic Shoots, Medium Volume Epicormic Shoots and High Volume Epicormic Shoots.

High Volume Epicormic Shoots Where >50% of the crown cover is comprised of live epicormic shoots.

Medium Volume Epicormic Shoots Where 10-50% of the crown cover is comprised of live epicormic shoots.

Low Volume Epicormic Shoots Where <10% of the crown cover is comprised of live epicormic shoots.

GENERAL TERMS

Cavity A usually shallow void often localised initiated by a wound and subsequent decay within the trunk, branches or roots, or beneath bark, and may be enclosed or have one or more opening.

Decay The process of degradation of wood by microorganisms (Australian Standard®, 2007) p. 6, and fungus.

Hazard The threat of danger to people or property from a tree or tree part resulting from changes in the physical condition, growing environment, or existing physical attributes of the tree, e.g. included bark, soil erosion, or thorns or poisonous parts, respectively.

Included Bark The bark on the inner side of the branch union, or is within a concave crotch that is unable to be lost from the tree and accumulates or is trapped by acutely divergent branches forming a compression fork. The growth of bark at the interface of two or more branches on the inner side of a branch union or in the crotch where each branch forms a branch collar and the collars roll past one another without forming a graft where no one collar is able to subsume the other. The risk of failure is worsened in some taxa where branching is acutely divergent or acutely convergent and ascending or erect.

Hollow A large void initiated by a wound forming a cavity in the trunk, branches or roots and usually increased over time by decay or other contributing factors, e.g. fire, or fauna such as birds or insects e.g. ants or termites. A hollow can be categorised as an Ascending Hollow or a Descending Hollow.

Kino The extractive polyphenols (tannins) formed in veins in the cambial zone as a defence in response to wounding in eucalypts. Often visible as an exudate when the kino veins rupture or are injured (Boland, et al., 2006) p. 691.

Risk The random or potentially foreseeable possibility of an episode causing harm or damage.

Significant Important, weighty or more than ordinary.

Significant Tree A tree considered important, weighty or more than ordinary. Example: due to prominence of location, or in situ, or contribution as a component of the overall landscape for amenity or aesthetic qualities, or curtilage to structures, or importance due to uniqueness of taxa for species, subspecies, variety, crown form, or as an historical or cultural planting, or for age, or substantial dimensions, or habit, or as remnant vegetation, or habitat potential, or a rare or threatened species, or uncommon in cultivation, or of aboriginal cultural importance, or is a commemorative planting.

Substantial A tree with large dimensions or proportions in relation to its place in the landscape.

Sustainable Retention Index Value (SRIV) A visual tree assessment method to determine a qualitative and numerical rating for the viability of urban trees for development sites and management purposes, based on general tree and landscape assessment criteria using classes of age, condition and vigour. SRIV is for the professional manager of urban trees to consider the tree in situ with an assumed knowledge of the taxon and its growing environment. It is based on the physical attributes of the tree and its response to its environment considering its position in a matrix for age class, vigour class, condition class and its sustainable retention with regard to the safety of people or damage to property. This also factors the ability to retain the tree with remedial work or beneficial modifications to its growing environment or removal and replacement. SRIV is supplementary to the decision made by a tree management professional as to whether a tree is retained or removed (IACA).

Structural Root Zone (SRZ) The minimum radial distance around the base of a tree and its root plate required for its stability in the ground against windthrow, and applied only to trees with a circular root plate (Mattheck, et al., 1994) pp. 77-87.

Tree Protection Zone (TPZ) A combination of the root protection zone (RPZ) and crown protection zone (CPZ) as an area around a tree set aside for the protection of a tree and a sufficient proportion of its growing environment above and below ground established prior to demolition or construction and maintained until the completion of works to allow for its viable retention including stability.

Visual Tree Assessment (VTA) A visual inspection of a tree from the ground based on the principle that, when a tree exhibits apparently superfluous material in its shape, this represents repair structures to rectify defects or to reinforce weak areas in accordance with the Axiom of Uniform Stress (Mattheck, et al., 1994) pp. 12-13, 145). Such assessments should only be undertaken by suitably competent practitioners.

LEANING TREES

A tree where the trunk grows or moves away from upright. A lean may occur anywhere along the trunk influenced by a number of contributing factors e.g. genetically predetermined characteristics, competition for space or light, prevailing winds, aspect, slope, or other factors. A leaning tree may maintain a static lean or display an increasingly progressive lean over time and may be hazardous and prone to failure and collapse. The degrees of leaning can be categorised as Slightly Leaning, Moderately Leaning, Severely Leaning and Critically Leaning.

Slightly Leaning A leaning tree where the trunk is growing at an angle within 0°-15° from upright. - Low Risk.

Moderately Leaning A leaning tree where the trunk is growing at an angle within 15°-30° from upright. - Medium Risk.

Severely Leaning A leaning tree where the trunk is growing at an angle within 30°-45° from upright. - High Risk.

Critically Leaning A leaning tree where the trunk is growing at an angle greater than >45° from upright. - Very High Risk.

Progressively Leaning A tree where the degree of leaning appears to be increasing over time. - Lodging.

Static Leaning A leaning tree whose lean appears to have stabilised over time.

SYMMETRY

Balance within a crown, or root plate, above or below the axis of the trunk of branch and foliage, and root distribution respectively and can be categorised as Asymmetrical and Symmetrical.

Asymmetrical Imbalance within a crown, where there is an uneven distribution of branches and the foliage crown or root plate around the vertical axis of the trunk. This may be due to Crown Form Codominant or Crown Form Suppressed as a result of natural restrictions e.g. from buildings, or from competition for space and light with other trees, or from exposure to the wind, or artificially caused by pruning for clearance of roads, buildings or power lines. An example of an expression of this may be, crown asymmetrical, bias to the west.

Symmetrical Balance within a crown, where there is an even distribution of branches and the foliage crown around the vertical axis of the trunk. This usually applies to trees of Crown Form Dominant or Crown Form Forest. An example of an expression of this may be crown symmetrical.

ROOTS

First Order Roots (FOR) Initial woody roots arising from the root crown at the base of the trunk, or as an adventitious root mass for structural support and stability. Woody roots may be buttressed and divided as a marked gradation, gradually tapering and continuous or tapering rapidly at a short distance from the root crown. Depending on soil type these roots may descend initially and not be evident at the root crown, or become buried by changes in soil levels. Trees may develop 4-11 (Perry, 1982) pp. 197- 221, or more first order roots which may radiate from the trunk with a relatively even distribution, or be prominent on a particular aspect, dependent upon physical characteristics e.g. leaning trunk, asymmetrical crown; and constraints within the growing environment from topography e.g. slope, soil depth, rocky outcrops, exposure to predominant wind, soil moisture, depth of water table etc.

Orders of Roots The marked divisions between woody roots, commencing at the initial division from the base of the trunk, at the root crown where successive branching is generally characterised by a gradual reduction in root diameters and each gradation from the trunk and can be categorized numerically, e.g. first order roots, second order roots, third order roots etc. Roots may not always be evident at the root crown and this may be dependent on species, age class and the growing environment. Palms at maturity may form an adventitious root mass.

Root Plate The entire root system of a tree generally occupying the top 300-600mm of soil including roots at or above ground and may extend laterally for distances exceeding twice the height of the tree (Perry, 1982) pp. 197-221. Development and extent is dependent on water availability, soil type, soil depth and the physical characteristics of the surrounding landscape.

Root Crown Roots arising at the base of a trunk.

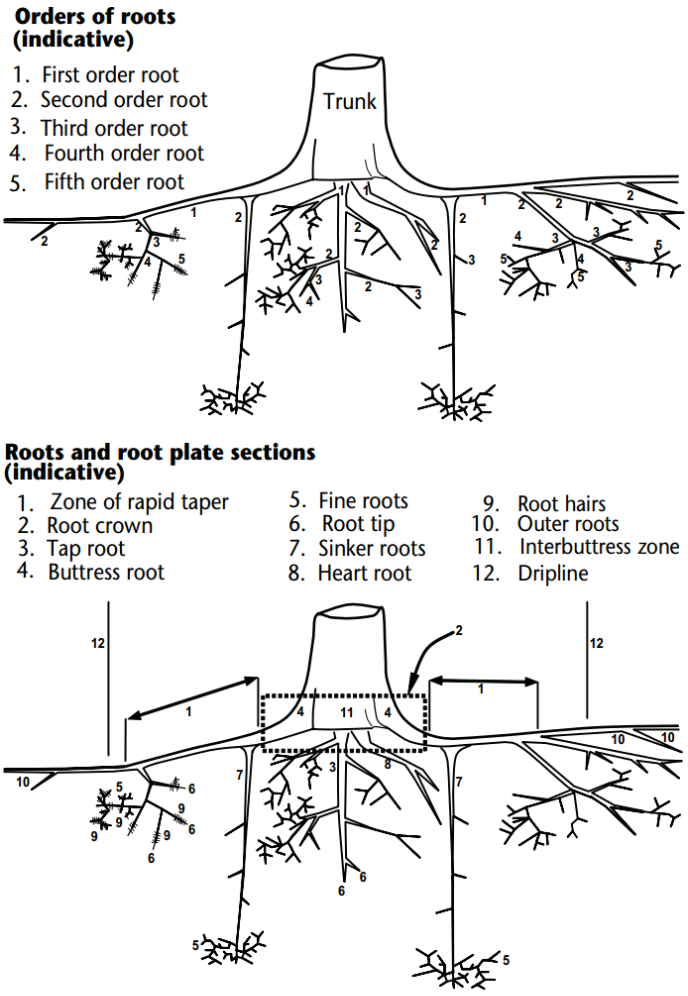


Figure 22 Orders of roots.

Zone of Rapid Taper The area in the root plate where the diameter of structural roots reduces substantially over a short distance from the trunk. Considered to be the minimum radial distance to provide structural support and root plate stability. See also Structural Root Zone (SRZ).

Structural Roots Roots supporting the infrastructure of the root plate providing strength and stability to the tree. Such roots may taper rapidly at short distances from the root crown or become large and woody as with gymnosperms and dicotyledonous angiosperms and are usually 1st and 2nd order roots, or form an adventitious root mass in monocotyledonous angiosperms (palms). Such roots may be crossed and grafted and are usually contained within the area of crown projection or extend just beyond the dripline.

TRUNK

A single stem extending from the root crown to support or elevate the crown, terminating where it divides into separate stems forming first order branches. A trunk may be evident at near the ground or be absent in acaulescent tr deliquescent habit, or may be continuous in tr excurrent habit. The trunk of any caulescent tr be divided vertically into three (3) sections and be categorised as Lower Trunk, Mid Trunk and Upper Trunk. For a leaning tree, these may b divided evenly into sections of one-third along t trunk (Figure 28).

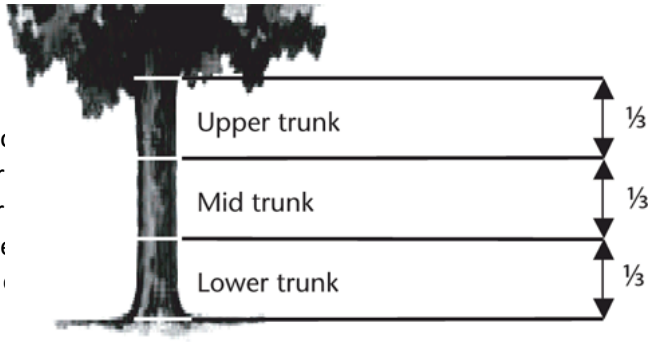


Figure 28 Trunk sections.

Co-Dominant Equal in size and relative importance, usually associated with either trunk/stems or scaffold limbs/branches in the crown; in the context of crown class, trees whose crowns form the bulk of the upper layer of the canopy but which are crowded by adjacent trees (Matheny, et al., 1994).

Diameter at Breast Height (DBH) Measurement of trunk width calculated at a given distance above ground from the base of the tree often measured at 1.4 m. The trunk of a tree is usually not a circle when viewed in cross section, due to the presence of reaction wood or adaptive wood, therefore an average diameter is determined with a diameter tape or by recording the trunk along its narrowest and widest axis, adding the two dimensions together and dividing them by 2 to record an average and allowing the orientation of the longest axis of the trunk to also be recorded. Where a tree is growing on a lean the distance along the top of the trunk is measured to 1.4m and the diameter then recorded from that point perpendicular to the edge of the trunk. Where a leaning trunk is crooked a vertical distance of 1.4m is measured from the ground. Where a tree branches from a trunk that is less than 1.4m above ground, the trunk diameter is recorded perpendicular to the length of the trunk from the point immediately below the base of the flange of the branch collar extending the furthest down the trunk, and the distance of this point above ground recorded as trunk length. Where a tree is located on sloping ground the DBH should be measured at half way along the side of the tree to average out the angle of slope. Where a tree is acaulescent or trunkless branching at or near ground an average diameter is determined by recording the radial extent of the trunk at or near the ground and noting where the measurement was recorded e.g. at ground.

Dominant One of four types of crown class; tree whose crown extends above the height of nearby trees in the stand, receiving light from above and he side

Leader The top most portion of the tree trunk (stem) that is able to grow more than the laterals below. (Harris, et al., 2004)

VIGOUR

The ability of a tree to sustain its life processes. This is independent of the condition of a tree but may impact upon it. Vigour can appear to alter rapidly with change of seasons (seasonality) e.g. dormant, deciduous or semi-deciduous trees. Vigour can be categorised as Normal Vigour, High Vigour, Low Vigour and Dormant Tree Vigour.

Normal Vigour The ability of a tree to maintain and sustain its life processes. This may be evident by the typical growth of leaves, crown cover and crown density, branches, roots and trunk and resistance to predation. This is independent of the condition of a tree but may impact upon it, and especially the ability of a tree to sustain itself against predation.

High Vigour Accelerated growth of a tree due to incidental or deliberate artificial changes to its growing environment that are seemingly beneficial, but may result in premature aging or failure if the favourable conditions cease, or promote prolonged senescence if the favourable conditions remain, eg water from a leaking pipe; water and nutrients from a leaking or disrupted sewer pipe; nutrients from animal waste, a tree growing next to a chicken coop, or a stock feedlot, or a regularly used stockyard; a tree subject to a stringent watering and fertilising program; or some trees may achieve an extended lifespan from continuous pollarding practices over the life of the tree.

Low Vigour Reduced ability of a tree to sustain its life processes. This may be evident by the atypical growth of leaves, reduced crown cover and reduced crown density, branches, roots and trunk, and a deterioration of their functions with reduced resistance to predation. This is independent of the condition of a tree but may impact upon it, and especially the ability of a tree to sustain itself against predation.

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DISCLAIMER

The author and Advanced Treescape Consulting take no responsibility for actions taken and their consequence if contrary to those expert and professional instructions are given as recommendations pertaining to safety. The conclusions and recommendations contained in this report refer to the tree(s) condition on the inspection day. All care has been taken using the most up-to-date Arboricultural information in the preparation of this report. The report is based on a visual inspection only. Tree health and environmental conditions can change irreversibly at any time due to unforeseen circumstances or events. Due to *Myrtaceae* family hybridisation, some tree species are difficult to accurately identify. Unless trees are in full flower identification is only probable.

Appendix 12: Curriculum Vitae

U W S (Hawkesbury)	Graduate Diploma in Horticulture Diploma in Horticulture
Hortus Australia	Diploma of Horticulture (Arboriculture) (RTF50203-6522-6/12/2005) Qualified AQF5
Ryde School of Horticulture	Tree Surgery Arboriculture Techniques
Central Coast Community College	Excel Module 1 and 2 Excel – Advanced
Workcover	OHS General Induction for Construction Work in NSW (CGI00871464SEQ1) St Johns Ambulance First Aid Certificate

CONFERENCE ATTENDANCE & TRAINING

2016	IACA Root Mapping Seminar - Ryde TAFE IACA Report Writing Seminar - Ryde TAFE IML Resistograph® Users Course - Belmont TAFE
2015	Quantified Tree Risk Assessment System - Estimating Probability of Failure Aboriginal Scar Trees: Significance Conservation and Management of Veteran Eucalypts in the Landscape - Griffith University
2012	Australian Institute of Horticulture Inc. - 'Don Burke Field Day' Professional Development Workshop
2011	Institute of Australian Consulting Arboriculturists (IACA) AS 4970 Forum Ecological Consultants Association of NSW - Impacts of Invasive Species
2010	Root Barrier Field Day
2009	Matheny & Clark: Arboriculture
2008	Quantified Tree Risk Assessment System - Principals and Application
2007	Quantified Tree Risk Assessment System - Principals and Application Quantified Tree Risk Assessment System - A Practitioners Guide to Visual Tree Assessment
2006	Barrell Tree A-Z 2 Day Workshop IML Resistograph® F500S Training Course
2005	Urban Tree Forum – Sydney City Council Urban Tree Risk Management – Treelogic DA Workshop Preparing Development Applications for Local Council –AIH Urban Forest – The New Imperative – Parks and Leisure Australia
2004	Visual Tree Assessment Workshop – Professor Doctor Claus Mattheck
2003	Urban Trees - Our Urban Urgency – Parks and Leisure Australia
1999	Tree Hazard Assessment – Parramatta Park – NAAA
1990	Aero Advanced Climbers Seminar NSW

INDUSTRY BACKGROUND

20th June 2001 to present	*Proprietor* **Advanced Treescape Consulting** (formerly known as RJK Consulting)
2002 - 2005	*Part Time Horticulturist* **Acorn/Bushlands Nursery/Aquarium Centre, Erina Heights**
1997 to present	*Consultant* **Horticulturist**
1997 to present	*Public Speaker* **Horticulturist/Arboriculturist Topics**
1997 - 2001	*Part Time Horticulturist* **Flower Power, Glenhaven**
1991 - 1995	*Proprietor* **KAC Peninsula Firewood** Assembled team to clear backlog of firewood
1990 - 1996	*Proprietor/Climber* **Kingdom's Arbor Care** (until its sale)
1986 - 1990	*Tree Worker* **Arbor 2000 Pro-Climb, Sydney**
1972 to present	*Bonsai enthusiast*

BUSINESS ACHIEVEMENT

Finalist in Central Coast Advocate Community Business Awards 2005 for Specialised Business category.

MEMBERSHIPS

- Institute of Australian Consulting Arboriculturists
- Australian Institute of Horticulture
- Arboriculture Australia
- Gosford City Council Tree Protection Committee - Committee Member - August 1998 to June 2004.