Licensed User
765

ASSESSMENT AND MANAGEMENT OPTIONS

Ficus macrophylla

Castle Drive, Lennox Head

Date: February 2018

Prepared For: Ballina Regional Council

PO Box 438 Miami 4220 Ph: 0412529946 www.terraark.com Email: admin@terraark.com

Author: Jan Allen

DISCLAIMER

Whilst all care is taken in the preparation of this report, no responsibility can be taken for the continued vitality of the trees mentioned or for any damage that they may cause in the future.

CONTENTS

SUMMARY OF ASSESSMENT 1

1.0 BACKGROUND AND SCOPE OF REPORT 2

1.1 Statement of Limitations 3
1.2 Assessment Methodology 4

2.0 SITE OBSERVATIONS 7

2.1 General Site Observations: 7
2.2 Details of tree inspection: 10
2.3 Prognosis 12
2.4 Tree Benefits 13

3.0 RISK ASSESSMENT FACTORS 15

3.1 Occupancy Rates/Targets: 15
3.2 Details of impact Potential: 16
3.3 Details of Failure Probability: 16
3.4 Summary of QTRA results 16

4.0 ROOT ENCROACHMENT AND TREE NUISANCE 18

4.1 Process and considerations 18
4.2 Applying AS4970-2009 19

5.0 MANAGEMENT OPTIONS 21

5.1 Risk Management 21
5.2 Root Pruning/Root Barrier 22
5.3 Tree Relocation 23
5.4 Tree Removal 24
5.5 Take no action 24

6.0 CONCLUSIONS AND RECOMMENDATIONS 26

7.0 APPENDIX A: AMENITY TREE VALUATION 28

8.0 APPENDIX B: CV OF AUTHOR 31

SUMMARY OF ASSESSMENT

- The inspection revealed that the tree displayed good vigour and form and was highly attractive, well recognised and visually prominent in the local area.
- The tree had a very high amenity value and considerable but unquantified ecological value and should be managed in the longer term to maximise tree longevity and public benefits.
- The risk assessment considered potential harm to pedestrians, occupants of the dwellings, local traffic and property damage to structures, parked vehicles and other private property.
- The current risk posed by the tree to property and pedestrians was found to be within a range considered to be as low as reasonably practicable and did not require mitigation within the next 12 months.
- It was not possible to determine with any confidence the likelihood of root damage occurring to private property without carrying out physical investigation of root location and acquiring further information about the soil profile and building construction history.
- Installation of a root barrier or root pruning trench within Council land would likely constitute a major incursion into the root protection area and therefore triggers a need for root mapping to determine feasibility. Those investigations need to be carried out before the option of a root barrier is eliminated from considerations.
- Tree relocation was not presented as an option to Council but should be fully considered. Investigations to inform the root barrier option will also to some extent inform the potential to move the whole tree to the park opposite.
- It was possible and preferable to manage the tree in situ if the investigation found that it would be feasible to insert an effective root barrier.
- Compensatory works would be required to improve growing conditions within the remainder of the growing area on Council land.
- Any negative effect on the tree canopy and consequential increase in risk could be managed through judicious pruning or other measures informed by a documented risk assessment.
- The tree should not be removed unless, after full investigation, all other options prove impracticable.

1.0 BACKGROUND AND SCOPE OF REPORT

I was engaged by Ballina Shire Council (BSC) to carry out an assessment and provide management advice in relation to a mature *Ficus macrophylla* (Moreton Bay Fig Tree) growing within the road verge fronting 7 and 9 Castle Drive, Lennox Head. This assessment report includes quantification of the current risk posed by the tree (Quantified Tree Risk Assessment QTRA), a brief appraisal of tree condition, an amenity valuation and discussion of management options.

BSC required an independent arborist's opinion following a Council decision to remove the tree. Advice was provided to Council in a report that discussed and nominated options for ongoing management of the tree (Item 11 of Ballina Shire Council 15/12/16 Ordinary Meeting, Attachments Page 232-247 of 254). Management options tabled in that report included installation of a root barrier, tree removal or taking no action other than maintaining the current management regime. The report recommended in favour of whole tree removal based on advice from Council's insurer that cover would not be provided against any future claims for damage or injury caused by the tree.

The tree was implicated in insurance claims against Council for alleged damage caused to property at 7 and 9 Castle Drive. I was informed by Council officers that they were satisfied that roots from the tree had caused upheaval of paving at 9 Castle Drive, as well as upheaval of the driveway and other damage to the house and external structures at 7 Castle Drive. I was not asked to investigate or make comment on the claim, except to the extent that it affected management considerations.

I was instructed to provide an opinion of options to manage the tree in a way that would mitigate ongoing risk and prevent further damage. I was asked if I could review the management options already considered and to identify any alternative management options. I was aware that Council's deliberation of management options was very likely to be influenced by the limitations imposed by Council's insurers and constrained by budget considerations.

This report was intended to provide Council management with an additional professional arboricultural opinion of potential tree management options. It was not intended to provide detailed management guidance, full physical investigation or economic feasibility of the options discussed.

1.1 Statement of Limitations

This statement of limitations constitutes an integral part of this assessment report. The assessment was undertaken by an Arborist with AQF level V (Diploma) qualification. Terra ARK is a registered user of the Quantified Tree Risk Assessment ® (QTRA) methodology[1]. Only registered licence holders having received training and regular updates from Quantified Tree Risk Assessment Limited are permitted to use the Quantified Tree Risk Assessment system.

It is important to recognise that QTRA does not attempt to evaluate risk exposure during extreme weather events [violent storms with wind speeds exceeding 75kph]. While there may be elevated risk of tree failures during severe storms, most trees have withstood numerous historical adverse weather events without significant consequence. Evidence of previous failures, any known maintenance history, and current site conditions were factored into the risk assessment for the tree.

This assessment was based on the observations made at the time of the inspection and information provided by the client and their employees. Any conclusions reached, or tree works recommended, do not imply that the tree will withstand adverse natural conditions (e.g. soil failure, erosion, severe storms or extended drought) or works carried out on or near it, including accidental or unpredicted damage from construction, land development or maintenance activities. Changes in the tree brought about by subsequent severe weather events, accidental or deliberate damage, mismanagement, sudden changes in tree health or by changes to the growing conditions, may impact on the validity of the conclusions.

The report is not a guarantee, but a professional opinion of the current condition of the tree, the potential risk of harm posed by it, and appropriate management options. Whilst all care is taken in the preparation of this report, no responsibility can be taken for the continued vitality of the tree mentioned or for any damage that it may cause in the future.

[1] https://www.qtra.co.uk/cms/index.php?section=4

NB: The risk assessment provided is valid for twelve months only.

1.2 Assessment Methodology

I carried out a site inspection on Wednesday the 31st of January 2017; two Council officers were in attendance to assist with provision of tree maintenance history. The tree assessment was a non-invasive, ground based visual inspection. Binoculars were used from different angles to view the tree canopy. A nylon hammer was used to sound the lower stem and buttresses. A digital camera, digital voice recorder and written notes were used to document site observations. Girth and canopy spread measurements were taken with a nylon tape measure; tree height was measured with a digital clinometer. The risk assessment and management recommendations within this report were based on the site observations and information provided by the Council officers attending the inspection. A woman residing at 7 Castle Drive, spoke with me briefly at that inspection and provided a verbal account of the tree issues and alleged damage.

QTRA methodology was applied to the risk assessment. QTRA evaluates the risk of significant harm from tree failure by quantifying the independent probabilities of three components of the tree hazard – 1) target; 2) impact potential and 3) probability of failure – enabling the product of the component risks (risk of significant harm) to be expressed as a ratio and compared with a generally accepted level of risk.

The current version (QTRA Version 5) utilises Monte Carlo simulations[2] to calculate the Risk of Harm (ROH). The mean value from each set of results for all possible combinations of Target, Size and Probability of Failure are presented as the QTRA ROH. Specific tree risks are calculated by the assessor utilising either the QTRA manual calculator or the software application.

[2] For further information refer to http:/en.wikipedia.org/wiki/Monte_Carlo_method

In the management of trees QTRA methodology proposes that an overall probability of 1/10,000 is taken as a threshold of tolerable risk of significant harm from tree failure to the public at large[3].

In applying this threshold where the risk of harm probability exceeds 1/10,000, remedial action to reduce the risk to or below the acceptable level is appropriate, unless the risk is limited to a select individual or group – such as tree owners – who make an informed decision to accept a greater or lesser risk. Additionally, and importantly, an individual tree might confer benefits over and above the general benefits from trees and these might be set against the risk of harm, as is practised in the management of industrial risk. The management options provided in this report, focus on reducing the risk of harm to tolerable levels not on the elimination of risk.

It is very important to recognise that the 1/10,000 threshold is NOT a hypothetical limit of tolerable risk, whereby 1/9,999 would be deemed unacceptable and 1/10,001 deemed tolerable. Risks that are evaluated as approaching the 1/10,000 threshold demand careful consideration of the costs and benefits associated with the specific trees being inspected.

Where a risk of harm is less than 1/1,000,000 it is considered to be broadly acceptable.

A risk within the range of <1/10,000 and 1/1,000,000 is considered to be tolerable where it is as low as reasonably practicable (ALARP). This is the range where it is necessary to consider the costs and benefits of risk control so that the cost of work carried out and the risk involved in carrying out the work is not disproportionate to the benefit gained.

The following table is an adapted inclusion from the QTRA User Manual Version 5[4] and shows the advisory risk thresholds applied to the risk assessment.

[3] Helliwell, D.R. 1990 *Acceptable Level of Risk Associated with Trees Arboric*. Journ. Vol. 14 No. 2: Health and Safety Executive 1996 *Use of Risk Assessment Within Government Departments Report* prepared by Interdepartmental Liaison Group on Risk Assessment HSE Books, Sudbury, Suffolk 48pp

[4] QTRA Tree Safety Management 2013 *Quantified Tree Risk Assessment User Manual Version 5*, Quantified Tree Risk Assessment Ltd

Table 1. Advisory Risk Thresholds and Ranges

Risk Thresholds	Description	Action
1/1 000	**Unacceptable** Risks will not ordinarily be tolerated	· Control the risk
	Unacceptable (where imposed on others) Risks will not ordinarily be tolerated	· Control the risk · Review the risk
	OR Tolerable (by agreement) Risks may be tolerated if · those exposed to the risk accept it, or · the tree has exceptional value	· Control the risk unless there is broad stakeholder agreement to tolerate it, or the tree has exceptional value · Review the risk
1/10 000	**Tolerable** (where imposed on others) Risks are generally tolerable	· Assess costs and benefits of risk control · Control the risk only where a significant benefit might be achieved at a reasonable cost · Review the risk
1/1 000 000	**Broadly Acceptable**	· No action currently required · Review the risk

Costs and Benefits of Risk Control.

Risk control measures bring benefits in terms of reducing or eliminating a risk, but those benefits come at a cost that should, in broad terms, be balanced against the benefits of risk control. For guidance on considering costs and benefits, please refer to the Quantified Tree Risk Assessment Practice Note, available at http://www.qtra.co.uk/cms/index.php?section=25 .

Based on the tree owner/manager accepting the principles set out in the Quantified Tree Risk Assessment Practice Note and or any other specific instructions, the risk assessor will take account of the cost/benefit balance when providing management recommendations

2.0 SITE OBSERVATIONS

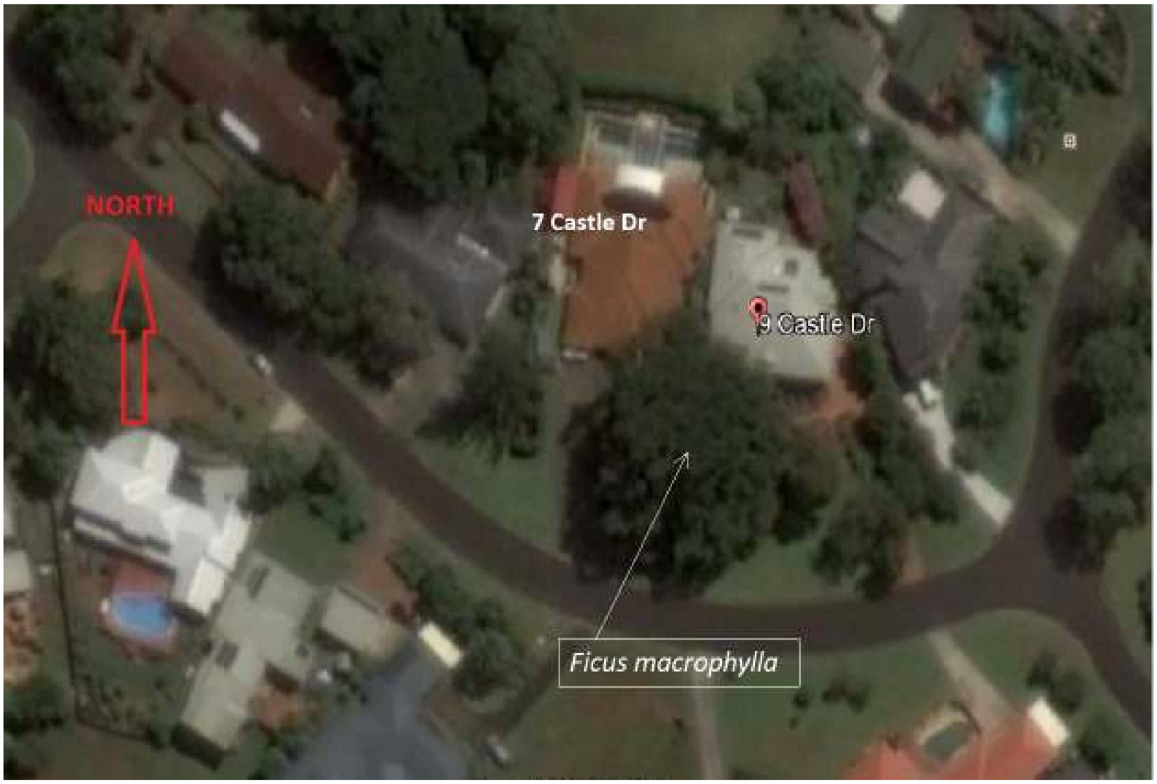

Figure 1: Aerial showing tree location (not to scale)[5]

2.1 General Site Observations:

The tree was located within the grassed road verge on the northern side of the road reserve, and near the unfenced boundary of number 7 and 9 Castle Drive, Lennox Head. It was growing on a gentle slope; the aspect was on the high southeast facing side of a hill with views of and partial exposure to wind from the Pacific coast. The tree canopy was highly visible and prominent in the streetscape. It was located directly opposite a Council reserve that consisted predominantly of mown grass.

The tree had a broad open grown canopy with full solar access on all sides; this indicated that it had matured without competition from surrounding or shading trees. It was a Moreton Bay Fig (*Ficus macrophylla*), potentially a naturally occurring remnant or regrowth tree; it was estimated to be greater than 150 years old. It was also possible that the tree was planted or associated

[5] Image provided by Digital Globe 2018 – Image date 28/01/2016

with an original farm settlement; fig trees were commonly retained or planted as shade trees for stock on dairy farms. Determination of a more accurate age or origin would require further investigation of settlement and clearing history with reference to naturally vegetation associations.

The unfenced and unmarked boundaries of the adjacent lots were set back behind and around the tree (see fig 2). It was n However, portions of the tree canopy appeared to overhang the property boundaries and it was evident that roots from the tree were growing within the adjacent properties for a good distance beyond the canopy. There were landscaped garden and turf areas under the canopy of the tree in both lots. The ground surrounding the tree was mostly well mulched with leaf litter close to the stem and mown grass under the canopy within the verge.

Figure 2: Image provided by Council indicating property boundaries in relation to the tree.

The land was modified to accommodate the subdivision and associated infrastructure. The natural site soils appeared to be well drained dark brown clay loams sands; the ground within number 7 had been partly filled for house construction so that it was higher by about a metre than the land under the tree and within number 9; the toe of the fill batter appeared to extend beyond the property boundary into Council land and under the tree canopy.

The position of the property boundary was not clear, but plans indicated that electrical assets were underground running close to the property boundaries. The electrical junction box was at the boundary of the two lots, directly to the north of the tree. Stormwater drains running from the dwellings to the kerb were in the vicinity, but the locations were not marked. There was a masonry letterbox in front of 7 Castle Drive to the west of the tree; the aerial image provided by Council (figure 2) indicated that it was possibly located within the road reserve. There was a paved pedestrian path to the north east of the tree inside 9 Castle Drive; no other visible infrastructure was located under the tree canopy which provided good shade to the street and front gardens.

The main accesses to the dwellings at 7 and 9 Castle Drive were located away from the tree canopy. The street was very quiet with not much vehicle traffic other than residents and visitors. No pedestrian traffic was noted during the site inspection although some local foot traffic (dog walkers, postal delivery, children etc) would be expected at either end of the day and on weekends.

There was little evidence of fallen branches on the ground; only small twigs and one dead branch about 30 mm diameter were observed. Council staff indicated that some smaller diameter live branches had previously failed, likely due to severe weather events.

I observed some structural damage within 7 Castle Drive; I was shown a stepped crack in the eastern wall, lifting concrete paving on the driveway, movement of a masonry letterbox and movement in a courtyard wall and portico piers at the front of the house. I observed one tree root in a gap between a path and the building wall at the western side of the house. I did not investigate the origin of the tree root or the cause of the house movement and made no conclusions about whether the tree roots might have caused or contributed to the damage.

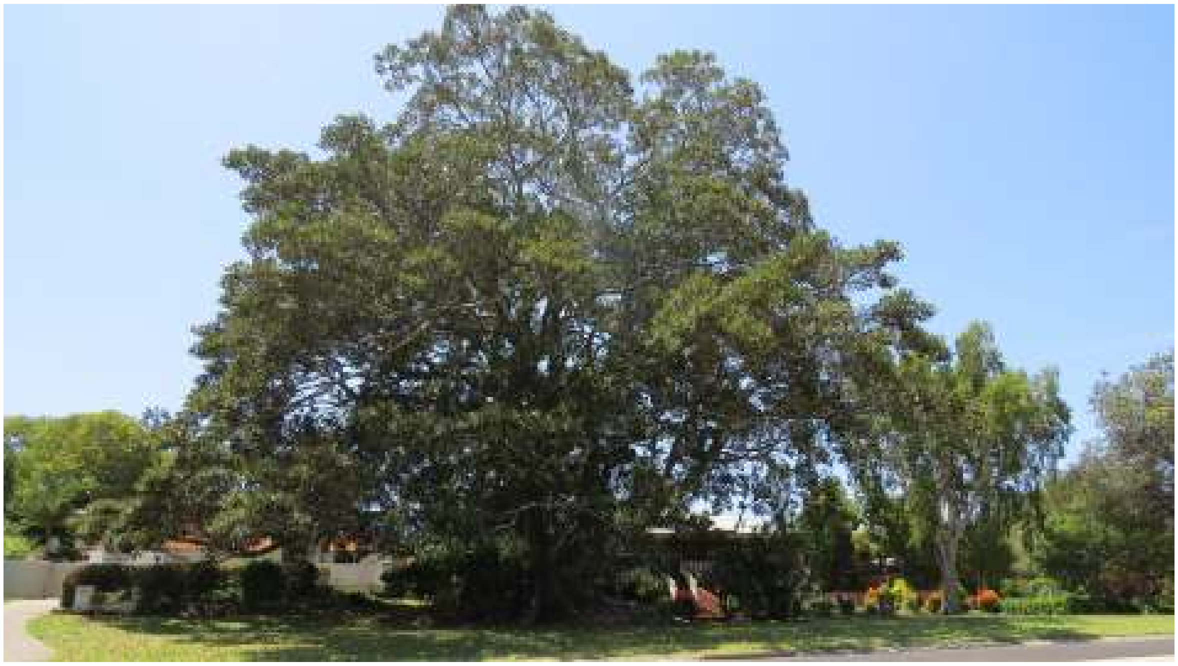

Figure 3: Ficus macrophylla (from south)

2.2 Details of tree inspection:

Genus: *Ficus*

Species: *macrophylla*

Common Name: Moreton Bay Fig Tree

Height: 27.1 metres

Stem Girth: measured at breast height: 14.65 metres

Stem Diameter: 4.66 metres

Age: estimated >150 years (based on growth characteristics and dimensions)

Growing Environment:

The tree was growing on what appeared to be well structured chocolate brown clay loam, most likely with reliable ground water availability. Site history prior to subdivision was unknown. There was some presumed site disturbance at the time of subdivision, road, and house construction which included raised soil levels to the north west (within 7 Castle Drive), probable trenching under the canopy for installation of electrical assets and stormwater and associated soil compaction damage; there was no evident recent disturbance within the root zone. The verge and private garden area was mostly mown grass with some shrub beds on private land under the canopy.

The tree had a large broad spreading domed canopy with no obvious phototropic bias, albeit with some past removal of large leaders and reduction of the spread over private property to the north. The canopy was partially exposed to ocean winds but there was no salt burn or wind shearing evident. The growth form of the tree was typical of similar open grown specimens of *Ficus macrophylla* found on similar sites, but overall untypically large for those remaining within urban subdivisions.

Tree Condition:

Observable woody tree roots were intact with no substantial injury; no soil heave or stem displacement was observed. There was likely some historical damage to roots dating back to subdivision works including for installation of underground service trenches, bulk earthworks and roadway construction. Excavation for electrical assets would most likely have severed large woody roots under the tree canopy near the property boundaries to a depth of at least 600 mm but no direct evidence of consequential detrimental damage was observed or indicated in the tree growth responses.

The lower stem crown and root buttresses appeared sound and without substantial injury to the bark excepting for some decay within a portion of the lower stem and buttress on the north eastern side. The growth response was vigorous and new adventitious roots had formed sound compensatory natural bracing across the injury and elsewhere around the stem. No fungal fruiting bodies or pathogens were observed within the injury or elsewhere around the tree.

The central leader of the tree was previously damaged (storm and/or lopping) and contained some decay, there were also some old pruning injuries that were only partially occluded. There was no evidence of other past substantial canopy failure. The remaining leaders formed a well-structured and balanced canopy with sound limb and branch junctions. There were some small diameter (< 80mm) dead branches in the tree and on the ground under the canopy; this would be expected as part of natural growth. However, portions of the canopy overhanging private land were well groomed and free of dead branches.

The foliage on the northern side was denser than elsewhere on the tree canopy; this was likely a response to regular pruning of small diameter branches to clear rooflines. The pruning wounds were well occluded (figure 5) with no evidence of subsequent epicormic regrowth developing or branch end decay.

No diseases or significant pests were noted. Growth shoots showed good colour and seasonal extension. There was some fig psyllid present on the leaves, but this was currently a minor and likely transient seasonal infestation. There were some epiphytic woody weeds growing in the main branch junctions which were not yet causing any problem. There was a European Honey Bee nest in the stem hollow on the north eastern side.

The existing damage and incipient decay observed was typical of veteran fig trees of advanced age. The damage did not have a substantial consequence on the structural integrity of the tree canopy or its health; overall the tree displayed sound structure and excellent vigour with potentially good longevity beyond another 100 years.

2.3 Prognosis

Tree roots were blamed for damage caused to structures within the adjacent residential land. While damage and displacement of structures was evident, I was not provided with any conclusive evidence or asked to investigate the matter. The matter of management of root damage is critical to tree viability and is discussed in section 4.0 of this report.

Placing the issue of tree root nuisance aside, if the tree is appropriately managed there is no reason why it should not remain functional and beneficial for at least another 60 years. Tree risk can be managed through balanced pruning or other canopy works if found to be justified by tree risk assessment. Over that time, the ecosystem services, habitat and amenity value of the tree will likely increase.

In any case, given that the tree root zone is not entirely within public land, BSC does not have complete control over potentially damaging activities. It is possible that any future construction activities within the adjacent private land, if not appropriately managed, could have detrimental impacts on the tree.

Root and canopy damage as a result of maintenance to electrical assets is also a threatening scenario, since these run under the tree canopy in relative proximity to the tree stem where large woody roots are evident at the soil surface.

Pruning for clearance of the residential dwellings has thus far been conservatively and well managed by BSC; however, it is possible that more radical and damaging pruning could be carried out from within private land by contractors or land managers with less skill or measure.

Management options for the tree are provided in section 5.0 of this report.

2.4 Tree Benefits

Any tree risk assessment should also consider the tree benefits. All trees confer environmental benefits that include shade, cooling, stormwater interception and uptake, air quality improvement, wind speed mitigation, CO2 sequestration, soil stabilisation and provision of habitat (i.e. roost, nesting, feed and shelter) for numerous vertebrate and invertebrate species. Long lived native trees of large proportions such as this tree, provide considerably more benefits than younger and smaller trees. Trees are a public asset that appreciates with age.

The tree was of an age where it would naturally begin to form stem and branch hollows; there was a stem hollow currently occupied by bees and it was likely that there was a hollow formed or forming in the branch stub end of the large central damaged leader. There is a scarcity of hollow bearing trees and of mature native trees able to provide habitat hollows in the near future[6]; the value of this remnant tree is increased by the fact that similar large mature native trees in urban areas are uncommon.

The tree was an attractive, visually impressive specimen growing in and contributing to the amenity and character of the built environment of the local area. The large canopy provided ample shade to the immediate streetscape and to the adjacent dwelling, modulating temperature extremes, and reducing reflected heat from the bitumen and roof surfaces. Any management decisions should consider the benefits of the tree and provide a proportionate response to the mitigation of actual rather than perceived risk or nuisance.

[6] Le Roux DS, Ikin K, Lindenmayer DB, Manning AD, Gibbons P (2014) *The Future of Large Old Trees in Urban Landscapes*. PLoS ONE 9(6): e99403. doi:10.1371/journal.pone.0099403

An amenity tree valuation is provided in Appendix A of this report. However, it should be noted that there are numerous known benefits of trees that the amenity valuation methodology does not consider, such as:

- The additional monetary value of ecosystem services conferred by the tree over its projected lifespan i.e. storm water interception and uptake, air quality improvement, carbon sequestration, temperature mitigation etc. Some of these values might be captured by undertaking an I-Tree Eco assessment. More information available here https://www.itreetools.org/eco/index.php.
- Large trees are also known to benefit community health outcomes through connecting people with nature and improving the walkability of neighbourhoods.
- Large established trees improve real estate values.[7]
- The tree provides significant habitat values (roosting, nesting and forage) for native fauna that will increase as the tree ages.

[7] Plant, L, A.N. Rambaldi and N. Sipe (2016), "Property Value Returns on Investment in Street Trees: A Business Case for Collaborative Investment in Brisbane, Australia" Discussion Paper no 563. School of Economics, The University of Queensland, St Lucia, QLD 4072.

3.0 RISK ASSESSMENT FACTORS

The risk assessment considered the worst-case scenarios under normal conditions within the next 12 months.

Risk of whole tree or major limb failure was extremely low probability and as such fell within a range considered to be broadly acceptable i.e < 1/1,000,000.

- Small diameter dead branches were observed in the tree; failure of loose dead wood in the next 12 months was considered most likely.
- Failure of live branches, and risk to pedestrians and residents was considered; the risk of significant harm was found to be already as low as reasonably practicable (ALARP).
- Risks to property and fixed structures located within adjacent private property was considered and found to currently be ALARP –
    - no loose deadwood or unsound branch was currently observed within the portions of the tree canopy directly over private land
    - no fixed structures other than the dwelling roofs and masonry letter box were within target range.
    - The canopy overhanging property targets was well managed under current pruning regimes

Potential risks identified and considered in detail were:

1. Shedding of loose dead branches over the private property and road reserve
    a) Risks to persons occupying the portion of the garden areas of 7 and 9 Castle Drive under the tree canopy
    b) Risks to pedestrians in the road reserve

3.1 Occupancy Rates/Targets:

The following target ranges were applied to calculation of the various risk scenarios based on site observations and other information supplied:

- Pedestrian usage of the road reserve area under the tree was assumed to be low and comprise local area residents only. It was conservatively calculated to be within:

  - range 4 (i.e. between 1 per/hr and 3 per day averaged across the year)
  - This also considered lawn mowing and other maintenance

- Pedestrian occupation of the garden areas of the adjacent dwellings was conservatively placed in
  - range 3 (2- 14 mins per day across the year).

3.2 Details of impact Potential:

The most likely failure scenarios considered during the assessment involved potential failure of small dead branches held in the canopy over the garden areas and the road reserve:

  - 25-80 mm diameter, being in range 4 (25-100 mm).
  - Degraded and loose deadwood was assigned a reduced mass of 50%

3.3 Details of Failure Probability:

For the calculated scenarios within the next 12 months the failure of loose small diameter dead branches between 25-80 mm diameters was the most probable and was placed within range 1.

3.4 Summary of QTRA results

Under the current site usage, the worst-case scenario in the next 12 months was calculated to be the risk of failure of small diameter dead branches over the portions of the garden and lawn areas within private property that were under the tree canopy.

The calculated risk of 1/100,000 is within the yellow range (see tables 1 and 2) and is currently considered to be ALARP no risk mitigation is currently required.

Small dead branches currently held in the tree canopy would not likely cause damage to those property targets located under the tree canopy (i.e. letterbox and dwelling roof).

.
The ongoing risk mitigation and tree management options are discussed further in section 5 of this report.

Table 2. ***Summary of QTRA results***

Scenario #	**Target Type**	**Target Range**	**Size Range**	**PoF Range**	**Multiple Targets**	**RoH**	**Tree Part**	**Target area**
1a	Human Occupant	3	4 (-50%)	1	(1T)	1/100,000	Loose dead wood	Private garden area
1b	Human Pedestrian	4	4 (-50%)	1	(1T)	1/1,000,000	Loose dead wood	Road Reserve

4.0 ROOT ENCROACHMENT AND TREE NUISANCE

It was established that the tree canopy did not pose an unacceptable risk or unreasonable nuisance to persons or property. However, it was evident that the tree roots were within the adjacent residential lots. The land development and building construction occurred on land occupied by Fig tree roots without apparent regard for potential root conflicts with new infrastructure or for the tree viability. Recently, BSC accepted insurance claims against them that nominated the tree roots as the cause of damage to structures and upheaval to paving in the adjacent residences. The commissioning of this report arose from the need for BSC to establish an effective control to prevent further damage to private property from the tree roots.

4.1 Process and considerations

In general, and put simply, preventing root growth in a particular direction or location while retaining a tree, requires inserting a physical barrier and/or pruning tree roots. The location and potential effectiveness of the root pruning and barrier is evaluated after fully considering and investigating both site constraints and the tolerance of the tree to the resultant loss of root mass and growing area. Where root encroachment is implicated in damage or nuisance it is not possible to effectively evaluate problems and prescribe management solutions without first investigating the below ground landscape. Soil cores, root mapping via use of ground penetrating radar, and non-destructive exploratory trenching are methods commonly used in due diligence investigations.

It was feasible that woody roots present within private land had contributed to the observed structural damage and movement. However, without further investigation of soil properties, root mapping and construction methods, it was not possible to ascertain to what extent the tree had caused or contributed to damage or how successful either root pruning or a root barrier might be in preventing further damage occurring. It should be noted that if the problems of structural damage within 7 Castle Drive were linked also to shrinkage and heave of reactive clay soils or substandard building then removal of fig roots would not fix the problem. Changes to soil moisture affected by tree removal could have further impact on the issue.

The location of underground electrical services and stormwater drains was established by Council officers, but no physical investigations were carried out to determine the extent, size and depth of the existing roots crossing the boundary, or the soil profile in which they were growing.

It is problematic to prevent the fig tree roots from entering the private properties due to the proximity of the boundaries to the tree stem, and the presence of underground electrical conduits on Council land between the tree and those boundaries. Inserting a root barrier at any point between the tree and the dwelling structures would entail trenching under the tree canopy and within the nominal tree protection zone; the proximity of works to the tree stem would be considered a 'major encroachment' according to AS4970 – 2009 *Protection of trees on development sites*[8]. Any reduction in that encroachment that might be achieved by placing the barrier or pruning trench inside private property or by reengineering the electrical assets, would be advantageous. The feasibility of these options need to be explored through cooperation with the property owners and the energy authority.

In this case considerations need to account for soil type and profile, root size, distribution and depth, existing obstacles (such as boulders, buried rubble or underground services), tree vigour, and tolerance of the Fig tree to the required damage.

4.2 Applying AS4970-2009

The Australian Standard for protection of trees on development sites (AS4970-2009) was used to inform management options for the tree with reference to the tree protection and structural root zones. It is generally regarded as a minimum standard for industry application when managing construction and development in proximity to trees. AS4970 provides guidelines and formulae for calculating the tree protection zone (TPZ) and structural root zone (SRZ). Application of AS4970 is relatively straightforward where works are at a distance that encroaches up to 10% inside the nominal TPZ. Where works are required at a closer distance to the tree stem they are considered a 'major encroachment'; this triggers a requirement for the project arborist to undertake further investigations (see section 3.3.4 of the *Australian Standard ® Protection of trees on development sites*). Most importantly AS4970 specifies a requirement for non-destructive investigations and mapping of the root

[8] Standards Australia August 2009 *Australian Standard ® Protection of trees on development sites*

system distribution including the extent of the SRZ. Note that the formula for calculation of the SRZ provided in AS4970 is indicative only and requires verification via site investigations if tree stability is to be adequately considered.

The nominal Fig Tree TPZ is the maximum radius allocated by AS4970, being 15m from the tree centre. When considering the long-term viability of the tree it is necessary to consider application of AS4970, but it is also important to recognise that the distribution of roots is rarely confined to a homogenous circular ring around any tree. Tree roots grow opportunistically along natural drainage and nutrient gradients, limited by site constraints that can include pre-existing barriers (buried obstacles, natural boulder, etc), infrastructure (retaining structures, roads, trenches) and barriers to drainage (anaerobic soils).

Since no physical investigation or root mapping was carried out to determine the actual extent of the SRZ, it was pre-emptive to eliminate the option of placement of a root barrier within Council land. It was not correct to assume that the tree would be destabilised by such works, without undertaking closer investigations to inform the decision.

5.0 MANAGEMENT OPTIONS

Given the very high amenity value of the tree, and the considerable ecosystem services conferred by it, removal should only be considered when all other management options are eliminated through due process. Cost analysis was not part of the scope of this report, however, any risk mitigation and management works, should be balanced against the value and benefits of the tree.

5.1 Risk Management

The outcome of the QTRA indicated that the highest current risk posed by the tree is the potential of harm to persons caused by failure of small diameter loose dead branches within the portion of the tree canopy overhanging the front gardens of 7 and 9 Castle Drive.

The current tree risk is 1/100,000 and currently ALARP so that no risk mitigation is required.

The current risk to property targets was found to be negligible and within a range that is considered broadly tolerable.

The overall tree risk can be easily mitigated by undertaking removal of loose dead branches in those portions of the tree canopy that overhang the garden areas. Since dead branches can remain stable in the canopy for some years, only loose dead branches require removal. Biennial removal of loose dead branches > 25 mm is recommended.

Pruning or removal of live branches is not necessary or warranted on the basis of risk. The commitment of resources to actively mitigate risks in the next 12 months, other than removal of loose dead branches is not recommended.

It is predicted that if there is no significant change in tree condition or catastrophic weather event, then the risk will likely remain within the current probability range for several years at least. However, monitoring and annual risk assessment is recommended, particularly after severe weather events, extended drought, or disturbances to the root zone.

Dependent upon any prescribed root management, preventative and remedial works may be warranted at some time in the future to offset the effects of damage caused to the tree roots. In any case, risk mitigation work should remain balanced and proportionate to the considerable tree value and benefits.

5.2 Root Pruning/Root Barrier

Placement of a root barrier was an option that was not fully investigated. The assumption that root pruning and attempts to insert a root barrier would destabilise the tree, trigger a state of decline and or cause the tree to become an increased risk to residents was preemptive. While severance of the roots and removal of growing area is not an ideal outcome, if a barrier or a root pruning trench can be inserted without destabilising the tree, then that option should take precedence to wholesale removal of the tree.

The following investigations are required to inform the decision:

- Root zone mapping of the location and distribution of the tree roots including the extent of the SRZ.
    - This should be carried out through non-destructive methods (e.g. ground penetrating radar, hand excavation, vacuum excavation or similar).
- Determine the soil characteristics and profile within the root zone.
- Locate the presence of any obstructions or other constraints to root growth (boulders, buried structures, anaerobic soils etc)
- Explore the feasibility of relocating the electrical assets to an alignment to the south of the tree (discuss with the energy authority).
- Determine the willingness of the landowners at 7 and 9 Castle Drive to permit excavation for root pruning or a barrier within their land.

The decision whether to install a barrier should also be balanced by the tree assessment, tolerance to root pruning and loss of growing area. The tree was found to have good vigour and reactive growth; the canopy was sound and healthy, and the foliage was already reduced on the northern side where root pruning and reduction would be required. The species is generally tolerant to root pruning, however careful treatment and compensatory works would be required to mitigate damaging effects. Ideally the roots would be pruned in stages over an extended period while the remaining growing area underwent improvements that might include:

- Temporary additional water;
- Vertical mulching throughout the rootzone;
- Establishment of nutrient dumps on the southern side of the tree;
- Light mulching of the root zone;
- Soil drenches to stimulate soil biological activity and root hair development.

While it was not possible to predict the effect of hypothetical root damage on the tree, given its good vigour and if provided with some care and attention during and after works, it is most probable that the tree would survive and be manageable in situ. Severe root damage could result in some branch dieback and trigger a natural retrenchment and early veteranisation of the canopy. However, this would not necessarily result in tree death or decline and would likely stabilise so that the live canopy had a reduced volume and shorter stature.

The risk of catastrophic canopy or stem failures would be entirely manageable through judicious pruning or other works such as installation of fall arrest systems or cabling. It would be possible for pruning works to mimic natural retrenchment and encourage an overall more compact canopy form thereby also managing risk factors. The potential of the tree being overcome by pathogens would be best managed by ensuring adequate ongoing care and hygienic practice is followed.

The threat of regenerated roots overtopping the barrier could be managed through intermittent repeated pruning of roots where necessary.

5.3 Tree Relocation

There was no discussion of the potential to relocate the tree in the report that informed the Council decision to remove the tree. Since tree relocation requires cutting and obtaining an intact root mass, similar investigations are required to those triggered in consideration of a root barrier. An investigation of the root distribution, soil profile and existing constraints is necessary to advance this option. Were this option to be fully explored then an arborist with proven experience and specialising in relocation of large trees would need to be engaged to provide a feasibility report and cost estimate.

Given the current proximity of the tree to the residential allotments at 7 and 9 Castle Drive, it is an initially attractive proposition to move the tree to a location in the park opposite where it would have adequate space to grow without conflict or complaint. The short distance and absence of above ground and overhead obstacles are logistical advantages. There are numerous examples of successful large fig tree transplants. However, tree relocations can be an expensive undertaking that inflicts by necessity severe damage with little assurance of long term tree viability.

There is no question that this tree is highly significant and very valuable to the community. Tree relocation is an option that should be examined before it is dismissed in a preference for tree removal. The cost of works should be balanced with the value of the tree, likelihood of success and alternate costs of removal and full compensatory replacement planting.

5.4 Tree Removal

The options presented to Council in the report that informed the decision to remove the tree, relied largely on the assumption that, to insert a root control barrier or undertake root pruning within Council land was a major encroachment of the TPZ and that would likely cause the tree to deteriorate to an extent where the risk was not practicably manageable. That assumption was not fully informed by investigations necessary to first determine the feasibility of the works, by a documented assessment of the tree risk, or by a full appraisal of the tree benefits and value.

Whole tree removal is a radical option that should not be pursued before the elimination of all other options and only if it is determined that the risk of continued root damage to private land and the resultant costs to Council can no longer be mitigated or tolerated. The value of the tree relative to the cost and type of damage should also be balanced against its loss.

Since the adjacent housing was likely constructed without due regard to the effect of tree roots on soil moisture content, removal of the tree could influence soil properties in a way that might exacerbate existing problems within private land. It may be that the complex relationship of the tree to the soil hydrology and structural integrity of the building was already accounted for in the claims assessors' reports.

If the tree were to be destroyed, it would not be possible to replace the tree with one of similar benefits within a human lifespan. The loss to the community would be considerable. Any compensatory replacement planting should reflect the immense tree value.

5.5 Take no action

Current pruning and inspection regimes were adequate to manage risk and nuisance arising from the tree canopy. The Council insurer paid for claims against tree root damage and instructed Council that no further cover will be provided unless action is taken to prevent further damage.

It could be argued that the tree was pre-existing and that the potential for tree root growth should and could have been addressed through correct engineering of structures or inclusion of root barriers at the time of subdivision and construction. However, it is reasonable for Council, having benefited from subdivision of the land, to now take practicable steps towards remedying the nuisance of root intrusion.

If repairs are to be undertaken to rectify structural damage, then they should account as much as possible for prevention of further damage i.e. building construction repairs should as much as practicable include adequate engineering to mitigate risk of tree root damage. This would to some extent reduce the risk of ongoing costs to Council although there is no guarantee that further problems would not arise. If further claims were made against Council for root damage, it would be prudent to fully investigate and require proof of tree roots as the cause, also considering soil reactivity and construction inadequacies.

To take no action would create a high level of uncertainty for Council and adjoining landowners about the potential of further damage and the resultant costs. Instead an approach of reasonable practicability should be applied to mitigation of the risk by fully investigating other tree management options.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The tree assessment revealed a highly valuable, vigorous and healthy amenity tree. The risk posed by the tree was negligible and currently as low as reasonably practicable (ALARP). Destruction of the tree would constitute the loss of a valuable community asset that could not be replaced within a human lifespan. The option of tree removal should only be considered once all other options are deemed impracticable.

The option of pruning the tree roots and inclusion of a root barrier within Council land was not fully investigated; the potential major encroachment into the TPZ should have triggered a higher level of consideration and determination of site constraints including actual root distribution, soil properties and the presence of buried obstacles, before dismissing this option.

Except for unforeseen constraints to inclusion of a root barrier or root pruning trench, there was no reason that the tree could not be managed in situ so that all reasonable steps were taken to prevent damage to the adjacent properties. The risk posed to property and persons from partial or entire tree failure could be managed through the current pruning and inspection regimes. If root pruning were to be carried out, then additional works would be required in the adjoining road verge to mitigate the loss of growing area and root mass. Any decline of the tree canopy could be reasonably managed through a program of remedial and/or retrenchment pruning to mitigate risk and prolong the tree viability.

It is recommended that the decision to remove the tree is rescinded or at least delayed until further investigations are carried out to properly determine the feasibility of root pruning and insertion of a root barrier, as well to fully consider the option of tree relocation.

Further investigations should include:

- A site survey to mark the actual property boundary locations.
- Mapping of the distribution of the fig tree roots.
- Determination of soil type and profile and the location of any buried obstacles or existing barriers to root growt.h
- Discussion with the local energy authority to determine the exact position and depth of electrical assets and options for repositioning them to the southern side of the tree.

- Engagement of a large tree relocation specialist to provide a feasibility and cost estimate for relocation of the tree to the reserve opposite.

7.0 APPENDIX A: AMENITY TREE VALUATION

This tree valuation methodology utilises the (modified) Burnley Method and is consistent with that used by many Local Government Authorities. It does not consider values of ecosystem services, social values or habitat values conferred by the tree across its lifespan. I-Tree Eco[9] is currently the accepted industry assessment model for valuing of ecosystem benefits of trees.

The (modified) Burnley Method provides a relative value of the tree based on projected replacement costs. A description of the methodology can be found here:
http://www.croydonconservation.org.au/wp-content/uploads/Burnley-method-Tree-value-pdf..pdf

Conservative values were applied by the assessor. Dollar values were rounded for calculations.

The formula relies on a base volumetric value that factors in the size of the tree (cone) and that then applies a set of modifiers to the total volumetric cost. **The base value** used was calculated using averaged cost examples provided by local wholesale suppliers.

i.e. for supply of a 100 litre tree with canopy volume of 2 cubic meters costing $175, the **base value = $87.50**

TREE SIZE (V) This is derived through application of the volume of a cone
Tree radius 15.75 metres; height 27.1 metres =7039.78 cubic metres

Starting value applied to the tree was:

(volume x base value) = **$615,981**

The modifiers used are highlighted in green below for each factor:

USEFUL LIFE EXPECTANCY (E):

This species is very long lived and could provide viable amenity well beyond the next 60 years.

[9] https://www.itreetools.org/eco/index.php

USEFUL LIFE EXPECTANCY RANGES	MODIFIER VALUE (E)
50 Years	1.0
40 - 49 Years	0.9
30 - 39 Years	0.8
20 - 29 Years	0.7
10 - 19 Years	0.6
< 10 Years	0.5

FORM AND VIGOUR (FV):

The tree displayed good wounding response and shoot growth indicating good vigour and only slight imperfections in form due to previous leader damage and removal.

FORM AND VIGOUR DESCRIPTORS	MODIFIERS (FV)
Perfect form and excellent vigour	1.00
Slight imperfections in form	0.90
Slightly reduced vigour	0.90
Slight imperfections & slightly reduced vigour	0.80
Good form with good vigour	0.75
Good form with average vigour	0.70
Good vigour with average form	0.70
Good form with poor vigour	0.65
Good vigour with poor form	0.65
Bifurcation of trunk & excellent vigour	0.60
Bifurcation of trunk & good vigour	0.55
Bifurcation of trunk & average vigour	0.50
Bifurcation of trunk & poor vigour	0.40
Poor form with average vigour	0.30
Poor vigour with average form	0.30
Poor form and poor vigour	0.20
Excessive deadwood, cavities & poor form	0.10
Dead	0.00

LOCATION (L):

The tree was well suited to the site and growing conditions, it provided good shading to the dwellings, road and pedestrian verge and was highly attractive. However, it was situated near electrical assets and the private property boundary. While some persons would be pleased to benefit from the tree, the current property owner perceived the tree as an ongoing threat due to root interference. No significant risk or nuisance from the tree canopy was established. It was unfortunate that the dwelling constructions were approved near the tree since they did not adequately accommodate the tree constraints which had resulted in root conflicts.

LOCATION DESCRIPTORS	MODIFIERS (L)
Perfect suitability	1.0
Could be better located but no problems	0.9
Minor problems, e.g. lifting paving	0.8
Species unsuited or causes problems	0.7
Species unsuited and causes problems	0.6
Species unsuited and causes major problems	0.5
Species unsuitable	0.4

The value of the tree was then determined using the formula:

VALUE ($) = TREE VOLUME x BASE VALUE x (E) x (FV) x (L)

= ($615,981) x 1.0 x 0.8 x 0.7

Tree Value = **$344,949**

Please note this amenity value does not measure or reflect additional ecosystem services conferred by the tree in mitigation of temperature, shade, reduced cooling costs, wind speed mitigation, stormwater interception and uptake, air quality improvement, carbon sequestration, community health and wellbeing, contribution to local biodiversity, or habitat benefits to native fauna as well as increased real estate value.

8.0 APPENDIX B: CV OF AUTHOR

JAN ALLEN

ACADEMIC QUALIFICATIONS

Diploma Horticulture (Arboriculture) Industry Training Group Australia 2010 (equivalent AQF level 5)
Diploma Horticulture Gold Coast School of Horticulture 2005 (equivalent AQF level 5)
Instructional Skills Certificate TND004 Gold Coast TAFE1996
Certificate in Small Business Management Bridging the Gap, Southport, QLD1996
Advanced Certificate in Tropical Horticulture NT Institute of TAFE, 1992
Tree Surgery Certificate (Course # 1522) Ryde College of TAFE, NSW1989
Drawing Certificate East Sydney TAFE, NSW1989
Certificate in Urban Horticulture Ryde College of TAFE, NSW1988

PROFESSIONAL AFFILIATIONS

Member of Australian Institute of Horticulture and Registered Horticulturist (0026)
International Society of Arboriculture

SPECIALIST SKILLS

Tree assessment and urban tree management, tree risk assessment (QTRA), disease diagnosis and management, trees and development, site supervision, landscape tree assessment, tree stock certifications; Heritage tree assessment, tree valuations; significant tree surveys and management of veteran trees; hollow tree habitat conservation, creation and management; plant identification and flora surveys; Research, writing, editing and review, training facilitation and presentation.

WORK RELATED LICENSES AND TRAINING

Quantified Tree Risk Assessment Licensed User #765 QTRA LTD Training 2006
30215 QLD Course in General Safety Induction (Construction Industry Blue Card) CSTC Pty Ltd 2005
Quality through Service Facilitator Training Group Training Australia1994
Systematic Management of Occupational Health and Safety National Safety Council, NSW 1989
Visual Tree Assessment and Tree Biomechanics Dr Claus Mattheck, Brisbane 2000, 2001, 2007
Introduction to Wood Decay Fungi and Microscopy Workshop Dr Francis Schwarze Brisbane 2011
License to Perform High Risk Activities (EWP) # 0003006454

CONTRIBUTION TO PAPERS, PRESENTATIONS AND OTHER PUBLICATIONS

August 2010 QAA Arborcamp – Introduction to The Veteran Tree Group
March 2010 and March 2012 Terra ARK, *Trees and Development Seminar – The Roots to Best Practice* – Brisbane
Feb 2012 QAA Basic report writing skills workshop
Feb 2012 GCCC Urban Design Seminar Series – *From Render to Reality Planning Principles to achieve design intent for Landscape Trees*
May 2015 (Griffith University) September 2015 (Indigiscapes Redlands) October 2015 (Wollongbar TAFE), February 2016 (Cleveland), May 2016 (Cairns JCU) *Scarred and Veteran Tree Management* THECA workshop series
Feb 2016 2nd International Urban Tree Diversity Conference Melbourne– presentation *Thinking in tree Time and the Benefits of Age Diversity*
Contributing Author – Subtropical Gardening Magazine

COMMITTEES AND WORKING GROUPS

Australian Standards *AS 2303 Tree Stock* EV18 committee and working group member Australian Institute of Horticulture representative

NON PROFESSIONAL MEMBERSHIPS

Veteran Tree Group Australia – Founding Member, Director and Secretary
Friends of the Gold Coast Botanic Gardens
Member of the Treenet Advisory Board

WORK EXPERIENCE

Nov '11-Current **QCAT Tree Assessor –** Undertake tree inspections and provide technical advice to the Qld Civil Administrative Tribunal relating to applications under the Neighbourhood Dispute Resolution Act

Feb '96 – Current **Terra ARK** PO Box 438 Miami
Manager, and Consulting Arborist. The business operating and trading as Terra ARK since February 1996 i.e. 22 years providing advice to tree and vegetation managers. This has included the supply of basic ecological site assessments, flora surveys, vegetation and open space management plans, tree audits, risk assessment and inspection reports, disease diagnosis and management, planting and vegetation planning advice, weed management and natural areas rehabilitation plans. The current business focus and expertise lies with urban tree management with particular focus on management of veteran and heritage trees, and tree risk assessment.

July – Dec '10 **Gold Coast City Council, Citywide Greening Project Officer -** Contract position within Parks and Recreation responsible for research and contribution to *Street Tree Management Strategy* document for whole of city.

Feb 1993-Feb '96 **Gold Coast City Council, Assistant City Arborist**- administration of Tree Preservation By-laws, assist in management of city trees (private and public); provision of horticultural & arboricultural advice to Council, ratepayers, developers and community groups; assist in contract supervision; assist in development assessment, environmental & landscape policy development and implementation.

Oct '94-Nov '95 **ARKishop**,
Arboricultural Consultant & Landscape Designer on various commercial and residential projects within Byron and Tweed Shires.

1992 - 1993 **Handcrafted Gardens,** Morayfield, QLD **Horticulturist,** Garden maintenance/ renovation in the Brisbane area.

Jan '92- June '92 **NT Tree Services,** Karama, NT **Arborist** – carry out all aspects of urban tree assessment, tree works, and associated machinery operation and maintenance.

March '91-Dec '91 **Charles Darwin University Casuarina campus – Technical Assistant, Horticulture School** – Design and source supply of new shade house facilities. Assist in technical writing, lesson preparation and delivery of workshops to students. Support delivery of international student program.

Jan '89- April '90 **Federal Airport Corporation**, Mascot Airport, Sydney, NSW**, Horticulturist**

1984- '88 **Jan's Garden Maintenance**, Sydney, NSW **Proprietor**, garden maintenance, renovation and design.