cheshire woodlands
arboricultural consultancy

Report of Michael Ellison

on the

SURVEY AND RISK ASSESSMENT OF 14 FIG TREES

AT

LAMAN STREET, COOKS HILL, NEWCASTLE, NSW

On behalf of

Save Our Figs Inc.
PO Box 155
Islington NSW 2296

Reference: CW/6502-R-12

Dated: 11 January 2012

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1. EXECUTIVE SUMMARY

1.1 Planted around 1930, 13 no. Hill's weeping fig trees and a later addition of 1 small leaved fig tree are located to the north and south sides of Laman Street to form a discontinuous avenue arching over the street to form a closed canopy.

1.2 In June 2007, severe stormy weather is reported to have resulted in the movement in the ground of 3 no. fig trees in the Laman Street avenue. As a result of the reported movement, an investigation was initiated and the trees were removed. The openings in the tree canopy have exposed adjacent trees to modified wind loading.

1.3 Investigations into ground conditions and the distribution of tree roots have revealed variable results and it has been suggested that the trees' root systems are asymmetrical to the extent that the trees lack adequate support.

1.4 Newcastle City Council proposes that the trees should be removed and replaced for reasons of safety, primarily to remove a high risk of harm to users of the highway but also to pedestrians accessing the Newcastle Region Art Gallery, the Municipal Library and generally passing through Laman Street.

1.5 I have surveyed the trees and carried out a Quantified Tree Risk Assessment for each tree in the avenue. I conclude that the risks from the fig trees are generally very low. There are some elevated risks resulting from modified wind loading where adjacent trees have been removed or lopped but that even these elevated risks are well within the boundaries of tolerability that might ordinarily be applied by a reasonable and informed landowner.

1.6 A universal principle of risk management is that the benefits of risk reduction (in terms of reduced harm) should be balanced with the cost of that risk reduction (in terms not only of the financial cost of implementing risk control measures but also the loss of benefits that are conferred by the hazardous agency). Overall, in finding a balance between risks and benefits, effective risk management should seek to 'do no harm'.

1.7 It is my opinion that the harm done by removing the Laman Street trees cannot be justified by the removal of the low risks that the trees present.

2. INTRODUCTION

2.1 The author of the report

2.1.1 I am Michael Ellison. I am senior partner with Cheshire Woodlands Arboricultural Consultancy of 9 Lowe Street, Macclesfield, United Kingdom and Director of Quantified Tree Risk Assessment Limited of the same address. I hold the Royal Forestry Society Certificate in Arboriculture and have thirty-four years experience in arboriculture as both a contractor and consultant, operating solely as a consultant since 1997. In November 2004, I was awarded Honorary Life Membership of the International Society of Arboriculture UK & Ireland Chapter for services to arboriculture in the field of Tree Risk Assessment. In September 2005, I received the United Kingdom Arboricultural Association Annual Award for services to arboriculture. My curriculum vitae is attached at Appendix 7.

2.1.2 My area of expertise is tree and woodland management in both urban and rural environments. With regard to my expertise to produce this report, I am the originator of the Quantified Tree Risk Assessment (QTRA) method and have provided training in the assessment of tree health, tree stability and the risks from falling trees since 1991. I frequently carry out assessments of the risks from falling trees and provide risk management advice to a wide range of government, private and commercial clients.

2.2 Background

2.2.1 The report concerns 13 Hill's weeping fig trees (***Ficus microcarpa*** var. ***hillii***) and one other fig tree, thought by Marsden[1] to be a small leaved fig (***Ficus obliqua***), located to the eastern end of Laman Street between Darby Street and Dawson Street, and believed to have been planted in the 1930s[2].

2.2.2 Investigations into the stability of the trees commenced in 2006 when consulting arborist Dennis Marsden was engaged by Newcastle City Council (the Council) to investigate the root-plate architecture of the trees[3]. Since this time, a considerable body of reporting and other documentation on the trees has been accumulated by the Council and others.

[1] Marsden, D. (2009). ***Assessment of Hill's Weeping Fig Ficus microcarpa var. hillii In Civic Cultural Precinct, Laman Street, Cooks Hill, Newcastle***. The Sugar Factory – ***Arbor Advocate***, West Pennant Hills, NSW. P. 6.
[2] Marsden, D. (2009) op. cit. P. 4.
[3] Marsden, D. (2006). ***Report - Investigation into Root-Plate Architecture of Hill's Weeping Figs along Laman Street outside Newcastle Region Art Gallery***. The Sugar Factory – ***Arbor Advocate***, West Pennant Hills, NSW. 50pp.

2.2.3 The Council proposes removal of the trees on the grounds that they present a high risk of harm. It is reported[4] that on 25 August 2011 at a meeting of Newcastle City Council "***Council resolves to remove the 14 Fig Trees as soon as practical under section 88 of the Roads Act 1993 (NSW) because Council is of the opinion that the Fig Trees are likely to cause danger to traffic, property and persons in the use of Laman Street and are a traffic hazard in severe weather events.***"

2.3 Purpose of the report

2.3.1 The assessment and report are commissioned with the primary purpose of reviewing the risks from the structural failure of the trees using the Quantified Tree Risk Assessment method. Where I consider it appropriate to supplement my own observations, the review is to take account of the investigations and observations of others that have been placed on public record since Marsden's initial investigation in 2006[5].

2.3.2 The circumstances surrounding the proposal to remove the fig trees based on a reported high risk necessitates my special consideration of detail with regard to the trees and their environment. Therefore, my investigations, assessment and report extend far beyond that which I would ordinarily consider reasonable for the Quantified Tree Risk Assessment of a situation such as that presented in Laman Street.

2.4 Instruction

2.4.1 I am instructed by Save Our Figs Inc., subject to physical access being available, to:

1. carry out a survey of fourteen fig trees situated on Laman Street between Darby Street and Dawson Street and carry out a Quantified Tree Risk Assessment.
2. produce a tree survey plan and a tree risk assessment schedule setting out my survey data
3. produce a report setting out my methods, observations and opinions, and if appropriate provide options for the management of the surveyed trees.

2.4.2 Because the trees are in the ownership of a third party and at the time of the instruction access around them was limited by security fencing, it was necessary to request consent to enter the secure area and set out what I would and would not do during that period of access. In this regard, a list of activities was submitted to the Council through the client.

[4] Council Decisions. Available online at http://www.newcastle.nsw.gov.au/environment/tree_management/laman_street_figs/council_decisions. Accessed 9 January 2012.
[5] Marsden, D. (2006). Op. cit.

2.4.3 On 22 December, the Council issued a memo refusing access to the secured area.

2.5 Limitations

2.5.1 The report is written for the specific purposes described at 2.3 above and further set out at 2.4. It is not intended to be relied upon for any other purpose. The report, schedule and tree survey drawing remain the copyright of Cheshire Woodlands and any transfer of rights to any third party must be with our express written consent.

2.5.2 The assessment of trees was limited by the presence of security fencing, which was policed by a security guard during my visits of December 2011 to January 2012. The assessment was carried out from ground level and the disclosure of hidden crown defects cannot, therefore, be expected.

2.6 Technical terms and explanations

2.6.1 I have indicated any technical terms in bold type. I have defined these terms when first used and included them in a glossary at Appendix 1. In Appendix 2 there is a tree risk assessment schedule, in Appendix 3 a tree survey drawing and in Appendix 4 photographs to assist in the understanding of the report. In Appendix 6 is a list of documents that I have considered.

3. EVIDENCE UPON WHICH MY OPINIONS ARE BASED

3.1 My observations and findings

3.1.1 My initial view of the Laman Street trees was taken on 7 April 2011 when I visited the site out of personal interest and took a general view of the trees. At this visit, access to the trees was partially restricted but more open than during my more recent visits. I took photographs of the trees and the security fencing (P1010644 in Appendix 4) but made no written notes of my observations.

3.1.2 My second visit to Laman Street was on 30 December 2011 when I carried out a detailed assessment of the trees, which was limited by restricted access imposed by security fencing. I have located on the tree survey drawing the approximate positions of the security fencing both on 7 April and 30 December. I photographed the trees using a digital camera at a high resolution to enable further desktop assessment where this might be required. I revisited the site on 31 December and 1 January 2012 and took additional photographs of the trees.

3.1.3 My on-site observations and my risk assessments are recorded in a tabulated risk assessment schedule and a tree survey drawing.

3.2 Observations of others

3.2.1 Due to the limitations imposed by access and the absence of consent for invasive investigations, I make use of observations and records made during earlier investigations by others and in each instance I cite the document from which those observations and records are sourced.

3.3 Documents

3.3.1 All of the documents that I have considered in forming my opinions are listed in chronological order in Appendix 6.

4. THE SITE

4.1 Topography

4.1.1 The site is at an elevation of around 17 metres with ground sloping away gently to the north, south and east. At a distance of approximately 1 kilometre from the east coast of New South Wales, the site is exposed to high winds, and Simonsen[6] suggests that wind gusts of 100km/h occur reasonably frequently.

4.2 Geology

4.2.1 Geological investigations carried out at the eastern end of Laman Street in 2007 by Katauskas Pty Ltd [7] provide soil profiles at four bore holes on and adjacent to the site of the art gallery. The reported geological investigations extend to depths of up to 31.47 metres. From these records, I have summarised the upper soil profiles below at 4.2.2 and I have noted the approximate locations of the bore holes BH1 to BH4 on my tree survey drawing. Significantly, the Geological investigation identifies generally sandy and therefore highly permeable soils in the upper 4 – 5 metres on and adjacent to Laman Street and that

[6] Simonsen, D. (2009). ***Arboricultural Statement – Quantified Tree Risk Assessment Fig trees in Cooks Hill – Newcastle.*** Treelogic, VIC. P. 7.
[7] Wright, P. (2007). ***Report on Geotechnical Investigation for Proposed Newcastle Region Art Gallery Redevelopment at 1 Laman Street, Cooks Hill, NSW.*** Jeffery and Katauskas Pty Ltd, NSW.

"***Groundwater seepage was encountered in the boreholes at depths ranging from 3.9m to 4.3m below the existing surface levels***."

4.2.2 Borehole summary

BH1	BH2	BH3	BH4
0-30mm asphaltic concrete	0-100mm asphaltic concrete	0-20mm asphaltic concrete	0-30mm asphaltic concrete
30 - 1500mm sandy fill	100 - 1000mm sandy fill	20 - 1200mm sandy fill	30 - 1000mm sandy fill
1500 – 3700mm silty sand with clay bands	1000 – 3000mm silty sand	1200 – 2500mm silty clay	1000 – 4200mm silty clay
3700 – 9000mm silty sand	3000 – 20400mm sand	2500 – 4200mm sandy clay	4200 – 8600mm silty sand

4.3 Pedestrian access

4.3.1 Simonsen[8] reproduces data provided by the Council stating that the annual average visitor attendance to the art gallery is 72,155 and visitors to the library 360,000. Simonsen also estimates that an additional 216,077 pedestrians pass through Laman Street without visiting either the art gallery or the library, which equates to an average of 49 non-visitors per hour passing through Laman Street over a notional 12 hour day.

4.4 Vehicular usage

4.4.1 Simonsen[9] quotes an annual flow rate of 877,095 vehicles, which was provided by the Council. This equates to an average daily flow rate of 2,403 vehicles. In addition to vehicles passing along Laman Street, I observed during my site visit of 7 April 2011 that vehicles were parking between the fig trees on the south side of the street. Access to the north side was excluded by security barriers.

4.5 Buildings and other property

4.5.1 I have not documented any risk assessments in relation to buildings or other property.

[8] Simonsen, D. (2009). Op. cit. P. 5.
[9] Simonsen, D. (2009). Op. cit. P. 5.

5. METHOD

5.1 Quantified Tree Risk Assessment

5.1.1 My assessment followed the principles set out in the Quantified Tree Risk Assessment Practice Note[10], a copy of which is included at Appendix 5. Quantified Tree Risk Assessment evaluates the 3 primary components of the risk from falling trees; 1) target (***in tree risk management, the target is that which might be harmed by a falling tree or branch***), 2) size of tree or branch under consideration, and 3) probability of failure of the tree or branch within the coming year. The values are applied in ranges as set out in tables 1, 2 and 4 of the Practice Note. The calculation uses the upper value for the selected range (e.g. target range 1, which spans a range of value from 1/1 to >1/20, calculates at the highest value of 1/1). The 3 components are multiplied and their product is the annualised risk of harm.

5.2 Assessment of land-use

5.2.1 Insofar as possible, the surrounding land-use was considered as it might ordinarily be occupied without the exclusion of vehicular traffic and the partial exclusion of pedestrians. In this regard, my assessment utilises pedestrian and vehicular traffic flow data reported by Simonsen[11] and which is supported by recorded visitor numbers to the art gallery and library. Based on my limited observations on site and the general character of the immediate surroundings, Simonsen's estimate of people passing through Laman Street seems to me a substantial overestimate, but I have nevertheless used it to inform my assessments of the trees in relation to pedestrian targets.

5.2.2 Based on the Council's data and Simonsen's assumptions in respect of passing pedestrians who are visiting neither the art gallery nor the library, I calculate that the average number of pedestrian movements across the whole area affected by the trees is 123 per hour. It is important to recognise that, while there will be discernible patterns of pedestrian distribution, only a proportion of visitors will pass beneath or within striking distance of any particular tree or branch and even then, a person will pass only to one side of a tree. Therefore, the risk assessment of any particular tree or branch requires consideration only of those pedestrians likely to pass beneath or within striking distance of it.

[10] Anon. (2011). ***Quantified Tree Risk Assessment Practice Note V4.02 (AUS).*** Quantified Tree Risk Assessment Ltd., Macclesfield, UK. 9 pp.
[11] Simonsen, D. (2009). Op. cit. P. 5.

Gallery visitors annually 72,155 x 2 movements each	=	144,310				
Library visitors annually 360,000 x 2 movements each	=	720,000				
Assumed other pedestrian movements	=	216,077				
	=	1,080,387	÷	365	=	2,960

2,960 per day ÷ 24 = 123 per hour

5.2.3 Having considered the general character of the area and the likely distribution of pedestrians prior to any of the current security measures, I have, in accordance with the QTRA method, valued the pedestrian targets during wind events exceeding 60 kph, which is the point above which I believe any failures would be reasonably expected to occur. I have applied QTRA target range 3 (up to 10 pedestrians per hour) to the northern footpath and range 2 (up to 36 pedestrians per hour) to the southern footpath and the pedestrian crossing from the Civic Park. I have valued the vehicular usage as target range 2 (up to 2,335 vehicles per day).

5.3 Buildings and other property

5.3.1 Quantified Tree Risk Assessment calculates the risk of harm from a tree based on the most significant relationship between the tree and a single target category (either people occupying vehicles on the highway, other human occupation, or property). It is my view that, on the basis of data provided above at 4.3 and 4.4, the consequences of tree or branch failure onto buildings, parked cars or other property that might be reasonably likely to be beneath the trees is secondary to the consequences of failure onto passing vehicles or pedestrians and for this reason I have not considered damage to property in any detail.

5.4 Assessment of the trees

5.4.1 At my first visit on 7 April 2011, a general view of the trees was taken from Laman Street and I did not enter the park to the north. I tapped around the stems and root-collars (***transitional zone of the main primary roots into the stem***) of trees 12020 and 12025, and took 23 photographs. I made no written notes of my observations.

5.4.2 At my survey of 30 December, the trees were assessed for general health and structural stability. The vitality (a measure of physiological condition) of the trees was assessed as being good with no outward signs of significant physiological impediment. This assessment of physiological condition informed my consideration of the structural state of the trees using the general approach known as Visual Tree Assessment (VTA)[12], where the structure of the tree is first assessed using visual observation of growth characteristics, decay and defects, which, if appropriate, may be further considered by tapping with a sounding hammer, invasive investigation, sampling, and testing or analysis of samples. Between 30 and 31December, I took 45 photographs of the trees.

5.4.3 The VTA approach relies substantially on the assumption that trees are structurally self-optimizing[13], and that providing the tree is of good vitality, any locally high stresses at the surface of the structure will stimulate the production of new wood of an amount and quality that is sufficient to regularise the mechanical stresses. This process is known as 'adaptive growth' and Lonsdale[14] advises "***For the tree as a whole, adaptive growth helps to bring about the condition in which no part is either under-loaded or over-loaded; i.e. there tends to be a uniform distribution of mechanical stresses***." Mattheck and Breloer[15] provide another useful, albeit somewhat anthropomorphic, description of the tree's ability to adapt to change – "***As it happens though, there is someone on this imperfect world who is able not only to estimate the wind load accurately but who can measure it exactly – the tree itself! Its ever watchful cambium lays down new wood wherever it is needed, by reacting both to the overall windiness of its surroundings, and the periodic oscillations in windspeed; i.e. gusts.***"

5.5 Tree risk assessment schedule.

5.5.1 Survey data and prioritised management recommendations are presented in the tree risk assessment schedule. For completeness, three risk assessments are recorded for each tree to consider the risks from secondary branches, primary branches, and whole tree failure. In the schedule, the risk of harm is expressed as a 'risk index', e.g. risk index 10 represents a risk of harm of 1/10,000 and Risk Index 140 represents a risk of harm of 1/140,000.

5.5.2 In the schedule, I have supplemented my observations with data collected in earlier surveys by other arborists. The sources of information are clearly referenced.

[12] Mattheck, C. and Breloer, H. (1994) ***The Body Language of Trees – A handbook for failure analysis***. HMSO, London. P 118 – 119.
[13] Mattheck, C. and Breloer, H. (1994). Op. cit.
[14] Lonsdale, D. (1999). ***Principles of Tree Hazard Assessment and Management***. HMSO, London. P. 27.
[15] Mattheck, C. and Breloer, H. (1994). Op. cit. P. 82.

5.6 Tree survey drawing

5.6.1 The approximate positions of the surveyed trees 12012 to 12025 and trees A, D and E, which were removed in 2007[16] are plotted on my drawing, which although of sufficient accuracy for the purpose of communicating my assessment is not to a particular scale. Where a tree is referenced in the schedule, it has been labelled with the reference number used by Marsden[17] and plotted with sufficient accuracy to identify its location. Additionally, the locations of bore holes are identified as referred to above at 4.2.2. The approximate positions of security fences are also identified.

6. SIGNIFICANT FINDINGS

6.1 Physiological condition of the trees

6.1.1 All of the surveyed trees express good vitality in their shoot extension and foliage distribution and colour. Wherever the inner crowns of the trees have been exposed to substantially increased light levels by either pruning or removal of adjacent trees, the trees have produced vigorous re-growth. Although my experience of these species is limited, I can state that the physiological condition of the trees appears normal.

6.2 Structural condition of the tree crowns

6.2.1 The trees have been topped on at least two occasions as is evidenced by the uniform pattern of acute angled unions of primary branches that have grown from the topped stems. Further topping is apparent at heights of between 4 to 8 metres as recorded in my schedule. It is possible that all of the original trees were topped at a uniform height at the time of planting or shortly thereafter, and the trees were subsequently topped in a more random fashion. I have seen no evidence that they were regularly pollarded (removal of the tree canopy, back to the stem or primary branches, usually to a point just outside that of the previous cutting).

6.2.2 Many of the primary branch unions are compression forks (***acute angled fork that is mechanically optimised for the growth pressure that two or more adjacent stems exert on each other***), which were assessed insofar as possible. Although there is evidence of localised adaptive growth, I have not identified any significant signs of failure in these compression forks or

[16] Hartley, M. (2010). ***Arborist Report – Laman Street, Newcastle.*** The Arborist Network, Sydney, NSW. 15 pp.
[17] Marsden, D. (2009) op. cit.

otherwise in the attachments of branches. I have taken full account of these features in my risk assessments.

6.2.3 It is reported[18] that trees A, D and E on the tree survey drawing were removed in 2007. These removals have created large gaps in the tree canopy and exposed adjacent trees to modified wind loading. It is reported by the Council[19] that during the night of 16 June or morning of 17 June 2011, two branches of 120mm and 100mm diameter fell from tree 12017 and one branch of 80mm diameter fell from tree 12022 and no damage or injury resulted from the failures. The failures occurred during a period of high wind when it is reported that a maximum wind gust of 70 kph was recorded at Nobby's weather station some 1 – 1.5 kilometres to the east. The failure points in the branches are reported to have shown no evidence of defect or weakness.

6.2.4 The reported failures are not unexpected given the modified wind exposure of previously sheltered branches. However, it is my opinion that given the good physiological health of the trees, on-going adaptive growth[20] will regularise the increased mechanical stresses and the risk of branch failure will continue to reduce. I have taken account of the modified exposure of branches in my risk assessment.

6.2.5 Trees 12013 and 12025 have recently been heavily lopped during an attempt to fell the trees. The lopping has exposed the trees to modified wind loading and my comments at 6.2.4 apply in this situation. However, the exposure being of recent origin means that adaptive growth will be less advanced than in the trees affected in 2007. Accordingly, I have applied a substantially elevated probability of secondary branch failure to trees 12013 and 12025. It is my opinion that adaptive growth will result in increasing branch stability over the coming 3 to 10 years.

6.3 Structural condition of stems and first-order branch attachments

6.3.1 I identified no significant defects or signs of significant structural weakness in the tree stems other than the primary branch attachments with compression forks discussed above at 6.2.2. Where I would ordinarily place a non-compromised first-order branch in probability of failure range 6 (1 in 1,000,000) or range 5 (1 in 100,000) depending on tree species, I have

[18] Hartley, M. (2010). Op. cit..
[19] Cordingley, F. (2011). Internal Memo of 15 July to all Councillors. Newcastle City Council, NSW. 4 pp.
[20] Lonsdale, D. (1999). Op. cit. P. 27.

placed most of the primary branches in range 4 (1 in 10,000) to account for the compression forks and the access limitations of my assessment. This approach introduces a degree of conservatism that may not have been necessary had I been permitted full access to the trees.

6.4 Asymmetrical tree crowns

6.4.1 The Council states[21] that "***All of the tree crowns are asymmetric. This is a natural consequence of the short planting distance between trees. Competition for light has lead*** [sic] ***to the development of branches where the greatest extension is towards the available light. Crown asymmetry in conjunction with root plate confinement and asymmetry is contributing to tree instability***". As has already been identified by Marsden[22] the asymmetry in the tree crowns is a natural consequence of closely spaced trees. My assessment has revealed no concerns in this regard, and even with the removal of trees A, D and E, there are no high risks resulting from crown asymmetry.

6.5 Structural condition of roots

6.5.1 My assessment revealed damage to surface roots in several trees where it appears that impact and abrasion from motor vehicles has occurred. This damage appears to be mainly superficial in that the affected roots exhibit signs of adaptive growth. McKenzie[23] identifies the presence of decay to buttress roots on the south side of tree 12015 and I have taken account of this in my risk assessment.

6.5.2 In August 2010, Marsden[24] investigated the severance of a root at the base of tree 12025, which occurred during water main repairs in July 2010. It was concluded that the severance "had not created a condition that would give rise to a risk of whole-tree failure under normal day-to-day conditions" and that the tree should be monitored by checking for movement and the development of fractures. I have taken these findings into account in my risk assessment. Additionally, I have observed that the stem of the tree has a minor lean to the east and exhibits growth patterns to the root-collar on the west side (P1030278 in Appendix

[21] Anon. (2011) Questions and Answers and Laman Street Figs. Newcastle City Council, NSW. P. 2. Available at http://www.newcastle.nsw.gov.au/__data/assets/pdf_file/0005/162293/Mediation_Notes_Final_11082011.pdf. Accessed on 10 January 2012.
[22] Marsden, D. (2009). Op. cit. P.19.
[23] McKenzie, I. (2010). ***Expert Witness Report – Parks and Playgrounds Movement Inc. v Newcastle City Council [2010] NSWQLEC 40745***. Arbor Views, NSW. Appendix 1.
[24] Marsden, D. (2010). Supplemental ***Report – Additional Trenching Investigation of Hill's Weeping Fig #12025 In Civic Cultural Precinct, Laman Street, Cooks Hill, Newcastle***. The Sugar Factory – ***Arbor Advocate***, West Pennant Hills, NSW. 18pp.

4) that are indicative of possible partial windthrow having occurred in the region of perhaps 20 years ago, since which time the tree appears to have stabilised.

6.5.3 Marsden[25] identifies root damage from various causes, including infrastructure maintenance, installation of kerbs and the northern footpath, damage by vehicles, and the establishment of planter beds. In all instances of above ground damage that I observed there was evidence of either old or on-going adaptive growth.

6.6 Asymmetrical rooting

6.6.1 In December 2006, Marsden[26] carried out a detailed investigation into the rootplate architecture of the Laman Street fig trees. By excavating a series of trenches along the centre-line of Laman Street the investigation sought to determine whether the root plates of the trees extended laterally into the street, or whether, as in neighbouring Tyrell Street, they had developed mainly in a linear fashion. It is reported that 7 out of the 8 trenches excavated contained only small woody roots of 5 – 10mm diameter along with small fibrous roots. One trench contained a small number of roots of up to 60mm diameter.

6.6.2 Based on the findings summarised above at 6.5.1, the Newcastle Tree Failure Case History[27] and, it appears, to some extent on the assumption that "***the root system of a typical tree can be described as shallow and widespread***"[28], the Council[29] says that evidence shows that there is a lack of support roots. However, the geological investigations of Wright[30] identifies sandy and therefore highly permeable ground conditions to a depth of at least 4 metres and the presence of groundwater at a depth of around 4 metres. These ground conditions are conducive to deep rooting and root growth can be expected to develop where water and mineral resources are available. It is clear from the aforementioned geological investigations that the upper metre of ground, into which Marsden's excavations extended are broadly as described by Marsden and given the impermeable bitumised road surface, it might reasonably be expected that relatively dry conditions will persist close to the surface and as a result there will be limited rooting.

[25] Marsden, D. (2009). P. 21.
[26] Marsden, D. (2006). Op.cit.
[27] Anon. (2010). ***A Case History Informing Tree Management in Laman Street***. Newcastle City Council, NSW. Available from http://www.newcastle.nsw.gov.au/__data/assets/pdf_file/0004/149467/Newcastle_Tree_Failure_Case_History.pdf. Accessed 11 January 2011.
[28] Marsden, D. (2006). Op.cit. P. 7.
[29] Cordingley, F. Internal Memo of 18 July to all Councillors. Newcastle City Council, NSW. 3 pp.
[30] Wright, P. (2007). Op. cit.

6.6.3 Robinson et. al.[31] advise "***The overall form or architecture of root systems is as varied as is that of shoot systems. There are extensively branched systems and unbranched ones; deeply penetrating and shallow ones; wide spreading systems and narrow ones. Several authors have attempted to provide classifications of this variety, but none of those attempts have been successful, at least not to the extent that they have been adopted widely***."

6.6.4 Kozlowski[32] reproduces a useful illustration (figure 1 below) of the depth and spread of root systems and how, far from having a typical form, root systems are highly variable in their depth and spread. The vascular function of roots in locating and transporting water and mineral elements determines the initial position of the root, following which structural adaptation will occur where there are mechanical loads. Given the tree species and geological conditions of the site, it is, in my opinion, highly likely that the fig trees have a root architecture similar to examples a, b, or d in figure 1 below, which are forms found growing in permeable ground.

[31] Robinson, D. et. al. (2003). ***Ecological Studies 168 – Root Ecology: Constraints on the Form and Function of Root Systems***. Springer Verlag, Berlin. P. 11.
[32] Kozlowski, T. (1971). ***Growth and Development of Trees – VolumeII, Cambial Growth, Root Growth and Reproductive Growth***. Academic Press, New York. P. 199.

Figure 1.

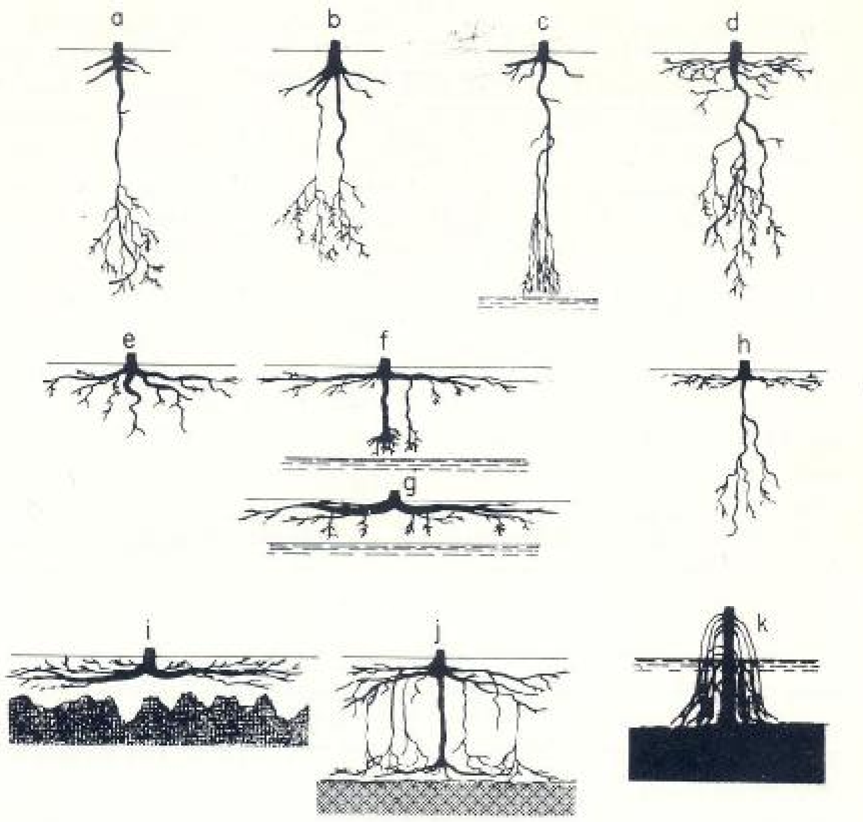


FIG. 5.2 Modification of root systems of forest trees by site. (a, b) Taproots and heart-roots with reduced upper laterals: patterns found in coarse sandy soils underlain by fine-textured substrata. (c) Taproot with long tassels, a structure induced by extended capillary fringe. (d) Superficial laterals and deep network of fibrous roots outlining an interlayer of porous materials. (e) Flattened heartroot formed in lacustrine clay over a sand bed. (f) Plate-shaped root developed in a soil with a reasonably deep ground water table. (g) Plate-shaped root formed in organic soils with shallow ground water table. (h) Bimorphic system of plate-like crown and heartroot or taproot, found in leached soils with a surface rich in organic matter. (i) Flatroot of angiosperms in strongly leached soil with raw humus. (j) Two parallel plate-roots connected by vertical joiners in a hardpan podzol. (k) Pneumatophores of mangrove trees on tidal lands. [From Wilde (1958). Forest Soils, The Ronald Press Company, New York,]

jack pine (*Pinus banksiana*) (Table 5.3). Oak tap roots were traced to depths of more than 10 feet, but few pine roots were found below 3 feet. A much higher proportion of pine than oak roots occurred in the top few inches of soil, especially the horizontal roots up to 1 inch in diameter.

There often are hereditary differences in root growth in various species

6.7 Infrastructure damage by tree roots

6.7.1 It is evident from the various documentation that there is on-going damage to infrastructure in Laman Street as a direct result of tree growth. It is also evident that in the installation and management of underground services, kerbs and footways, the trees are being damaged repeatedly.

7. CONCLUSIONS

7.1 In consideration of my own findings and the factual observations of others, I believe that my assessment of the risks from the trees has been sufficient to inform their reasonable risk management.

7.2 I conclude from my investigations that the risks from the fig trees are generally very low and that while there are some elevated risks resulting from modified wind loading where adjacent trees have been removed or lopped. At an annualised risk of death 1 in 170,000, even the highest of these elevated risks are well within the boundaries of tolerability that might ordinarily be applied by a reasonable and informed landowner.

7.3 The trees provide multiple benefits to the local community, which have been usefully summarised by McKenzie[33] and these should be accounted for in any management decisions.

7.4 When managing risks from falling trees, there is a temptation to dictate how people interface with the trees, as is evident in the installation of the barriers at Laman Street. On close analysis, the imposition of risk control decisions - that the public are usually quite capable of making for themselves – will be seen to have undesirable consequences by depriving the public of the associated benefits, such as free access.

7.5 A universal principle of risk management is that the benefits of risk reduction in terms of reduced harm should be balanced with the cost of that risk reduction in terms not only of the financial cost of implementing risk control measures but also the loss of benefits that are conferred by the hazardous agency – in this case the trees. Overall, effective risk management should seek, at the very least, to ‘do no harm’.

7.6 The outputs of the tree risk assessment process should inform risk management and not dictate it and it is the Council that must determine, through engagement with its stakeholders how it might most effectively allocate resources to the management of risk. However, the risks from the Laman Street fig trees have been so grossly exaggerated that it seems necessary to review the process that has led to the decision to remove the trees.

[33] McKenzie, I. (2010). Op. cit.

7.7 Since its launch in 2005, the Quantified Tree Risk Assessment method has undergone wide application by many arborists, foresters and land managers. Feedback from users has informed on-going development of the method, which is now substantially different to that applied in 2006 when the first Quantified Tree Risk Assessment of the Laman Street trees was carried out. Through experience and logical thinking, we have determined that the probability of failure in trees is far lower than we first suspected. As a result, our assessments are generating lower risk estimates.

Signed.

M J Ellison
Dated 11 January 2012

APPENDIX CW 1

GLOSSARY OF ARBORICULTURAL TERMS

Abscission. The shedding of a leaf or other short-lived part of a woody plant, involving the formation of a corky layer across its base; in some tree species twigs can be shed in this way

Abiotic. Pertaining to non-living agents; e.g. environmental factors

Absorptive roots. Non-woody, short-lived roots, generally having a diameter of less than one millimetre, the primary function of which is uptake of water and nutrients

Adaptive growth. In tree biomechanics, the process whereby the rate of wood formation in the cambial zone, as well as wood quality, responds to gravity and other forces acting on the cambium. This helps to maintain a uniform distribution of mechanical stress

Adaptive roots. The adaptive growth of existing roots; or the production of new roots in response to damage, decay or altered mechanical loading

Adventitious shoots. Shoots that develop other than from apical, axillary or dormant buds; see also 'epicormic'

Anchorage. The system whereby a tree is fixed within the soil, involving cohesion between roots and soil and the development of a branched system of roots which withstands wind and gravitational forces transmitted from the aerial parts of the tree

Architecture. In a tree, a term describing the pattern of branching of the crown or root system

Axil. The place where a bud is borne between a leaf and its parent shoot

Bacteria. Microscopic single-celled organisms, many species of which break down dead organic matter, and some of which cause diseases in other organisms

Bark. A term usually applied to all the tissues of a woody plant lying outside the vascular cambium, thus including the phloem, cortex and periderm; occasionally applied only to the periderm or the phellem

Basidiomycotina (Basidiomycetes). One of the major taxonomic groups of fungi; their spores are borne on microscopic peg-like structures (basidia), which in many types are in turn borne on or within conspicuous fruit bodies, such as brackets or toadstools. Most of the principal decay fungi in standing trees are basidiomycetes

Bolling. A term sometimes used to describe pollard heads

Bottle-butt. A broadening of the stem base and buttresses of a tree, in excess of normal and sometimes denoting a growth response to weakening in that region, especially due to decay involving selective delignification

Bracing. The use of rods or cables to restrain the movement between parts of a tree

Branch:

- Primary. A first order branch arising from a stem
- Lateral. A second order branch, subordinate to a primary branch or stem and bearing sub-lateral branches
- Sub-lateral. A third order branch, subordinate to a lateral or primary branch, or stem and usually bearing only twigs

Branch bark ridge. The raised arc of bark tissues that forms within the acute angle between a branch and its parent stem

Branch collar. A visible swelling formed at the base of a branch whose diameter growth has been disproportionately slow compared to that of the parent stem; a term sometimes applied also to the pattern of growth of the cells of the parent stem around the branch base

Brown-rot. A type of wood decay in which cellulose is degraded, while lignin is only modified

Buckling. An irreversible deformation of a structure subjected to a bending load

Buttress zone. The region at the base of a tree where the major lateral roots join the stem, with buttress-like formations on the upper side of the junctions

Cambium. Layer of dividing cells producing xylem (woody) tissue internally and phloem (bark) tissue externally

Canker. A persistent lesion formed by the death of bark and cambium due to colonisation by fungi or bacteria

Canopy species. Tree species that mature to form a closed woodland canopy

Cleaning out. The removal of dead, crossing, weak, and damaged branches, where this will not damage or spoil the overall appearance of the tree

Compartmentalization. The confinement of disease, decay or other dysfunction within an anatomically discrete region of plant tissue, due to passive and / or active defences operating at the boundaries of the affected region

Compression fork. An acute angled fork that is mechanically optimised for the growth pressure that two or more adjacent stems exert on each other.

Compression strength. The ability of a material or structure to resist failure when subjected to compressive loading; measurable in trees with special drilling devices

Compressive loading. Mechanical loading which exerts a positive pressure; the opposite to tensile loading

Condition. An indication of the physiological vitality of the tree. Where the term ‘condition’ is used in a report, it should not be taken as an indication of the stability of the tree

Construction exclusion zone. Area based on the Root Protection Area (in square metres) to be protected during development, by the use of barriers and / or ground protection

Crown/Canopy. The main foliage bearing section of the tree

Crown lifting. The removal of limbs and small branches to a specified height above ground level

Crown thinning. The removal of a proportion of secondary branch growth throughout the crown to produce an even density of foliage around a well-balanced branch structure

Crown reduction/shaping. A specified reduction in crown size whilst preserving, as far as possible, the natural tree shape

Crown reduction/thinning. Reduction of the canopy volume by thinning to remove dominant branches whilst preserving, as far as possible the natural tree shape

Deadwood. Dead branch wood

Decurrent. In trees, a system of branching in which the crown is borne on a number of major widely-spreading limbs of similar size (cf. excurrent). In fungi with toadstools as fruit bodies, the description of gills which run some distance down the stem, rather than terminating abruptly

Defect. In relation to tree hazards, any feature of a tree which detracts from the uniform distribution of mechanical stress, or which makes the tree mechanically unsuited to its environment

Delamination. The separation of wood layers along their length, visible as longitudinal splitting

Dieback. The death of parts of a woody plant, starting at shoot-tips or root-tips

Disease. A malfunction in or destruction of tissues within a living organism, usually excluding mechanical damage; in trees, usually caused by pathogenic micro-organisms

Distal. In the direction away from the main body of a tree or subject organism (cf. proximal)

Dominance. In trees, the tendency for a leading shoot to grow faster or more vigorously than the lateral shoots; also the tendency of a tree to maintain a taller crown than its neighbours

Dormant bud. An axial bud which does not develop into a shoot until after the formation of two or more annual wood increments; many such buds persist through the life of a tree and develop only if stimulated to do so

Dysfunction. In woody tissues, the loss of physiological function, especially water conduction, in sapwood

Incorporating extracts from Lonsdale, D. 1999. Principles of Tree Hazard Assessment. Her Majesty's Stationary Office, London

DBH (Diameter at Breast Height). Stem diameter measured at a height of 1.5 metres (UK) or the nearest measurable point. Where measurement at a height of 1.5 metres is not possible, another height may be specified

Deadwood. Branch or stem wood bearing no live tissues. Retention of deadwood provides valuable habitat for a wide range of species and seldom represents a threat to the health of the tree. Removal of deadwood can result in the ingress of decay to otherwise sound tissues and climbing operations to access deadwood can cause significant damage to a tree. Removal of deadwood is generally recommended only where it represents an unacceptable level of hazard

Endophytes. Micro-organisms which live inside plant tissues without causing overt disease, but in some cases capable of causing disease if the tissues become physiologically stressed, for example by lack of moisture

Epicormic shoot. A shoot having developed from a dormant or adventitious bud and not having developed from a first year shoot

Excrescence. Any abnormal outgrowth on the surface of tree or other organism

Excurrent. In trees, a system of branching in which there is a well defined central main stem, bearing branches which are limited in their length, diameter and secondary branching (cf. decurrent)

Felling licence. In the UK, a permit to fell trees in excess of a stipulated number of stems or volume of timber

Flush-cut. A pruning cut which removes part of the branch bark ridge and or branch-collar

Girdling root. A root which circles and constricts the stem or roots possibly causing death of phloem and / or cambial tissue

Guying. A form of artificial support with cables for trees with a temporarily inadequate anchorage

Habit. The overall growth characteristics, shape of the tree and branch structure

Hazard beam. An upwardly curved part of a tree in which strong internal stresses may occur without being reduced by adaptive growth; prone to longitudinal splitting

Heartwood/false-heartwood/ripewood. Sapwood that has become dysfunctional as part of the natural aging processes

Heave. A term mainly applicable to a shrinkable clay soil which expands due to re-wetting after the felling of a tree which was previously extracting moisture from the deeper layers; also the lifting of pavements and other structures by root diameter expansion; also the lifting of one side of a wind-rocked root-plate

High canopy tree species. Tree species having potential to contribute to the closed canopy of a mature woodland or forest

Incipient failure. In wood tissues, a mechanical failure which results only in deformation or cracking, and not in the fall or detachment of the affected part

Included bark (ingrown bark). Bark of adjacent parts of a tree (usually forks, acutely joined branches or basal flutes) which is in face-to-face contact

Increment borer. A hollow auger, which can be used for the extraction of wood cores for counting or measuring wood increments or for inspecting the condition of the wood

Infection. The establishment of a parasitic micro-organism in the tissues of a tree or other organism

Internode. The part of a stem between two nodes; not to be confused with a length of stem which bear nodes but no branches

Lever arm. A mechanical term denoting the length of the lever represented by a structure that is free to move at one end, such as a tree or an individual branch

Lignin. The hard, cement-like constituent of wood cells; deposition of lignin within the matrix of cellulose microfibrils in the cell wall is termed Lignification

Lions tailing. A term applied to a branch of a tree that has few if any side-branches except at its end, and is thus liable to snap due to end-loading

Loading. A mechanical term describing the force acting on a structure from a particular source; e.g. the weight of the structure itself or wind pressure

Longitudinal. Along the length (of a stem, root or branch)

Lopping. A term often used to describe the removal of large branches from a tree, but also used to describe other forms of cutting

Mature Heights (approximate):

- Low maturing – less than 8 metres high
- Moderately high maturing – 8 – 12 metres high
- High maturing – greater than 12 metres high

Microdrill. An electronic rotating steel probe, which when inserted into woody tissue provides a measure of tissue density

Minor deadwood. Deadwood of a diameter less than 25mm and or unlikely to cause significant harm or damage upon impact with a target beneath the tree

Mulch. Material laid down over the rooting area of a tree or other plant to help conserve moisture; a mulch may consist of organic matter or a sheet of plastic or other artificial material

Mycelium. The body of a fungus, consisting of branched filaments (hyphae)

Occluding tissues. A general term for the roll of wood, cambium and bark that forms around a wound on a woody plant (cf. woundwood)

Occlusion. The process whereby a wound is progressively closed by the formation of new wood and bark around it

Pathogen. A micro-organism which causes disease in another organism

Photosynthesis. The process whereby plants use light energy to split hydrogen from water molecules, and combine it with carbon dioxide to form the molecular building blocks for synthesizing carbohydrates and other biochemical products

Phytotoxic. Toxic to plants

Pollarding. The removal of the tree canopy, back to the stem or primary branches, usually to a point just outside that of the previous cutting. Pollarding may involve the removal of the entire canopy in one operation, or may be phased over several years. The period of safe retention of trees having been pollarded varies with species and individuals. It is usually necessary to re-pollard on a regular basis, annually in the case of some species

Primary branch. A major branch, generally having a basal diameter greater than 0.25 x stem diameter

Primary root zone. The soil volume most likely to contain roots that are critical to the health and stability of the tree and normally defined by reference BS5837 (2005) Guide for Trees in Relation to Construction.

Priority. Works may be prioritised, 1. = high, 5. = low

Probability. A statistical measure of the likelihood that a particular event might occur

Proximal. In the direction towards from the main body of a tree or other living organism (cf. distal)

Pruning. The removal or cutting back of twigs or branches, sometimes applied to twigs or small branches only, but often used to describe most activities involving the cutting of trees or shrubs

Radial. In the plane or direction of the radius of a circular object such as a tree stem

Rams-horn. In connection with wounds on trees, a roll of occluding tissues which has a spiral structure as seen in cross-section

Rays. Strips of radially elongated parenchyma cells within wood and bark. The functions of rays include food storage, radial translocation and contributing to the strength of wood

Reactive Growth/Reaction Wood. Production of woody tissue in response to altered mechanical loading; often in response to internal defect or decay and associated strength loss (cf. adaptive growth)

Removal of dead wood. Unless otherwise specified, this refers to the removal of all accessible dead, dying and diseased branchwood and broken snags

Removal of major dead wood. The removal of, dead, dying and diseased branchwood above a specified size

Respacing. Selective removal of trees from a group or woodland to provide space and resources for the development of retained trees.

Residual wall. The wall of non-decayed wood remaining following decay of internal stem, branch or root tissues

Ring-barking (girdling). The removal of a ring of bark and phloem around the circumference of a stem or branch, normally resulting in an inability to transport photosynthetic assimilates below the area of damage. Almost inevitably results in the eventual death of the affected stem or branch above the damage.

Root-collar. The transitional area between the stem / s and roots

Root-collar examination. Excavation of surfacing and soils around the root-collar to assess the structural integrity of roots and / or stem

Root protection area. An area of ground surrounding a tree that contains sufficient rooting volume to ensure the tree's survival. Calculated with reference to Table 2 of BS5837 (2005) and shown in plan form in square metres

Root zone. Area of soils containing absorptive roots of the tree / s described. The Primary root zone is that which we consider of primary importance to the physiological well-being of the tree

Sapwood. Living xylem tissues

Secondary branch. A branch, generally having a basal diameter of less than 0.25 x stem diameter

Selective delignification. A kind of wood decay (white-rot) in which lignin is degraded faster than cellulose

Shedding. In woody plants, the normal abscission, rotting off or sloughing of leaves, floral parts, twigs, fine roots and bark scales

Silvicultural thinning. Removal of selected trees to favour the development of retained specimens to achieve a management objective

Simultaneous white-rot. A kind of wood decay in which lignin and cellulose are degraded at about the same rate

Snag. In woody plants, a portion of a cut or broken stem, branch or root which extends beyond any growing-point or dormant bud; a snag usually tends to die back to the nearest growing point

Soft-rot. A kind of wood decay in which a fungus degrades cellulose within the cell walls, without any general degradation of the wall as a whole

Spores. Propagules of fungi and many other life-forms; most spores are microscopic and dispersed in air or water

Shrub species. Woody perennial species forming the lowest level of woody plants in a woodland and not normally considered to be trees

Sporophore. The spore bearing structure of fungi

Sprouts. Adventitious shoot growth erupting from beneath the bark

Stem/s. The main supporting structure / s, from ground level up to the first major division into branches

Stress. In plant physiology, a condition under which one or more physiological functions are not operating within their optimum range, for example due to lack of water, inadequate nutrition or extremes of temperature

Stress. In mechanics, the application of a force to an object

Stringy white-rot. The kind of wood decay produced by selective delignification

Storm. A layer of tissue which supports the fruit bodies of some types of fungi, mainly ascomycetes

Structural roots. Roots, generally having a diameter greater than ten millimetres, and contributing significantly to the structural support and stability of the tree

Subsidence. In relation to soil or structures resting in or on soil, a sinking due to shrinkage when certain types of clay soil dry out, sometimes due to extraction of moisture by tree roots

Subsidence. In relation to branches of trees, a term that can be used to describe a progressive downward bending due to increasing weight

Taper. In stems and branches, the degree of change in girth along a given length

Target canker. A kind of perennial canker, containing concentric rings of dead occluding tissues

Targets. In tree risk assessment, persons or property or other things of value which might be harmed by mechanical failure of the tree

Topping. In arboriculture, the removal of the crown of a tree, or of a major proportion of it

Torsional stress. Mechanical stress applied by a twisting force

Translocation. In plant physiology, the movement of water and dissolved materials through the body of the plant

Transpiration. The evaporation of moisture from the surface of a plant, especially via the stomata of leaves; it exerts a suction which draws water up from the roots and through the intervening xylem cells

Understorey. A layer of vegetation beneath the main canopy of woodland or forest or plants forming this

Understorey tree species. Tree species not having potential to attain a size at which they can contribute to the closed high canopy of a woodland

Vascular wilt. A type of plant disease in which water-conducting cells become dysfunctional

Vessels. Water-conducting cells in plants, usually wide and long for hydraulic efficiency; generally not present in coniferous trees

Veteran tree. A loosely defined term for an old specimen that is of interest biologically, culturally or aesthetically because of its age, size or condition and which has usually lived longer than the typical upper age range for the species concerned

Vigour. The expression of carbohydrate expenditure to growth (in trees).

Vitality. A measure of physiological condition expressed through the health and growth of foliage, shoots and adaptive woody tissues.

White-rot. A range of kinds of wood decay in which lignin, usually together with cellulose and other wood constituents, is degraded

Wind exposure. The degree to which a tree or other object is exposed to wind, both in terms of duration and velocity

Wind pressure. The force exerted by a wind on a particular object

Windthrow. The blowing over of a tree at its roots

Wound dressing. A general term for sealants and other materials used to cover wounds in the hope of protecting them against desiccation and infection; only of proven value against fresh wound parasites

Woundwood. Wood with atypical anatomical features, formed in the vicinity of a wound

APPENDIX CW 2

INDIVIDUAL QUANTIFIED TREE RISK ASSESSMENT (QTRA)

SITE: LAMAN STREET, COOK'S HILL, NEWCASTLE, NSW
CLIENT: SAVE OUR FIGS INC.
BRIEF: RISK ASSESSMENT OF 14 NO. FIG TREES ON LAMAN STREET BETWEEN DARBY ST. AND DAWSON ST.
ASSESSMENT LIMITED BY RESTRICTED ACCESS
ALL RISK CALCULATIONS AREBASED ON ASSUMED UNRESTRICTED ACCESS

SURVEYOR: M J ELLISON
ASSESSMENT DATE: 30 DECEMBER 2011
VIEWING CONDITIONS: FINE WEATHER
JOB REFERENCE: 6502-RAS

REF.	SPECIES	AGE RANGE	HEIGHT (M)	CROWN SPREAD N	CROWN SPREAD S	CROWN SPREAD E	CROWN SPREAD W	STEM DIA. (MM)	VITALITY	RISK ASSESSMENT OF	TARGET RANGE	SIZE RANGE	PROB FAILURE RANGE	RISK INDEX
12012	Hill's weeping fig (*Ficus microcarpa* var. *hillii*)	M	[21] 15	[16]	[12]	[5]	[11]	[1030]	G	NON-SPECIFIC SECONDARY BRANCH FAILURE ONTO PEDESTRIAN AREA	3	4	3	5900
										NON-SPECIFIC PRIMARY BRANCH FAILURE ONTO ROAD	2	2	4	**410**
										WHOLE TREE FAILURE ONTO ROAD	2	1	5	2000

COMMENTS

- Displacement of bitumen footpath surface and 'No Parking' sign
- Compression fork of co-dominant stems at a height of approximately 0.7 metres
- Mechanical damage to south side of crown, probably from high-sided vehicle
- Crown partially suppressed by tree 12013 and biased to west side
- Topped/pollarded many years ago at heights of between 4 – 5m
- [Older root severance]

MANAGEMENT OPTIONS

- Cut sign at ground level and relocate at a distance of at least 3.5m from centre of stem using minimum excavation possible (Priority 6)
- Assess for signs of damage following extreme wind events (Priority 2)

QTRA RANGE INPUT VALUES

RANGE	TARGET	SIZE	PROBABILITY OF FAILURE
1	1/1	1/1	1/1
2	1/20	1/2	1/100
3	1/72	1/8.6	1/1,000
4	1/720	1/82	1/10,000
5	1/17,280	1/2,400	1/100,000
6	1/120,960		1/1,000.000

QTRA GUIDANCE
The Quantified Tree Risk Assessment Practice Note is a technical summary of the QTRA method as it is currently practiced and includes guidance on how QTRA can inform the management of risks from falling trees. Available from http://www.qtra.co.uk/cms/index.php?section=25

HEADINGS & ABBREVIATIONS

REF:	TREE OR GROUP REFERENCE
SPECIES:	COMMON NAME WITH BOTANICAL NAME AT FIRST OCCURANCE
AGE RANGE:	Y = YOUNG, SM = SEMI MATURE, EM = EARLY MATURE, M = MATURE, PM = POST MATURE
HEIGHT:	OTHER THAN WHERE THE HEIGHT OF A TREE IS CRITICAL TO THE OUTCOME OF THE RISK ASSESSMENT, APPROXIMATELY 1 IN 10 TREES ARE MEASURED AND THE REMAINDER ESTIMATED AGAINST THE MEASURED TREES
CROWN SPREAD:	MEASURED OR ESTIMATED DIAMETER OF CROWN AT THE WIDEST POINT OR FOR EACH OF THE CARDINAL POINTS
STEM DIA:	STEM DIAMETER - MEASURED AT A HEIGHT OF APPROXIMATELY 1.3 METRES
VITALITY:	A MEASURE OF PHYSIOLOGICAL CONDITION. D = DEAD, MD = MORIBUND, P = POOR, M = MODERATE, G = GOOD
SIZE RANGE:	SIZE CATEGORY OF MOST SIGNIFICANT PART CONSIDERED LIKELY TO FAIL. RANGES 1-5. 1 = LARGE, 5 = SMALL
PROB OF FAILURE RANGE:	PROBABILITY OF FAILURE WITHIN 12 MONTHS. RANGES 1-5. 1 = HIGH, 5 = LOW
TARGET RANGE:	HIGHEST VALUE TARGET THAT THE MOST SIGNIFICANT PART LIKELY TO FAIL COULD STRIKE. RANGES 1-6. 1 = HIGH, 6 = LOW VALUE/OCCUPANCY
RISK INDEX:	E.G. RISK INDEX 20 = RISK OF SIGNIFICANT HARM 1 IN 20,000. WHERE THERE ARE MULTIPLE RISK CALCULATIONS FOR A TREE, THE HIGHEST IS IDENTIFIED WITH A BOLD FONT
DATA IN BRACKETS []	FROM MARSDEN. D. 2009. REPORT - ASSESSMENT OF HILL'S WEEPING FIG *FICUS MICROCARPA* VAR. *HILLII* IN CIVIC PRECINCT, LAMAN STREET COOKS HILL, NEWCASTLE
DATA MARKED**	FROM MARSDEN. D. 2010. REPORT – ADDITIONAL TRENCHING INVESTIGATION OF HILL'S WEEPING FIG #12025 IN CIVIC PRECINCT, LAMAN STREET COOKS HILL, NEWCASTLE
REFERENCES:	MCKENZIE, I. 2010. EXPERT WITNESS REPORT – PARKS AND PLAYGROUND MOVEMENT INC V NEWCASTLE CITY COUNCIL [2010] NSWQLEC 40745. ARBOR VIEWS, NSW.

PRIORITY

1. RISK MANAGEMENT – HIGH
2. RISK MANAGEMENT – MEDIUM
3. RISK MANAGEMENT - LOW
4. RISK MANAGEMENT – LONG TERM
5. DAMAGE TO STRUCTURE – HIGH
6. DAMAGE TO STRUCTURE – MEDIUM
7. DAMAGE TO STRUCTURE – LOW
8. GENERAL MANAGEMENT – HIGH
9. GENERAL MANAGEMENT – MEDIUM
10. GENERAL MANAGEMENT – LOW
11. ONGOING MANAGEMENT
12. PRIOR TO NEXT ASSESSMENT

INDIVIDUAL QUANTIFIED TREE RISK ASSESSMENT (QTRA)

SITE: LAMAN STREET, COOK'S HILL, NEWCASTLE, NSW
CLIENT: SAVE OUR FIGS INC.
BRIEF: RISK ASSESSMENT OF 14 NO. FIG TREES ON LAMAN STREET BETWEEN DARBY ST. AND DAWSON ST. ASSESSMENT LIMITED BY RESTRICTED ACCESS

SURVEYOR: M J ELLISON
ASSESSMENT DATE: 30 DECEMBER 2011
VIEWING CONDITIONS: FINE WEATHER
JOB REFERENCE: 6502-RAS

REF.	SPECIES	AGE RANGE	HEIGHT (M)	CROWN SPREAD N	CROWN SPREAD S	CROWN SPREAD E	CROWN SPREAD W	STEM DIA. (MM)	VITALITY	RISK ASSESSMENT OF	TARGET RANGE	SIZE RANGE	PROB FAILURE RANGE	RISK INDEX
12013	Hill's weeping fig	M	[21] 22	[18]	[13]	[7]	[7]	[1360]	G	NON-SPECIFIC SECONDARY BRANCH FAILURE ONTO PEDESTRIAN AREA	3	4	2	590
										NON-SPECIFIC PRIMARY BRANCH FAILURE ONTO ROAD	2	2	4	**410**
										WHOLE TREE FAILURE ONTO ROAD	2	1	5	2000

COMMENTS
- Compression forks of first order branches between heights of 1.3 – 2.5m
- Recently heavily pruned to remove large primary branches on south-east side, which has modified crown exposure to wind and will temporarily increase the likelihood of branch failure onto road during extreme wind loading
- Signs of displacement of bitumen surface of footpath and concrete kerb
- Topped/pollarded many years ago at heights of between 5 – 7m
- [North side roots 20 & 25cm dia. chopped, other roots severed]

MANAGEMENT OPTIONS
- Assess for signs of damage following extreme wind events (Priority 2)

REF.	SPECIES	AGE RANGE	HEIGHT (M)	CROWN SPREAD N	CROWN SPREAD S	CROWN SPREAD E	CROWN SPREAD W	STEM DIA. (MM)	VITALITY	RISK ASSESSMENT OF	TARGET RANGE	SIZE RANGE	PROB FAILURE RANGE	RISK INDEX
12014	Hill's weeping fig	M	[22] 23	[18]	[6]	[8]	[9]	[1560]	G	NON-SPECIFIC SECONDARY BRANCH FAILURE ONTO PEDESTRIAN AREA	3	3	3	620
										LOWEST PRIMARY BRANCH ON EAST SIDE -- FAILURE ONTO ROAD	2	2	4	**410**
										WHOLE TREE FAILURE ONTO ROAD	2	1	5	2000

COMMENTS
- Exposed to modified wind loading as a result of adjacent trees being removed in recent years
- Lowest primary branch on east side has a high length to diameter ratio and has been recently exposed
- Partial compression fork between heights of 1.5 – 2m with palm growing in fork
- Signs of a past secondary branch failure at a height of approximately 4m on the east side from what appears to have been a compression fork
- Past pruning to remove low branches over footpath and road
- Signs of lifting of kerbs and bitumen surfaces to footpath and road, which appear attributable to root growth
- Topped/pollarded many years ago at heights of between 4 – 5m
- [No root severance apparent]

MANAGEMENT OPTIONS
- Assess for signs of damage following extreme wind events (Priority 2)
- Cut palm at base (Priority 4)

INDIVIDUAL QUANTIFIED TREE RISK ASSESSMENT (QTRA)

SITE: LAMAN STREET, COOK'S HILL, NEWCASTLE, NSW
CLIENT: SAVE OUR FIGS INC.
BRIEF: RISK ASSESSMENT OF 14 NO. FIG TREES ON LAMAN STREET BETWEEN DARBY ST. AND DAWSON ST. ASSESSMENT LIMITED BY RESTRICTED ACCESS

SURVEYOR: M J ELLISON
ASSESSMENT DATE: 30 DECEMBER 2011
VIEWING CONDITIONS: FINE WEATHER
JOB REFERENCE: 6502-RAS

REF.	SPECIES	AGE RANGE	HEIGHT (M)	CROWN SPREAD N	CROWN SPREAD S	CROWN SPREAD E	CROWN SPREAD W	STEM DIA. (MM)	VITALITY	RISK ASSESSMENT OF	TARGET RANGE	SIZE RANGE	PROB FAILURE RANGE	RISK INDEX
12015	*Ficus* sp.	M	[17] 18	[14]	[3.5]	[3]	[4]	[850]	G	NON-SPECIFIC SECONDARY BRANCH FAILURE ONTO PEDESTRIAN AREA	3	4	3	5900
										NON-SPECIFIC PRIMARY BRANCH FAILURE ONTO ROAD	2	2	4	410
										WHOLE TREE FAILURE ONTO ROAD	2	1	4	**200**

COMMENTS
- Partially suppressed by adjacent trees
- Lower-crown developing on south side since removal of adjacent tree
- Compression forks at a height of approximately 1.3 - 2m with signs of localised adaptive growth
- Topped/pollarded several years ago at heights of between 4 –5m. Appears to be more recent than topping of the Hill's figs
- Old bark wounds to stem and possible root damage on south side
- Minor cavities at old pruning wound to primary branches/stems
- [Some damage to roots on tensile side]
- Decayed buttress roots to south (McKenzie 2010)

MANAGEMENT OPTIONS
- Assess for signs of damage following extreme wind events (Priority 2)

REF.	SPECIES	AGE RANGE	HEIGHT (M)	CROWN SPREAD N	CROWN SPREAD S	CROWN SPREAD E	CROWN SPREAD W	STEM DIA. (MM)	VITALITY	RISK ASSESSMENT OF	TARGET RANGE	SIZE RANGE	PROB FAILURE RANGE	RISK INDEX
12016	Hill's weeping fig	M	[22] 24	[16]	[13]	[6]	[10]	[1450]	G	NON-SPECIFIC SECONDARY BRANCH FAILURE ONTO PEDESTRIAN AREA	3	3	3	620
										NON-SPECIFIC PRIMARY BRANCH FAILURE ONTO ROAD	2	2	4	**410**
										WHOLE TREE FAILURE ONTO ROAD	2	1	5	2000

COMMENTS
- Compression forks between 1.6 – 2.5m
- Several low secondary and primary branches have been removed over both footpath and road in recent years
- Signs of a small secondary branch failure over road, which could be attributable to modified wind exposure following removal of adjacent tree to the south side
- Topped/pollarded many years ago at heights of between 5 – 6m
- [Bad scaffold arrangement on north side with one branch sitting on another]

MANAGEMENT OPTIONS
- Assess for signs of damage following extreme wind events (Priority 2)

INDIVIDUAL QUANTIFIED TREE RISK ASSESSMENT (QTRA)

SITE: LAMAN STREET, COOK'S HILL, NEWCASTLE, NSW
CLIENT: SAVE OUR FIGS INC.
BRIEF: RISK ASSESSMENT OF 14 NO. FIG TREES ON LAMAN STREET BETWEEN DARBY ST. AND DAWSON ST. ASSESSMENT LIMITED BY RESTRICTED ACCESS

SURVEYOR: M J ELLISON
ASSESSMENT DATE: 30 DECEMBER 2011
VIEWING CONDITIONS: FINE WEATHER
JOB REFERENCE: 6502-RAS

REF.	SPECIES	AGE RANGE	HEIGHT (M)	CROWN SPREAD N	CROWN SPREAD S	CROWN SPREAD E	CROWN SPREAD W	STEM DIA. (MM)	VITALITY	RISK ASSESSMENT OF	TARGET RANGE	SIZE RANGE	PROB FAILURE RANGE	RISK INDEX
12017	Hill's weeping fig	M	[21] 24	[18]	[12]	[6]	[5]	[1240]	G	NON-SPECIFIC SECONDARY BRANCH FAILURE ONTO PEDESTRIAN AREA	3	3	3	620
										NON-SPECIFIC PRIMARY BRANCH FAILURE ONTO ROAD	2	2	4	**410**
										WHOLE TREE FAILURE ONTO ROAD	2	1	5	2000

COMMENTS
- Compression forks of primary branches between heights of 1.8 – 2.5m
- Old pruning wounds to the lower crown where low branches have been removed from over the road
- Signs of displacement of concrete kerb and tarmac footpath surface by root growth
- Exposed to modified wind loading following removal of adjacent trees to the east
- Topped/pollarded many years ago at heights of between 5 – 6m
- Old bark wounds to root-collar on south side
- [Roots deflected by kerb, some severance]

MANAGEMENT OPTIONS
- Assess for signs of damage following extreme wind events (Priority 2)

REF.	SPECIES	AGE RANGE	HEIGHT (M)	CROWN SPREAD N	CROWN SPREAD S	CROWN SPREAD E	CROWN SPREAD W	STEM DIA. (MM)	VITALITY	RISK ASSESSMENT OF	TARGET RANGE	SIZE RANGE	PROB FAILURE RANGE	RISK INDEX
12018	Hill's weeping fig	M	[22] 23	[18]	[13]	[5]	[6.5]	[1280]	G	NON-SPECIFIC SECONDARY BRANCH FAILURE ONTO PEDESTRIAN AREA	3	4	3	5900
										NON-SPECIFIC PRIMARY BRANCH FAILURE ONTO ROAD	2	2	4	**410**
										WHOLE TREE FAILURE ONTO ROAD	2	1	5	2000

COMMENTS
- Exposed to modified wind loading following removal of adjacent trees to the west
- Abundant epicormic growth to the lower-crown
- Compression fork of co-dominant primary branches/stems at a height of approximately 4m
- Root-collar appears to be displacing adjacent kerb
- Topped/pollarded many years ago at heights of between 5 – 6m
- [No apparent root severance on south but older severance north side]

MANAGEMENT OPTIONS
- Assess for signs of damage following extreme wind events (Priority 2)

INDIVIDUAL QUANTIFIED TREE RISK ASSESSMENT (QTRA)

SITE: LAMAN STREET, COOK'S HILL, NEWCASTLE, NSW
CLIENT: SAVE OUR FIGS INC.
BRIEF: RISK ASSESSMENT OF 14 NO. FIG TREES ON LAMAN STREET BETWEEN DARBY ST. AND DAWSON ST. ASSESSMENT LIMITED BY RESTRICTED ACCESS

SURVEYOR: M J ELLISON

ASSESSMENT DATE: 30 DECEMBER 2011
VIEWING CONDITIONS: FINE WEATHER
JOB REFERENCE: 6502-RAS

REF.	SPECIES	AGE RANGE	HEIGHT (M)	CROWN SPREAD N	CROWN SPREAD S	CROWN SPREAD E	CROWN SPREAD W	STEM DIA. (MM)	VITALITY	RISK ASSESSMENT OF	TARGET RANGE	SIZE RANGE	PROB FAILURE RANGE	RISK INDEX
12019	Hill's weeping fig	M	[22] 23	[18]	[13]	[15]	[5]	[1370]	G	NON-SPECIFIC SECONDARY BRANCH FAILURE ONTO PEDESTRIAN AREA	3	4	3	5900
										NON-SPECIFIC PRIMARY BRANCH FAILURE ONTO ROAD	2	2	4	**410**
										WHOLE TREE FAILURE ONTO ROAD	2	1	5	2000

COMMENTS
- Old primary branch failure on the south-east side at a height of approximately 2m, which appears to have been at a compression fork. Good adaptive growth around wound
- Compression forks of primary branches
- Root-collar beginning to overgrow adjacent kerb, which shows signs of being displaced
- Topped/pollarded many years ago at heights of between 5 – 8m
- [Roots deflected by kerb, older severance north side]

MANAGEMENT OPTIONS
- Assess for signs of damage following extreme wind events (Priority 2)

REF.	SPECIES	AGE RANGE	HEIGHT (M)	CROWN SPREAD N	CROWN SPREAD S	CROWN SPREAD E	CROWN SPREAD W	STEM DIA. (MM)	VITALITY	RISK ASSESSMENT OF	TARGET RANGE	SIZE RANGE	PROB FAILURE RANGE	RISK INDEX
12020	Hill's weeping fig	M	[21] 22	[7]	[11]	[6]	[7.5]	[960]	G	NON-SPECIFIC SECONDARY BRANCH FAILURE ONTO PEDESTRIAN AREA	2	3	3	**170**
										NON-SPECIFIC PRIMARY BRANCH FAILURE ONTO ROAD	2	2	4	410
										WHOLE TREE FAILURE ONTO ROAD	2	1	5	2000

COMMENTS
- Past damage to surface roots, particularly on the north and west sides. Signs of subsequent adaptive root growth on both north-east and west sides with four smooth-barked primary roots at the root-collar on the east side
- Adjacent surfacing is mainly bitumen with a area of exposed soil around root-collar extending to approximately 9 m2
- Exposed to modified wind loading following removal of adjacent trees to the east
- Topped/pollarded many years ago at heights of between 4 – 5m
- [Surface roots damaged by vehicles]

MANAGEMENT OPTIONS
- Assess for signs of damage following extreme wind events (Priority 2)

INDIVIDUAL QUANTIFIED TREE RISK ASSESSMENT (QTRA)

SITE: LAMAN STREET, COOK'S HILL, NEWCASTLE, NSW
CLIENT: SAVE OUR FIGS INC.
BRIEF: RISK ASSESSMENT OF 14 NO. FIG TREES ON LAMAN STREET BETWEEN DARBY ST. AND DAWSON ST. ASSESSMENT LIMITED BY RESTRICTED ACCESS

SURVEYOR: M J ELLISON
ASSESSMENT DATE: 30 DECEMBER 2011
VIEWING CONDITIONS: FINE WEATHER
JOB REFERENCE: 6502-RAS

REF.	SPECIES	AGE RANGE	HEIGHT (M)	CROWN SPREAD N	CROWN SPREAD S	CROWN SPREAD E	CROWN SPREAD W	STEM DIA. (MM)	VITALITY	RISK ASSESSMENT OF	TARGET RANGE	SIZE RANGE	PROB FAILURE RANGE	RISK INDEX
12021	Hill's weeping fig	M	[21] 22	[6]	[11]	[3.5]	[7]	[910]	G	NON-SPECIFIC SECONDARY BRANCH FAILURE ONTO PEDESTRIAN AREA	2	3	3	**170**
										NON-SPECIFIC PRIMARY BRANCH FAILURE ONTO ROAD	2	2	4	410
										WHOLE TREE FAILURE ONTO ROAD	2	1	5	2000

COMMENTS

- Removal of several low primary branches in recent years
- Compression forks of primary branches and stem at heights between 2 – 2.5m
- Crown exposed to modified wind loads resulting from removal of two trees to the east side in recent years
- Abundant epicormic growth
- Roots overgrowing road-edge gulley
- Adjacent surfacing is mainly bitumen with a area of exposed soil around root-collar extending to approximately 10 m2
- Past damage to surface roots, particularly on the east and west sides
- Two large buttress roots on the north side extending towards the trench excavation carried out by Marsden
- Topped/pollarded many years ago at heights of between 4 –5m
- [Surface roots damaged by vehicles]

MANAGEMENT OPTIONS

- Assess for signs of damage following extreme wind events (Priority 2)

INDIVIDUAL QUANTIFIED TREE RISK ASSESSMENT (QTRA)

SITE: LAMAN STREET, COOK'S HILL, NEWCASTLE, NSW
CLIENT: SAVE OUR FIGS INC.
BRIEF: RISK ASSESSMENT OF 14 NO. FIG TREES ON LAMAN STREET BETWEEN DARBY ST. AND DAWSON ST. ASSESSMENT LIMITED BY RESTRICTED ACCESS

SURVEYOR: M J ELLISON
ASSESSMENT DATE: 30 DECEMBER 2011
VIEWING CONDITIONS: FINE WEATHER
JOB REFERENCE: 6502-RAS

REF.	SPECIES	AGE RANGE	HEIGHT (M)	CROWN SPREAD N	CROWN SPREAD S	CROWN SPREAD E	CROWN SPREAD W	STEM DIA. (MM)	VITALITY	RISK ASSESSMENT OF	TARGET RANGE	SIZE RANGE	PROB FAILURE RANGE	RISK INDEX
12022	Hill's weeping fig	M	[21] 23	[7]	[12]	[5]	[7]	[1170]	G	NON-SPECIFIC SECONDARY BRANCH FAILURE ONTO PEDESTRIAN AREA	2	3	4	1700
										NON-SPECIFIC PRIMARY BRANCH FAILURE ONTO PEDESTRIAN AREA	2	2	4	**410**
										WHOLE TREE FAILURE ONTO ROAD	2	1	5	2000

COMMENTS

- Compression forks of primary branches/stems between heights of 1.5 – 3m. Young palm tree in fork
- Two crossing and abrading primary branches at a height of 4m on south side
- Past pruning to remove primary and secondary branches on south side
- Abundant epicormic shoots and branches in lower/mid crown
- Small area of exposed soil around root-collar
- Planting bed edged with concrete kerbs approximately 2m to the west
- Topped/pollarded many years ago at heights of between 4 –5m
- [Surface roots damaged by vehicles]

MANAGEMENT OPTIONS

- Cut palm at base
- Assess for signs of damage following extreme wind events (Priority 2)

INDIVIDUAL QUANTIFIED TREE RISK ASSESSMENT (QTRA)

SITE: LAMAN STREET, COOK'S HILL, NEWCASTLE, NSW
CLIENT: SAVE OUR FIGS INC.
BRIEF: RISK ASSESSMENT OF 14 NO. FIG TREES ON LAMAN STREET BETWEEN DARBY ST. AND DAWSON ST. ASSESSMENT LIMITED BY RESTRICTED ACCESS

SURVEYOR: M J ELLISON
ASSESSMENT DATE: 30 DECEMBER 2011
VIEWING CONDITIONS: FINE WEATHER
JOB REFERENCE: 6502-RAS

REF.	SPECIES	AGE RANGE	HEIGHT (M)	CROWN SPREAD N	CROWN SPREAD S	CROWN SPREAD E	CROWN SPREAD W	STEM DIA. (MM)	VITALITY	RISK ASSESSMENT OF	TARGET RANGE	SIZE RANGE	PROB FAILURE RANGE	RISK INDEX
12023	Hill's weeping fig	M	[21] 22	[13]	[12]	[4]	[7]	[980]	G	NON-SPECIFIC SECONDARY BRANCH FAILURE ONTO FOOTWAY	2	3	4	1700
										NON-SPECIFIC PRIMARY BRANCH FAILURE ONTO ROAD	2	2	4	**410**
										WHOLE TREE FAILURE ONTO ROAD	2	1	5	2000

COMMENTS
- Partial compression fork of primary branch attachment at a height of 1.5 – 2m with young palm tree growing in accumulated detritus
- Signs of a past secondary branch failure at a height of approximately 4m on the east side
- Past removal of low secondary branches overhanging footpath and road
- Past removal of primary branches on the south side
- Old, large diameter branch pruning stub on south-west side
- Planting bed with edged with concrete kerbs installed around base in recent years
- Pedestrian crossing immediately to the west
- Topped/pollarded many years ago at heights of between 4 –5m

MANAGEMENT OPTIONS
- Cut palm at base
- Assess for signs of damage following extreme wind events (Priority 2)

REF.	SPECIES	AGE RANGE	HEIGHT (M)	CROWN SPREAD N	CROWN SPREAD S	CROWN SPREAD E	CROWN SPREAD W	STEM DIA. (MM)	VITALITY	RISK ASSESSMENT OF	TARGET RANGE	SIZE RANGE	PROB FAILURE RANGE	RISK INDEX
12024	Hill's weeping fig	M	[21] 22	[13]	[12]	[4]	[7]	[1110]	M	NON-SPECIFIC SECONDARY BRANCH FAILURE ONTO PEDESTRIAN AREA	2	3	4	1700
										NON-SPECIFIC PRIMARY BRANCH FAILURE ONTO ROAD	2	2	4	**410**
										WHOLE TREE FAILURE ONTO ROAD	2	1	5	2000

COMMENTS
- History of secondary branch removal from the lower crown on the south side
- Compression forks of primary branches/stems between first order branches at height of 1.5 to 2m
- Planting bed with edged with concrete kerbs installed around base in recent years
- Pedestrian road-crossing to east side
- Topped/pollarded many years ago at heights of between 4 – 5m

MANAGEMENT OPTIONS
- Assess for signs of damage following extreme wind events (Priority 2)

INDIVIDUAL QUANTIFIED TREE RISK ASSESSMENT (QTRA)

SITE: LAMAN STREET, COOK'S HILL, NEWCASTLE, NSW
CLIENT: SAVE OUR FIGS INC.
BRIEF: RISK ASSESSMENT OF 14 NO. FIG TREES ON LAMAN STREET BETWEEN DARBY ST. AND DAWSON ST. ASSESSMENT LIMITED BY RESTRICTED ACCESS

SURVEYOR: M J ELLISON
ASSESSMENT DATE: 30 DECEMBER 2011
VIEWING CONDITIONS: FINE WEATHER
JOB REFERENCE: 6502-RAS

REF.	SPECIES	AGE RANGE	HEIGHT (M)	CROWN SPREAD N	CROWN SPREAD S	CROWN SPREAD E	CROWN SPREAD W	STEM DIA. (MM)	VITALITY	RISK ASSESSMENT OF	TARGET RANGE	SIZE RANGE	PROB FAILURE RANGE	RISK INDEX
12025	Hill's weeping fig	M	[21] 22	[9]	[13]	[3]	[12]	[1160]	G	SECONDARY BRANCH FAILURE ONTO PEDESTRIAN AREA	2	4	2	**160**
										PRIMARY BRANCH FAILURE ONTO PEDESTRIAN AREA	2	2	4	410
										WHOLE TREE FAILURE ONTO PEDESTRIAN ACCESS	2	1	5	2000

COMMENTS

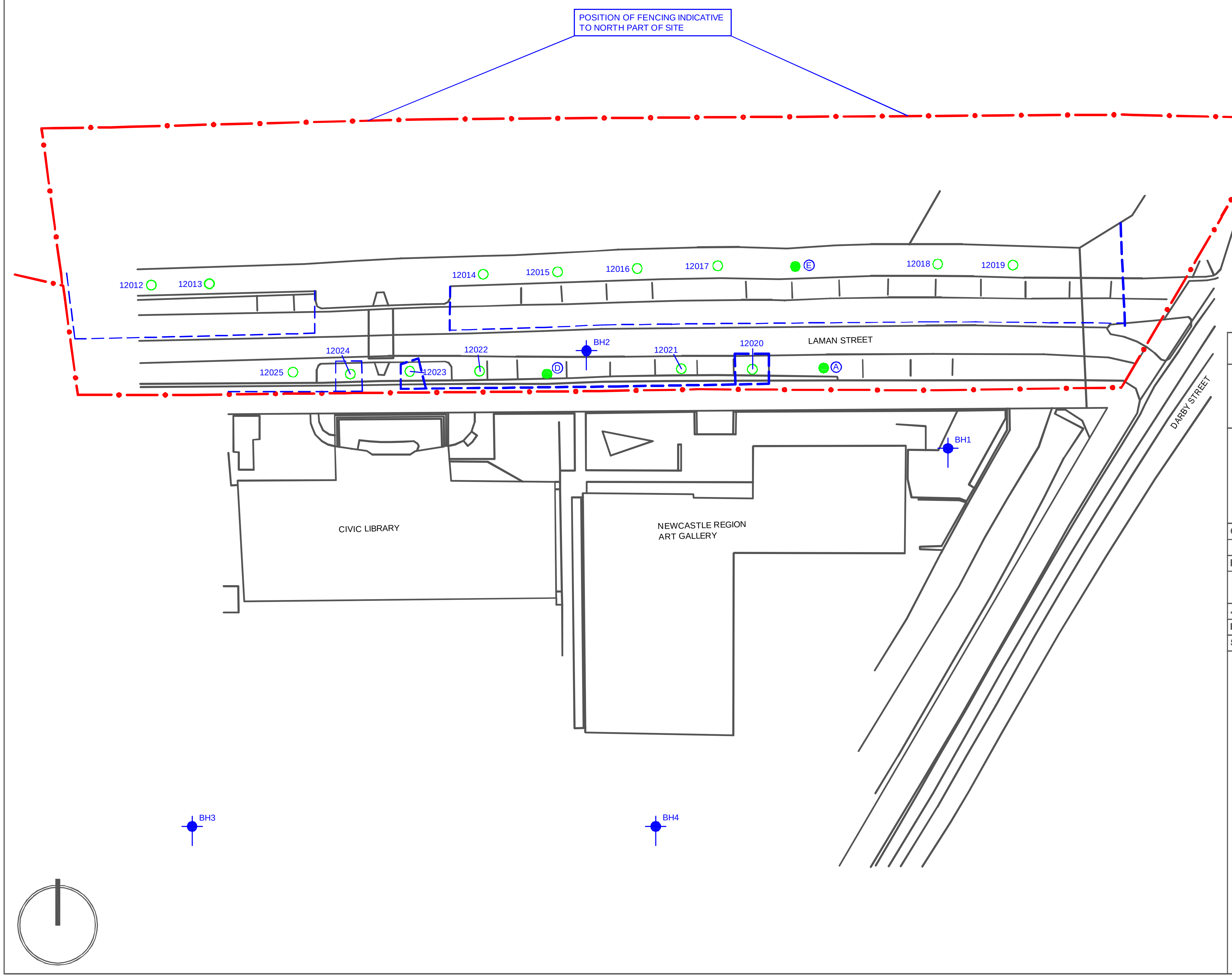
- Root-collar configuration is indicative of old, historical (probably in excess of 20 years old) rootplate failure that has re-stabilised. Stem possibly having moved 5-10 degrees to the east during a high wind event
- Recently heavily lopped on the north side to remove large primary branches, which has modified the tree's exposure to wind and increased the likelihood of branch and whole tree failure during extreme wind loading
- History of large branch removal from the lower crown on the south side
- Compression forks of first order branches/stems between heights of 1.6 – 3m
- Surface treatment around base partially obscured by leaf litter, vegetation and debris but there appears to be a small area of exposed soil surrounded by bitumen surfacing
- Topped/pollarded many years ago at heights of between 4 – 5m
- [Large surface roots damaged by vehicles]
- **110mm dia. root severed on the south-east side at a distance of 1.4 metres from edge of stem during water main repairs in July 2010

MANAGEMENT OPTIONS

- Assess for signs of damage following extreme wind events (priority 2)

APPENDIX CW 3

TREE SURVEY DRAWING



TREE SURVEY DRAWING

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CLIENT	SAVE OUR FIGS INC.
PROJECT	LAMAN STREET NEWCASTLE NEW SOUTH WALES
JOB REF	CW/6502-P1
DATE	11 JANUARY 2012
SCALE	NOT SPECIFIED

STEM POSITIONS OF EXISTING SURVEYED TREES

STEM POSITIONS OF PREVIOUSLY REMOVED TREES

BH2 BORE HOLES (LOCATED APPROXIMATELY)

SECURITY BARRIERS PRESENT AT 30 DECEMBER 2011

SECURITY BARRIERS PRESENT AT 7 APRIL 2011

APPENDIX CW 4

Photographs taken by the author

P1010644

P1030278

Adaptive root development

APPENDIX CW 5

Quantified Tree Risk Assessment Practice Note

"When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind"

William Thomson, Lord Kelvin, Popular Lectures and Addresses [1891-1894]

. INTRODUCTION

The Quantified Tree Risk Assessment (QTRA) method was first published in 2005 (Ellison 2005), following which a programme of training and user licensing was developed. Licensed users of the QTRA method attend either a one or a two-day training workshop and receive tuition in the basic application of the method. Update workshops provide both advanced training and update information relating to revision of the method; attendance is at the discretion of the user. Users, currently, from fifteen countries have access to an internet discussion forum and receive updated information as the method evolves and develops.

A Balanced Approach

In the management of trees, risk minimisation is often cited as an objective. This is not a reasonable aim because the benefits of risk reduction must be balanced with its costs, both financial and in terms of lost benefits from the tree. Where risk reduction comes at a disproportionately high cost in relation to lowering the level of risk, the risk control measure can be said to be disproportionate and unreasonable. Indeed, where safety from trees is concerned, the law, both common and in statute, requires only that the occupier of land do what is reasonable (Mynors 2002). By quantifying the risk of harm from falling trees, QTRA enables comparison of the costs and benefits of risk reduction.

When managing risks in all walks of life we strive to balance the costs of our actions and choices with the benefits that they provide, and managing trees should be no different. Although the majority of tree-risk management decisions are not analysed in terms of the detailed costs and benefits of risk reduction, the balance between the costs and benefits of implementing risk control underpins the process.

Risk Assessment

Risk assessment is the overall process of risk identification, risk analysis, and risk evaluation. (Anon. 2009). Developed for the assessment of risks from falling trees, the QTRA method enables cost-effective identification of the risks and quantification of the risk analysis to provide a numerical aid for the evaluation and treatment of risks.

A risk from tree failure exists only if (1) there is potential for tree failure and (2) potential for harm to result. It is the task of the risk assessor to consider both the likelihood and potential consequences of tree failure. The outcome of this assessment, which in QTRA is termed the 'risk of harm', will then inform the tree manager's evaluation of the risks. Additionally, the assessor's observations can inform consideration of benefits accruing from the tree.

Through the provision of a comprehensive range of values[1], QTRA enables the tree assessor to evaluate and quantify the risk from tree failure in three key stages. (1) to value property and land-use in terms of both vulnerability to impact and likelihood of occupation, (2) to consider the relative severity of impact, taking account of the size-category of the tree or branch etc. concerned, (3) to quantify within broad bands, the assessor's estimate of the probability that the tree or branch will fail within the coming year. By multiplying these values the assessor can calculate an annualised[2] risk of harm from a tree. This risk is considered against broadly acceptable and tolerated levels of risk and the risks between trees can be ranked and compared.

Taking a Proportionate Approach

The risks from tree failure are usually very low and high risks will most commonly be encountered in areas either with high levels of human occupation or with valuable property. In areas of low human

[1] See tables 1, 2, 3 & 4.

[2] The inputs to the calculation are considered over the coming year, therefore the risk of harm relates to the same timeframe.

occupation and low property value, the assessment of risks from trees may be unnecessary beyond valuing or categorising land-use. Even when land-use indicates that the assessment of trees is appropriate, it is seldom proportionate to calculate the risk for each tree in a population. Often, all that is required is a brief but particular consideration of the trees to identify gross characteristics of structural weakness or declining health.

QTRA enables a range of approaches from the broad risk assessment of large collections of trees to the detailed assessment of each tree where land-use and the character of the trees dictate. QTRA risk calculations for groups of trees are based on the highest-risk tree and if the risk from that tree is tolerable, it follows that risks from the remaining trees will also be tolerable and further calculations are unnecessary.

. DEFINITION OF TERMS

Risk

Risk is the combination of the probability of an event and its consequence (Anon. 2009).

In terms of assessing risks from falling trees and branches, the commonly quoted equation 'risk = likelihood x consequence' is appropriate; e.g. risk is the product of (1) the likelihood that the tree will fail in the coming year, (2) the likelihood of the target being occupied, and (3) the magnitude of the expected consequence.

Risk of Significant Harm

The QTRA output is termed the 'risk of harm' and is a combined measure of the likelihood and the consequence of tree failure considered in terms of the loss, within the coming year, of a human life, something of comparable value or a proportion thereof.

ALARP (As Low As Reasonably Practicable)

Determining that risks have been reduced to 'As Low As Reasonably Practicable' involves an evaluation and comparison of both the risk to be reduced and the sacrifice or cost involved in reducing that risk. If it can be shown that there is gross disproportion between them, the risk being insignificant in relation to the sacrifice or cost, it can be demonstrated that to reduce the risk further is not reasonably practicable.

Cost and Benefit

Trees confer many benefits on people and the wider environment. Trees are essential to our well-being and enhance both built and natural environments. It is reasonable to assume that removal of all risks from trees would have disastrous consequences for the quality of life and our environment. When managing the risk from falling trees, as with any risk, it is essential to maintain a balance between the costs and benefits of risk reduction (Anon. 2001), which should be considered in the determination of ALARP. Equally, it is not only the financial cost of controlling the risk that should be considered, but also the loss of tree-related benefits and the risk to workers and the public from the risk control measure itself.

Acceptable and Tolerable Risks

People are constantly exposed to and accept varying degrees of risk. For example, if you want to travel by car you must accept that even with all the extensive risk control measures, such as seat belts, speed limits, air bags, and crash barriers, there is still a significant risk of death. This is an everyday risk that is taken for granted and accepted by millions of people in return for the benefits of convenient travel.

The 'Tolerability of Risk Framework' (ToR) (Anon. 2001), which is represented graphically in Figure 1. considers a range of risk, with at one end the risk being 'broadly acceptable' – where there is no need to consider further risk reduction – and at the other end the risk is 'unacceptable' and not to be tolerated. However, when a risk is of such a magnitude that it is no longer broadly acceptable, it may still be tolerated if it is ALARP. In other words, the risk may be tolerable if the cost of further reducing it is grossly disproportionate to the benefit of risk reduction. Both 'tolerability' and 'gross disproportion' are concerned with whether or not the benefits of risk control are sufficient to justify the cost of the control.

In terms of its general application, the Tolerability of Risk Framework can be summarised as having (1) a 'broadly acceptable region' where the upper limit is an annualised risk of death 1/1,000,000, (2) an 'unacceptable region' of which the lower limit is 1/1,000, and between these (3) a necessarily wide 'tolerable region' within which the tolerability of a risk will be dependent upon the costs and benefits of further risk reduction.

In respect of trees, many risks cross the broadly acceptable 1/1,000,000 boundary, but remain tolerable because any further reduction generally would involve a disproportionate cost in terms of the lost environmental, visual and other benefits in addition to the financial cost of controlling the risk.

The UK Health and Safety Executive (Anon. 2001) suggests that "*an individual risk of death of one in a thousand per annum should on its own represent the dividing line between what could be just tolerable for any substantial category of workers for any large part of a working life, and what is unacceptable for any but fairly exceptional groups. For members of the public who have a risk imposed on them 'in the wider interest of society' this limit is judged to be an order of magnitude lower – at 1 in 10 000 per annum.*" Furthermore, "*HSE believes that an individual risk of death of one in a million per annum for both workers and the public corresponds to a very low level of risk and should be used as a guideline for the boundary between the broadly acceptable and tolerable regions.*"(ibid).

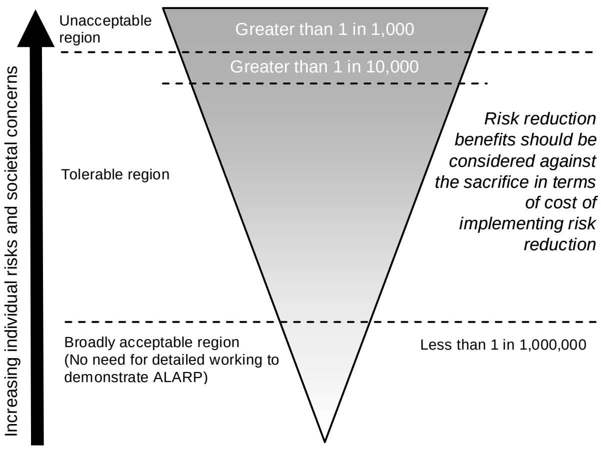

Figure 1. Adapted from the Tolerability of Risk framework (Anon. 2001)

Value of Statistical Life

In QTRA, placing a hypothetical statistical value on a human life has two particular benefits. Firstly, the 'value of statistical life' (VOSL), as a widely applied risk management device, uses the notional value of a hypothetical individual life to guide the proportionate allocation of resources to risk reduction. In the UK, this value is currently in the region of $1,500,000 - $2,250,000 (£1,000,000 - £1,500,000[3]). "*A value of statistical life of $1,500,000 is just another way of saying that a reduction in risk of death of 1/100,000 per year has a value of $15 per year*" (Anon. 1996). Secondly, the QTRA method utilises VOSL to equate the value of damage to property with the value of life e.g. where a life has a statistical value of $1,500,000, a building with a replacement cost of $15,000 is valued at 0.01 (1/100) of a life, which allows comparison of the risks to people and property.

Internationally, there is wide variation in VOSL and its computation. In QTRA, the value of $1,500,000 (£1,000,000) is currently applied both to provide a consistent basis for comparing the loss of life with the loss of property and to equate the costs and benefits of risk reduction. To provide consistency in risk assessment outputs VOSL should be applied consistently across international boundaries.

Target

In the context of tree-failure risk assessment, a target is anything of value that could be harmed in the event of tree failure.

. OWNERSHIP OF RISK

Where many people are exposed to a risk, it is shared between them. Where only one person is exposed, that individual is the recipient of all of the risk an if they have control over it they are also the owner of the risk. As individuals, we are concerned mostly with the risks to ourselves and those close to us, but as shared risks that are imposed upon the wider community become elevated, societal concern – through regulatory control or common law duties - will usually require the implementation of risk controls.

Although QTRA outputs might occasionally relate to the individual, this is seldom the case. More often in QTRA, calculation of the risk of harm is based on the total time that the target area is occupied – i.e. how many people per hour or how many vehicles per day – without attempting to identify how many different individuals share the risk.

Where the risk of harm relates to a specific individual or a known group of people, the risk manager might consider the views of those who are exposed when formulating management decisions. On the one hand, the benefits associated with the

[3] Currency exchange rate at January 2011

risk may be enjoyed by the wider community, but not by those exposed to the risk and on the other, an exposed person might explicitly accept an elevated risk in return for particular benefits.

. QUANTIFIED TREE RISK ASSESSMENT

When applying the QTRA method, the assessor quantifies, as probabilities, the three components of the tree failure risk: 1) Target, 2) Impact Potential (size), and 3) Probability of Failure within the coming year. The quantifications are applied in broad ranges of value[4] and using the upper value for each range, they are multiplied and their product is the annualised 'risk of harm'. To simplify the assessment process, the ranges, or bands are applied on the basis of their upper values, but where the risk of harm exceeds an actionable threshold, the assessment can be considered in more detail before proposing control measures.

Target Evaluation

Frequent assessment of trees and of associated risks may be essential in areas of high public access where trees are within striking range of people or valuable property that is susceptible to damage. Conversely, in locations without valuable property and having very low human access, the survey and assessment of trees for safety is unlikely to be necessary. Therefore, the nature of the target beneath or adjacent to a tree will usually dictate the level of risk assessment that is required.

In the initial assessment of targets, six ranges of value are used. Table 1 sets out these values for vehicular occupation, human occupation, and the monetary value of damage to property.

Human Occupation

The probability of pedestrian occupation at a particular location is calculated on the basis that a pedestrian will spend, on average, five seconds walking beneath the average tree. For example, ten pedestrians per day each occupying the target for five seconds is a daily occupation of fifty seconds, by which the total seconds in a day are divided to give a probability of target occupation (50/86,400 = 1/1,728). Where a longer occupation is likely, as with a habitable structure, outdoor café or park bench, the period of occupation can be measured or estimated as a proportion of a given unit of time, e.g. six hours per day (1/4).

The target will ordinarily be recorded in the QTRA as a range (1 - 6, Table 1). When the assessor identifies an elevated risk, the target can be more accurately calculated and recorded.

Often the nature of a structural weakness in a tree is such that the probability of failure is greatest during windy weather, whilst the probability of the site being occupied by people during such weather conditions is often considerably reduced; this particularly applies in woodlands, parks and private gardens. To account for the influence of weather on the risk from tree failure, the occupation by people is considered specifically in relation to weather conditions. When estimating human targets, the risk assessor must answer the question 'in the weather conditions that I expect the likelihood of failure of the tree to significantly increase, what will be the likely level of human occupation?' Taking this approach, rather than valuing the average usage, ensures that the assessor considers the multi-faceted relationship between weather, people and trees, and the sentient nature of the average person with their ability to recognise and avoid unnecessary risks.

The occupation of a target can exceed constant and it is necessary to consider the probability of multiple occupants. For example, if it is projected that the average over a one-year period will be constant occupation by 10 people, we calculate the risk of harm in relation to one person constantly occupying the target before identifying that the average occupation is 10 people. This is expressed as target 1(10T)/1, where 10T represents the number of people or vehicles constantly occupying the target. In respect of monetary value of property, this would be equivalent to a risk of losing $15,000,000 as opposed to $1,500,000.

Vehicles on the Highway

In the case of vehicles, probability of occupation may relate to either the falling tree or branch striking the vehicle or the vehicle striking the fallen tree. Both types of impact are influenced by vehicle speed; the faster the vehicle travels the less likely it is to be struck by the falling tree, but the more likely it is to strike a fallen tree. 'Stopping distances' and an average vehicle length are used in the calculation of vehicle occupation of highways. The probability of a vehicle occupying any particular point in the road is

[4] See tables 1, 3 & 4.

the ratio of the time a point in the road is occupied by vehicles - including a safe stopping distance - to the total time in a day. The average vehicle on a UK road is occupied by 1.6 people (Anon. 2010). To account for the substantial protection that the average vehicle provides against most tree-failure impacts and in particular, the frontal collision, QTRA values the substantially protected 1.6 average occupants summed with the average vehicle value as equivalent to one exposed human life.

Property

When assessing risks in relation to buildings, the target might be the building or the occupants and the building. It is necessary for the assessor to consider whether occupants of a building are either protected from harm by the structure or substantially exposed to the impact from a falling tree.

When evaluating the exposure of property to tree failure, it is necessary to estimate approximately the cost of repair or replacement that might result from failure of the tree as represented in Table 1.

As previously described, the ranges of monetary value for property used in Table 1 are based on the assumption that, for the purpose of the risk assessment, the loss of $1,500,000 is equivalent to the loss of a life. For example, target range 2 represents a probability of pedestrian occupation up to 1/20 ($1,500,000 ÷ 20 = $75,000). Therefore, a likely property repair cost of $75,000, which is one-twentieth the value of VOSL, is apportioned 1/20 in the QTRA.

On 1st January each year, Quantified Tree Risk Assessment Ltd. provides users of the method with monetary conversion rates that enable application of the method internationally.

Table 1. 'Target' ranges for property, pedestrians and vehicles.

Target Range	Property (repair or replacement costs)	Pedestrian Frequency	Vehicular Frequency examples	Probability (of occupation or fraction of value of $1,500,000)
1	>$75,000 - $1,500,000 (>£50,000 - £1,000,000)	>36 per hour - constant	26,102 vehicles @ 110kph (68mph) 32,359 vehicles @ 80kph (50mph) 46,702 vehicles @ 50kph (32mph)	1/1
2	>$21,000 - $75,000	>10 per hour - 36 per hour	1,305 vehicles @ 110kph (68mph) 1,617 vehicles @ 80kph (50mph) 2,335 vehicles @ 50kph (32mph)	1/20
3	>$2,100 - $21,000	>1 per hour - 10 per hour	363 vehicles @ 110kph (68mph) 449 vehicles @ 80kph (50mph) 649 vehicles @ 50kph (32mph)	1/72
4	>$87 - $2,100	>1 per day - 1 per hour	36 vehicles @ 110kph (68mph) 45 vehicles @ 80kph (50mph) 65 vehicles @ 50kph (32mph)	1/720
5	>$13 - $87	> 1 per week - 1 per day	2 vehicles @ 110kph (68mph) 2 vehicles @ 80kph (50mph) 3 vehicles @ 50kph (32mph)	1/17,280
6	≤ $13	≤ 1 per week	None	1/120,960

Vehicular, pedestrian and property targets are categorised by their frequency of use or their monetary value. For example, the probability of a vehicle or pedestrian occupying a target area in 'target' range 4 is between the lower and upper limits of >1/17,280 and 1/720. E.g. using the 'value of statistical life' of $1,500,000 the property repair or replacement value for 'target' range 4 is >$87 - $2,100.

Vehicular frequency examples for 'target' range 1 are calculated on the basis of the stopping distance for a given road speed providing a duration of occupation for the average vehicle on that road. The total time in a day is divided by the duration of occupation with the quotient being the number of vehicles per day required to produce constant occupation. All other 'target' ranges are calculated as a proportion of the 'target' range 1 value e.g. 'target' range 2 (probability ratio 1/20) 26,102/20 = 1305.1.

Impact Potential

A small dead branch of less than 10mm diameter is unlikely to cause significant harm even in the case of direct contact with a target, whilst on average a falling branch with a diameter greater than 250mm is likely to cause some harm in the event of contact with all but the most robust target. The increased potential for harm in relation to the size of tree or branch is proportional to a degree but this is by no means a linear relationship and there is a limit to the severity of harm in relation to the force upon impact by a tree.

The QTRA method categorises 'Impact Potential' by the diameter of tree stems and branches. A biomass equation derived from weight measurements of trees of different stem diameters is used to produce a data set (Table 2) of comparative weights of trees and branches ranging from 10 to 600mm diameter.

A diameter of 600mm has been selected to represent upper limit of potential impact in the QTRA calculation. This threshold provides a baseline for the comparative valuation of potential impacts from trees. The increased potential for harm from trees larger than 600mm diameter is not considered in terms of increased force upon impact, but might be considered in relation to the increased target area that could be affected by a larger tree.

The 'impact potential' probabilities are grouped into five ranges of size (Table 3).

Occasionally, an assessor will take the view that the reduction in mass arising from dieback and degradation of a tree or branch is significant in the risk assessment and will discount the Impact Potential component by applying a 'reduced mass' value. If the mass of a branch is considered to be half that of a live branch of the same diameter, a reduced mass of 1/2 might be applied, reducing the 'impact potential' and thereby the overall risk of harm by half. This consideration might be on the basis that the branch is lighter as a result of degradation (lesser force on impact) or is reduced in size (smaller area of impact), and while the latter could be considered by adjusting the target value, this would usually require a disproportionate amount of time in revaluing the target.

Table 2. Biomass weight estimates.

Dbh (mm)	Weight (kg) $y=ax^b$	Fraction of weight as a ratio
10	0. 11263	1/23,505.722
25	1. 0713	1/2,471.6699
50	5. 8876	1/449.74
100	32. 357	1/81.834
150	87. 67	1/30.203
200	177. 82	1/14.891
250	307. 77	1/8.604
300	481. 81	1/5.496
350	703. 8	1/3.762
400	977. 26	1/2.71
450	1305. 5	1/2.03
500	1691. 4	1/1.566
550	2138	1/1.24
600	2647	1/1

Source. Tritton & Hornbeck (1982)x=dbh (cm); y=dry weight estimate; a=allometric coefficient 0.1126294414; b= allometric coefficient 2.458309949

Table 3. Impact Potential.

Impact potential range	Size of part likely to impact the target	Impact Potential
1	> 450mm (18") dia.	1/1
2	> 250mm (10") dia.- 450mm (18") dia.	1/2
3	>100mm (4") dia.- 250mm (10") dia.	1/8.6
4	> 25mm (1") dia.- 100mm (4") dia.	1/82
5	10mm ($^2/_5$") dia.- 25mm (1") dia.	1/2500

* Range 1 is based on a diameter of 600mm.

Probability of Failure

The Probability of Failure component has six ranges, each representing a range of probability of tree or branch failure occurring within the coming year, and calculated from the upper value of that range. Probability of failure is recorded in the QTRA assessment as the upper limit of a range (1 - 6, Table 4).

Table 4. Probability of Failure.

Probability of failure range	Probability
1	1/1
2	1/100
3	1/1,000
4	1/10,000
5	1/100,000
6	1/1,000,000

The probability that the tree or selected tree-part will fail within a year.

The QTRA Calculation

The product of the three component values is the annualised 'Risk of Harm', which is expressed as a probability and rounded, usually to two significant figures.

Below are two examples of QTRA calculations.

Example 1.

	Target		Impact Potential		Probability of Failure		Risk of Harm
Range	6		1		2		
Probability	1/120,960	x	1/1	x	1/100	=	1/12,000,000

Example 1 is the assessment of a large, very unstable tree with a probability of failure of 1/100 for the coming year situated in a low use recreational area. The target is a footpath with less than one pedestrian passing the tree each day and falls within target range six.

Example 2.

	Target		Impact Potential		Probability of Failure		Risk of Harm
Range	1		2		4		
Probability	1(5T)/1	x	1/1	x	1/10,000	=	1(5T)/10,000

In example 2, a large defective branch overhangs a busy urban high street that is on average occupied constantly by five people and here multiple target occupation is considered.

The risk of harm 1(5T)/10,000, having an occupancy of five people, has a fivefold increase in the magnitude of consequence and is therefore equivalent to a risk of harm 1/2,000 and would ordinarily require risk control.

Accuracy of Outputs

The purpose of QTRA is not necessarily to provide high degrees of accuracy, but to provide for the quantification of risks from falling trees in a way that a risk can be assessed within broad ranges where this is sufficient and with greater rigour when required.

Where the input values are broadly estimated, the proposed risk thresholds should be applied cautiously. Where the manager is reasonably confident in the input values, the thresholds can be more rigorously applied. An example of this would be where, based on an initial brief assessment, a recreational woodland target is estimated to be within range 5 (up to one person passing each day). As a result, no tree in the woodland can achieve a 'risk of harm' exceeding 1/17,000. This is because even with a large unstable tree the 'general limit of tolerability' of 1/10,000 is not exceeded (target 1/17,280 x impact potential 1/1 x probability of failure 1/1 = 1/17,000). If the estimate of occupancy is based on accurate historical data and providing that the trees cannot be demonstrated to be of particularly low value, their detailed assessment should not be required for safety purposes. However, in order to make a decision not to assess the trees, it would be necessary to be reasonably confident that the target valuation is either based on accurate data or an over estimate. If the landowner had estimated an occupation of one person every two or three days, one could be reasonably confident that there was no need to assess the trees because range 5 values the target at one person a day. Conversely, where the occupancy could be as high as one or two people a day, then it could be appropriate to monitor and measure occupation more accurately.

. MAKING RISK MANAGEMENT DECISIONS

Applying the ToR Framework to QTRA Outputs

It is proposed that, in applying ToR to the outputs of QTRA, an annualised risk of harm 1/1,000,000 is the 'broadly acceptable limit', below which the risk is already ALARP. A risk of significant harm, 1/10,000 is the 'general limit of tolerability' and 1/1,000 is the 'extraordinary limit of tolerability'.

Between the 'broadly acceptable limit' (1/1,000,000) and the 'extraordinary limit of tolerability' (1/1,000) is the 'tolerable region of ToR. Where a risk falls within this region, it is necessary to consider whether it is ALARP. Here, management decisions are informed by consideration of the costs of risk control, including the nature and extent of benefits that would be lost to risk control measures. The assessor might consider the costs of risk control when providing options for management, but the tree manager, who owns the risk and exercises control over the costs, will consider the balance and make the final decision.

Considering Benefits from Trees

When implementing risk reduction there will usually be a financial cost. In this regard and even without considering the non-monetary costs, VOSL can be used to evaluate the proportionality of a risk control. Using a VOSL of $1,500,000 it can be established that a reduction in the risk of death from 1/10,000 to 1/1,000,000 – from the 'general limit of tolerability' to 'broadly acceptable' - has a value of $150 per year. Example 3 puts this evaluation into a tree management context where the benefit in terms of risk reduction can be considered against the financial cost.

Example 3.

	Target		Impact Potential		Probability of Failure		Risk of Harm
Range	3		3		2		
Probability	1/72	x	1/8.6	x	1/100	=	1/62,000

In example 3, a large defective branch (impact potential range 3) overhangs a country road along which travel on average five hundred vehicles each day at an average speed of 30 mph (target range 3). The branch has a compromised attachment to the tree and is assessed as having a probability of failure for the coming year of between 1/1,000 and 1/100. The risk of harm is calculated as 1/62,000 and it needs to be considered whether the risk is ALARP. The cost of removing the branch and reducing the risk to broadly acceptable (1/1,000,000) is roughly estimated at $375. To establish whether this is a reasonable cost of risk control, the following equation is applied. $1,500,000 x 1/62,000 = $24.19 indicating that the projected cost of $375 would be grossly disproportionate to the risk when considered in addition to the tree-related benefits that will be lost and the risks to tree workers from implementing the risk control measure.

There will be occasions when a tree is of such minimal value and the monetary cost of risk reduction so low that it might be reasonable to reduce further an already relatively low risk. Conversely, a tree might be of such considerable value that an annual risk of death greater than the 'general limit of acceptability' of 1/10,000 would be deemed tolerable. These thresholds and costs, against which risk reduction is balanced, can be informed by the risk assessor but must be selected by or agreed with the owner or manager of the risk.

Summary of QTRA Risk Thresholds

1. **Broadly Acceptable:** 1/1,000,000 – below which the risk is already ALARP.
2. **Tolerable Region:** between 1/1,000,000 and 1/1,000 – risks will be considered in order to determine whether they are ALARP and the costs of both expenditure and lost benefits will be balanced against the benefits of risk reduction.
3. **General Limit of Tolerability:** 1/10,000 – the limit of tolerability for the imposition of a risk upon others. This limit will usually be tolerable if the risk manager considers that tree confers not necessarily a special benefit, but a reasonable level of benefit that might ordinarily be expected from a tree of its type and age.
4. **Extraordinary Limit of Tolerability:** 1/1,000 – The upper limit of risk tolerance, which might be applied in exceptional circumstances where particularly special benefits would be lost to risk control measures. Management decisions to retain trees that are assessed as being between 1/10,000 and 1/1,000 would ordinarily require broad stakeholder support.

A tree owner may choose to operate to a higher or lower 'general limit of tolerability' than the proposed 1/10,000, but whatever level is chosen, the precision with which limits are applied should reflect the manager's confidence in the risk assessment outputs.

International Versions

As with previous versions, monetary values in this practice note will be adapted for use in all countries where there are QTRA users. Currency specific versions will be available at www.qtra.co.uk from 1 November 2011.

Acknowledgements

We would like to thank the many QTRA users who have contributed suggestions for the development and improvement of the method. In addition, we would like to express our gratitude to David Ball, David Evans, David Lonsdale, Glyn Thomas and Martin Norris for their critical comments and detailed consideration of the draft manuscript.

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Revisions

Revision 4.02. Modified layout.

APPENDIX CW 6

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APPENDIX CW 7

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Personal information

- Age 54
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Employment

- 1976 - 978. Climbing Arborist employed by L. Cawley, Poynton, Cheshire
- 1978 - 1997. Arboricultural Contractor. Self employed
- 1993 - 2001. Arboricultural Consultant. Self employed
- 2001 – present. Partner in the firm of Cheshire Woodlands Arboricultural Consultancy
- 2004 – present. Director of Quantified Tree Risk Assessment Limited

Qualifications

- Royal Forestry Society Certificate in Arboriculture

Author of

- Tree Preservation Orders, The Contractors Perspective. Presented to the Arboricultural Association Annual Conference 1996, University of Exeter.
- Quantified Tree Risk Assessment Used in the Management of Trees as Landscape Features, Habitats and Environmental Control Agents. Journal of Arboriculture. International Society of Arboriculture, Savoy, Illinois. 2005.
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- Using QTRA to Guide the Assessment of Tree Stability. CUGE 3rd Regional Arboriculture Seminar. Tree Stability in Urban Areas – Global Trends and Issues. 16 November 2009.

- Quantified Tree Risk Assessment Licensed User training. One-day workshop delivered regularly between February 2005 and presented in nine countries.
- A Practitioner's Guide to Visual Tree Assessment One-day workshop delivered regularly between February 2005 and presented in nine countries.

Additional professional activities

- Arboricultural Association, Education Committee - member (1992-1993)
- Arboricultural Association, Northern Branch Committee - member (1992-1993)
- Arboricultural Association, Northwest Sub-group - chairman (1991-1993)
- Arboricultural Association, Approved Contractor Programme - Second Assessor (1992-1996)
- International Society of Arboriculture, UK and Ireland Chapter - Executive Committee member (1994-1996)
- International Society of Arboriculture, UK and Ireland Chapter - Arborist Certification Liaison Officer (1994-1996)
- Arboricultural Association, Approved Contractor Programme - Senior Assessor (1996-1998)

Clients and projects

- Available upon request.