BY APPOINTMENT
TO HER MAJESTY THE QUEEN
TREE SURGEONS
F.A. BARTLETT TREE EXPERTS CO. LTD.

Bartlett Consulting

TREE HEALTH & STRUCTURAL INTEGRITY REPORT

Our Ref: JPL/160201/R/sh

Your Ref: N/A

Date: Monday 18th July 2016

CLIENT:	Caroline Korniczky
SITE ADDRESS:	St Christopher's School 32 Belsize Lane Hampstead London NW3 5AE
DATE & TIME OF VISIT:	Tuesday 12th July 2016, 10.00am
PEOPLE PRESENT:	James Percy-Lancaster (Bartlett Consulting) Paul Moore (School Caretaker)
REPORT COMPLETED BY:	James Percy-Lancaster

Summary:

In reading and understanding the contents of this report, it should be remembered that no tree can be deemed risk free. As with all things in the natural environment, they are subject to unpredictable forces such as extreme weather, effects of disease, and man's influence upon them. In reaching a conclusion as to a level of risk the tree poses, we investigate every obvious and available facet of the structure of the tree and its surroundings.

Where applicable, these conclusions and recommendations seek to reduce the risk to a level as low as reasonably practical, given the location of the tree, the site use, the owners' acceptance of the level of risk, and the perception of the tree's value to the environment.

Table of Contents

Consultancy Group Office: Coursers Farm, Coursers Road, Colney Heath, St. Albans, Hertfordshire AL4 0PG
Tel: 01727 825090 Fax: 01727 824809 consultancy@bartlettuk.com

1.0 SCOPE OF REPORT

1.1 Survey Brief

To carry out an advanced Level 3* inspection and risk assessment of a single Norway Maple (*Acer platanoides*), located within the curtilage of St Christopher's School, 32 Belsize Lane, Hampstead, London. The commissioned Level 3 inspection consisted of an internal decay detection and structural integrity assessment with the use of the IML Resistance Micro-Drill PD400.

To compile and collate all of the visual tree assessment survey and diagnostic information and data; to create a complete picture and understanding of the health and structural condition of the tree; to complete a qualified risk assessment and to make fully informed management recommendations, in accordance with current Arboricultural practice and tree health care techniques.

1.2 Background

St Christopher's School previously instructed Bartlett Tree Experts to undertake crown reduction works to the said tree, in response to the identification of a large historical wound and associated cavity at the base of the tree.

Mr Richard Trippett, Arboricultural Representative, Bartlett Tree Experts – Beaconsfield office initially visited the property during June 2016 to reassess the tree and client's needs. Because of the continued presence of cavity he referred the matter to Bartlett Consulting for a detailed assessment of the internal decay.

1.3 Report References

As a progressive company, we keep abreast of research data relating to Arboriculture. All observations, recommendations and works are based on current industry standard reference material and extensive FA Bartlett research findings, derived from the company's own facilities at the University of Reading in England as well as in Charlotte, North Carolina, in the USA. A selection of pertinent items is shown in Appendix 2.

Specific tree survey methodologies and references applied by Bartlett Consulting for this project include:

- Smiley, T, Fraedrich, B & Hendrickson, N. (2011) *Tree Risk Management*. Bartlett Tree Research Laboratories. Charlotte, NC.
- Dunstar, J.A, Smiley. T, Matheny. N, Lilly. S. (2013) *Tree Risk Assessment Manual*. International Society of Arboriculture. Champaign, IL.
- Lonsdale, D. (1999) *The Principles of Tree Hazard Assessment & Management (Research for Amenity Trees)* Department of the Environment. London.
- Schwarze, F. W. M. R, Engels. J, Mattheck. C. (2000) *Fungal Strategies of Wood Decay in Trees*. Springer-Verlag. Berlin. Heidelberg. New York.
- Schwarze, F. W. M. R. (2008) *Diagnosis & Prognosis of the Development of Wood Decay in Urban Trees*. ENSPEC. Pennsylvania State University. State College, PA.
- Shigo, A. (1991) *Modern Arboriculture*. Shigo & Trees Associates. Durham, NH.
- Mattheck, C, Breloer, H. (1994) *The Body Language of Trees (Research for Amenity Trees)* Department of the Environment, London.
- Mattheck, C, Bethge K, Weber K. (2015) *The Body Language of Trees – Encyclopaedia of Visual Tree Assessment* Karlsruhe Institute of Technology Campus North.

1.0 SCOPE OF REPORT (continued…)

1.4 Report Limitations & Methodologies

This report is restricted to the single Norway Maple tree detailed in the Survey Brief above. The statements, findings and recommendations made within the report do not take into account any effects of extreme climate and weather incidences, vandalism, changes in the natural and/or built environment around the trees after the date of this report, nor any damage whether physical, chemical or otherwise.

Bartlett Consulting and Bartlett Tree Experts cannot accept any liability in connection with the above factors nor where recommended tree management is not carried out in accordance with modern tree health care techniques, within the timelines proposed and specification provided.

1.5 Assessment of Ecological Status of Tree & Potential Constraints

Following the site visit and tree survey and assessment, we believe that there is a low potential for wildlife and ecological associations with the tree subject to this report. Ecological associations are considered to be limited to nesting birds.

The Wildlife and Countryside Act 1981, as amended by the Countryside and Rights of Way Act 2000, provides statutory protection to birds, bats, insects and other species that inhabit trees, hedgerows, or other associated vegetation. It is the recommendation of Bartlett Consulting that professional, detailed, advice from an ecologist is sought (if not done-so already) to confirm the consideration of Bartlett Consulting and to check if any such constraints apply to this site and its development proposals.

All trees must be thoroughly and properly assessed for nesting birds prior to the commencement of any recommended tree works.

*** Levels of Tree Assessment**

Level 1 Limited Visual Assessment: A visual assessment of an individual tree or a population of trees near a specified target, conducted from a specific perspective, in order to identify certain obvious defects or specified conditions. Observations are made from ground level and the tree is not climbed.

Level 2 Basic Assessment: A detailed visual inspection and assessment of a tree and the surrounding site. The basic assessment requires the tree risk assessor to walk completely around the tree. Tree dimensions are recorded using hand tools such as a diameter tape, laser range finder and measuring tape. Further information is gathered using a "sounding hammer", binoculars and other tools such as a depth probe.

Level 3 Advanced Assessment: An advanced assessment is performed to provide detailed information about specific tree parts, defects, targets, or site conditions. Methods of advanced assessment can include climbing inspections, decay detection, root excavations, lean monitoring and pull tests.

It is important to understand that as trees are living and dynamic organisms, it is not possible to maintain them free of risk. Some level of risk must be accepted in order to experience the full range of benefits that trees provide. As such, we reference the recently published document by the National Tree Safety Group (NTSG), Common Sense Risk Management of Trees (Forestry Commission 2011). This document provides guidance on trees and public safety in the UK for owners', managers and advisors.

2.0 TREE PRESERVATION ORDER & CONSERVATION AREA PROTECTION STATUS

The Town & Country Planning Act (Tree Preservation) (England) Regulations 2012 and the Town & Country Planning Act 1990 (as amended) provides legislative protection for trees within England.

A tree protection status check was conducted by Bartlett Consulting on 18th July 2016, through the London Borough of Camden Council website and 'Conservation Area Map'.

http://www.camden.gov.uk/ccm/content/environment/planning-and-built-environment/two/conservation-and-listed-buildings/conservation-areas/find-a-conservation-area-in-Camden/

2.1 Tree Preservation Order (TPO) Status

Unknown

2.2 Conservation Area (CA) Status

Fitzjohns Netherhall

2.3 Tree Management Implications

Prior to any works being conducted to the Red Oak tree, it is the recommendation of Bartlett Consulting, for the appointed contractor to check the statutory status of the tree.

Please note that the removal of dead trees and the pruning of dead wood from living trees are permitted and "excepted" works under the 2012 Regulation listed above. These works can be undertaken only after 5 working days' notice has been given to the local planning authority.

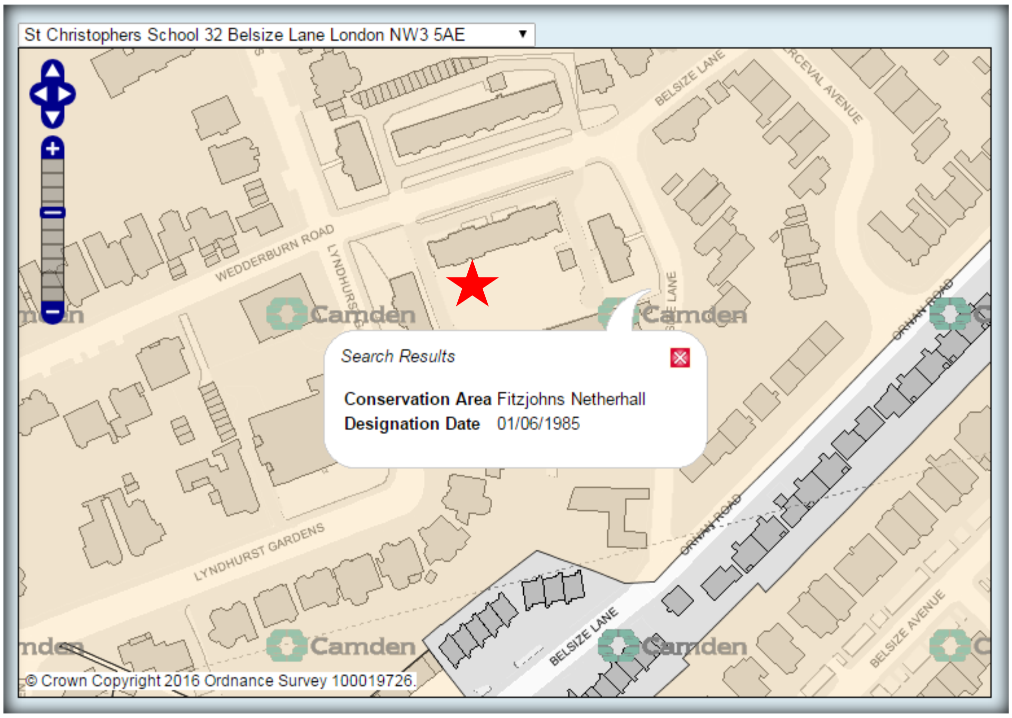


Figure 1: Showing the screenshot of the Camden Council website Interactive Conservation Area Map. with the Horn Hill Village Hall highlighted with a red star.

3.0 TREE & SITE DETAILS

The Norway Maple tree (*Acer platanoides*) is approximately 60 years old (±10 years) and stands at a height of 15.0 metres. The stem has a diameter of 640 millimetres, when measured at 1.5 metres above ground level and the crown has a spread of 5.0 / 4.0 / 4.5 / 3.5 metres, in the direction of the four cardinal compass points. The tree has a single stem from ground level with a crown break at 5.0 metres above ground level.

The Norway Maple tree is located on a gentle slope, estimated to be approximately 5%, with an aspect of west to east. The tree is located within a designated outdoor nature play area, surfaced with Astroturf and timber decking.

The identified targets include main school building and associated classrooms to the north, outdoor multi-use games area (MUGA) to the east, School Caretakers shed/outbuilding to the south and finally a third party property located along Lyndhurst Gardens to the west; all of which have frequent occupancy rate and are either within the drip line or within 1 x the height of the tree.

Figure 2: Showing the Norway Maple tree, as viewed from the east.

4.0 SUMMARY OF VISUAL TREE ASSESSMENT

The Norway Maple tree is located within a designated outdoor nature play area located adjacent to the western boundary wall. The play area is surfaced with Astroturf and timber decking; this occupies approximately the majority of the tree's rooting environment. The soils present beneath these areas are suspected to be compacted as a result of continued and regular use.

Comment could not be made with regards to the rooting environment to the west as this was within a third party property. The eastern flank of the tree features a retaining wall, installed to accommodate the MUGA; it is suspected that root severance had occurred during its installation. A small fish pond is also located to the north east of the, measured to be 1.5 metres away from the trees main stem; root damage is also suspected as a result of the excavations for the pond.

The tree's position is not considered to be an important component within the local landscape as there are other trees within the immediate vacuity; therefore, the tree has a moderate visual amenity and provides little contribution to the immediate landscape and street scene.

Due to the presence of the timber decking around the base of the tree, its buttresses could not be fully evaluated. A large abrasion on the western buttress was observed and is suspected to have been caused by repetitive foot fall.

The tree's root collar and main stem featured a significant wound on the south side, reaching up to 1.5 metres above ground level. This wound is historic and suspected to be a result of mechanical damage. Heartwood is exposed, desiccated, decaying and also featured multiple boring beetle exit holes. At its widest point, the wound measured 130 millimetres when probed; the cavity revealed that it was occupied by an active wood ant's nest.

Upon closer examination, fungal mycelium was discovered inside the cavity. No discernible fungal fruiting body was found but a sample has been extracted and set to the Bartlett Research Laboratory for detailed analysis.

The wound wood development either side of the cavity appears to be developing well; however the tree was sounded as part of the visual assessment, using a nylon hammer, to listen for variations in resonance. Where there is wood degradation and cavities, the sound will resonate with a deeper tone than when the wood is solid. Areas of dead bark will return a loud and sharp 'crack'. Sounding was carried out around the full 360^0 of the stem, from ground level to a height of 2.5 metres above and poor resonance was emitted.

The main stem bifurcated at 4.0 metres above ground level and featured a significant 'compression fork' with adaptive growth below, between 3.0 – 4.0 metres above ground level. This is considered to be a significant structural issue, further compounded by the presence of internal decay below the bifurcation and adaptation, making it susceptible to splitting.

The tree's crown appears to have been previously reduced, suspected by approximately 30%; resulting in multiple wounds throughout the crown, measuring an average diameter of 100 millimetres. The response growth is considered to be adequate but suspected to have developed from weak points of attachment.

The re-growth developing from the previous pruning points is considered adequate although suspected to be weakly attached. The crown exhibited good vigour with approximately 5% deadwood throughout. It was noted during the tree inspection that approximately 20% of the leaf area featured burnt edges; this is suspected to be a result of drought stress.

5.0 FUGAL, DISEASE OR INSECT PATHOGEN

5.1 Canker Rot Fungus (*Daedalea unicolor*)

The presence of a large immature fungal fruiting body attributed as *Daedalea unicolor* was found within the cavity of the tree's main stem.

Host trees are primarily Maple species but it is also found occasionally on other broadleaved trees.

The fruiting bodies are generally found attached to the tree's lower main stem and within the tree's buttresses.

Daedalea unicolor forms an annual fruiting body, initially predominantly a pore layer of creamy-white maze structure before becoming more bracket-like.

Daedalea unicolor initially affects the non-functioning heartwood and the advancement of decay can progress into the functioning sapwood of host trees.

The decay can develop extensively as it is able to spread into the previously sound sapwood. If the decay is advanced and extensive, stem breakage and wind throw can occur.

Dr Glynn Percival
Plant Physiologist
Bartlett Research Laboratory

Figure 3: Showing the fungal fruiting body present within the cavity of the Norway Maple tree.

6.0 TESTING USING A RESISTANCE MICRO-DRILL MACHINE

A Resistance Micro-drill is used to establish the internal structural integrity of an individual tree or tree parts. The device drills a micro needle with a bit diameter of 3.0 millimetres at a constant speed, and measures both the drilling resistance and feed speed, to a nominal depth of 40 centimetres within the stem or branch. The sawdust remains in the bore hole and thus closes the drilling tunnel.

The resistance of the wood to the drill is provided on a graphic print-out with the timber density shown along the y-axis of the graph line as the small peaks and troughs, while the depth of the drill is shown along the x-axis of the graph line at a scale of 1:1. The graph translates as information on the internal structure of the wood tested, indicating the levels of decay, unseen voids or cracks, and types of wood decay, as well as providing significant information about the material properties and thickness of the residual wall of sound-wood around the stem or branch.

Resistance Micro-drill testing is typically used along with other data collection in the overall assessment of a tree's condition. It is generally employed during aerial inspection, or on part of the tree below ground level, where other methods of internal assessments are not practical, and also where results from Sonic Tomography are suspected to be inconclusive and require further confirmation.

6.1 Micro-drill Testing Locations

A total of sixteen tests were conducted on the Norway Maple, four tests performed upon the tree at various heights, commencing at approximately 100 millimetres above ground level just above the tree's buttresses, with the subsequent tests conducted at 1000, 1500 and 2000 millimetres above ground level. Please refer to Figure 4 for locations.

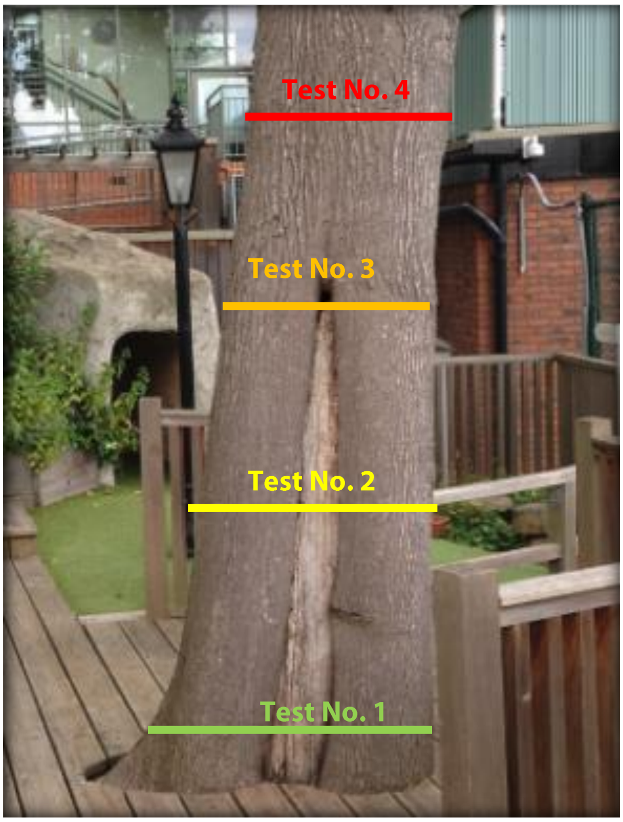
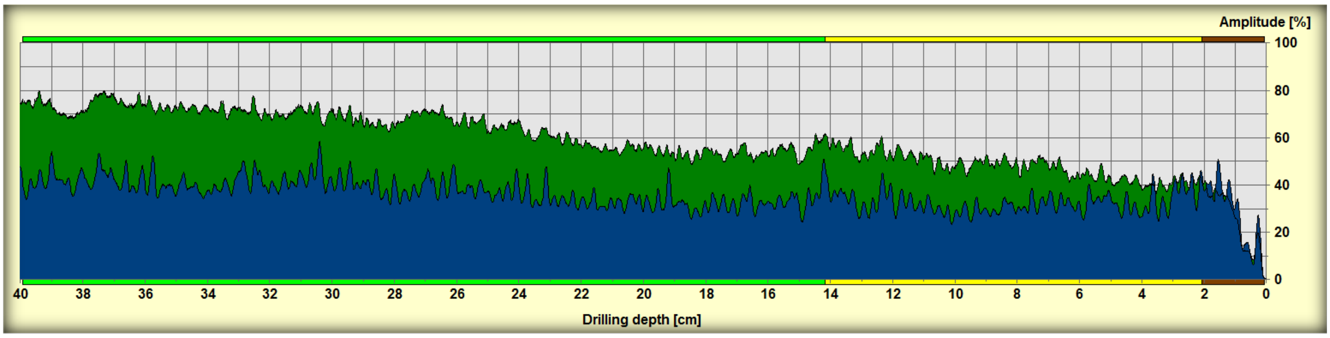


Figure 5: Showing the Resistance Micro-Drill testing locations on the Norway Maple tree.

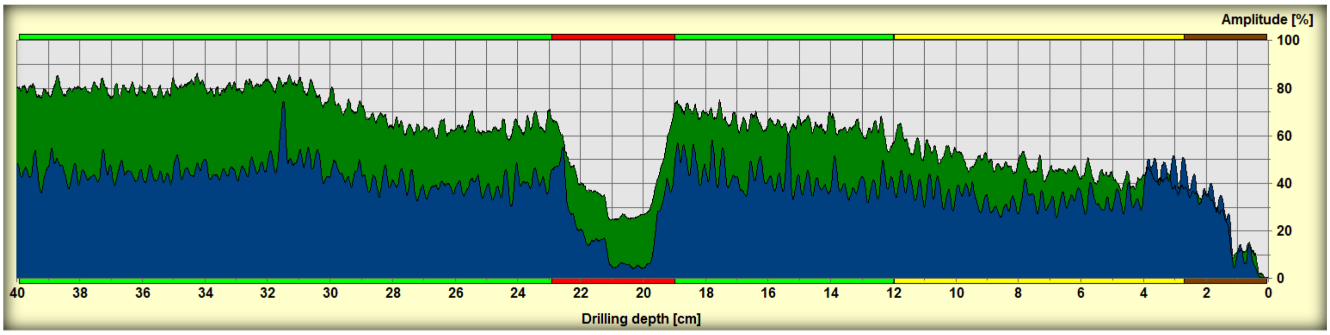
6.0 TESTING USING A RESISTANCE MICRO-DRILL (Continued…)

6.2 Resistance Micro-drill Test Results obtained from 100 mm above ground level.

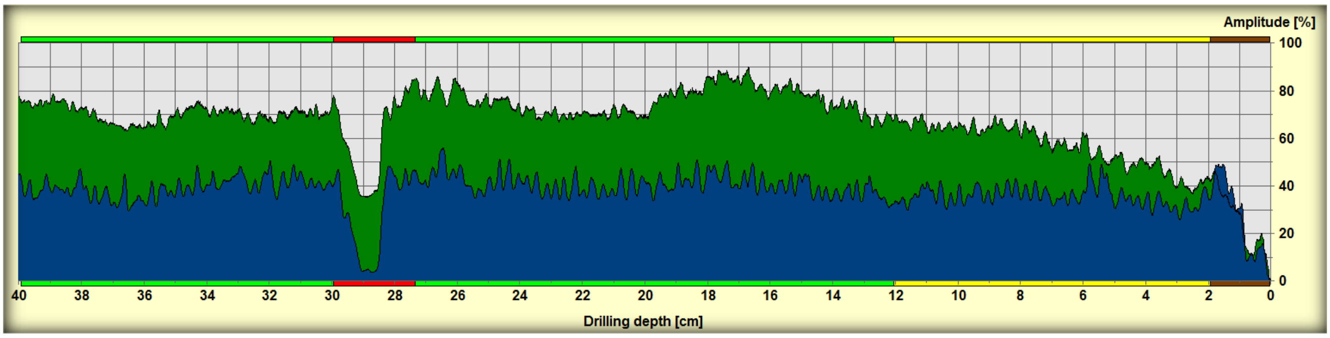
Test 1; North/East – South/West



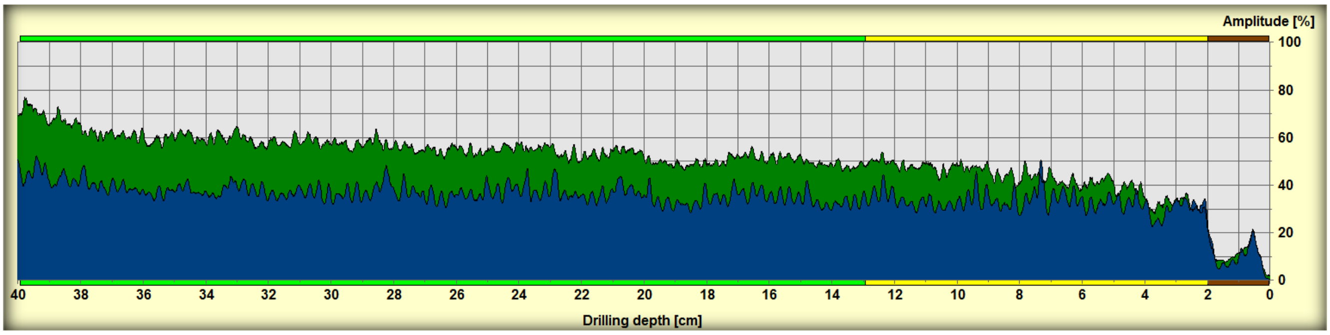
Test 2; South/East – North/West



Test 3; South/West – North/East



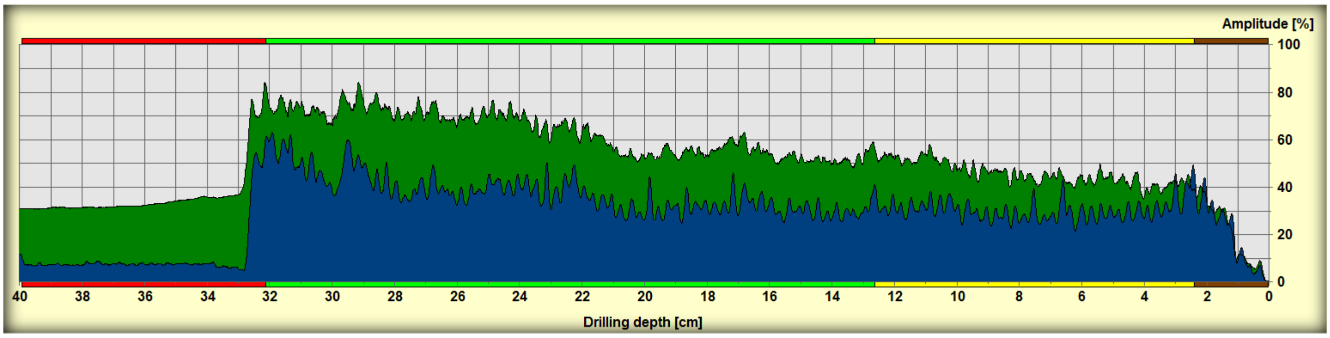
Test 4; North/West – South/East



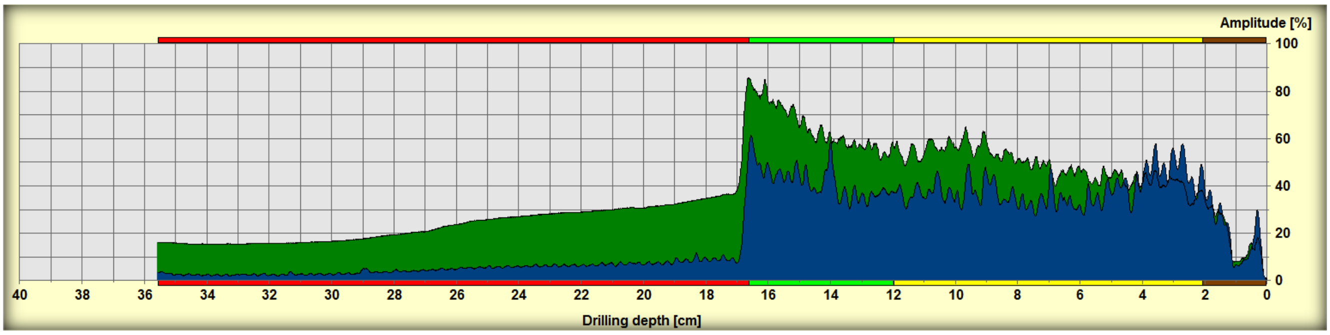
6.0 TESTING USING A RESISTANCE MICRO-DRILL (Continued…)

6.3 Resistance Micro-drill Test Results obtained from 1000 mm above ground level

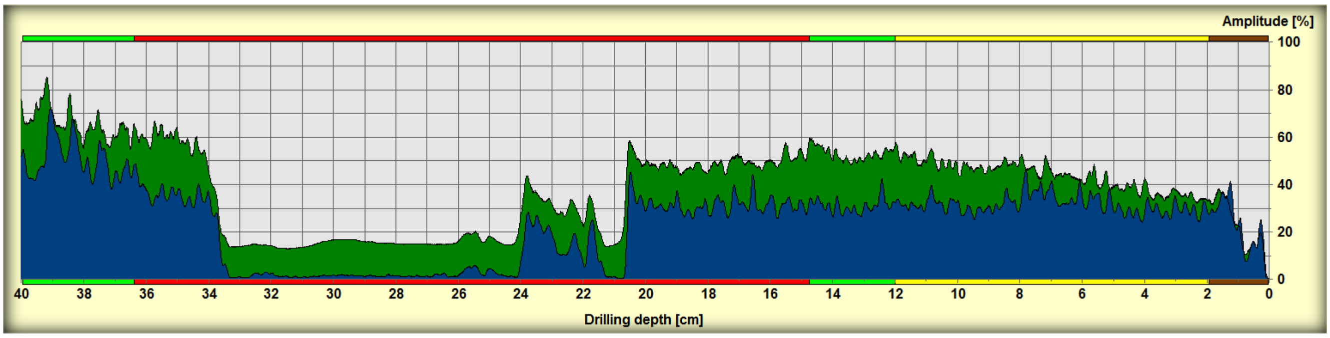
Test 5; North/East – South/West



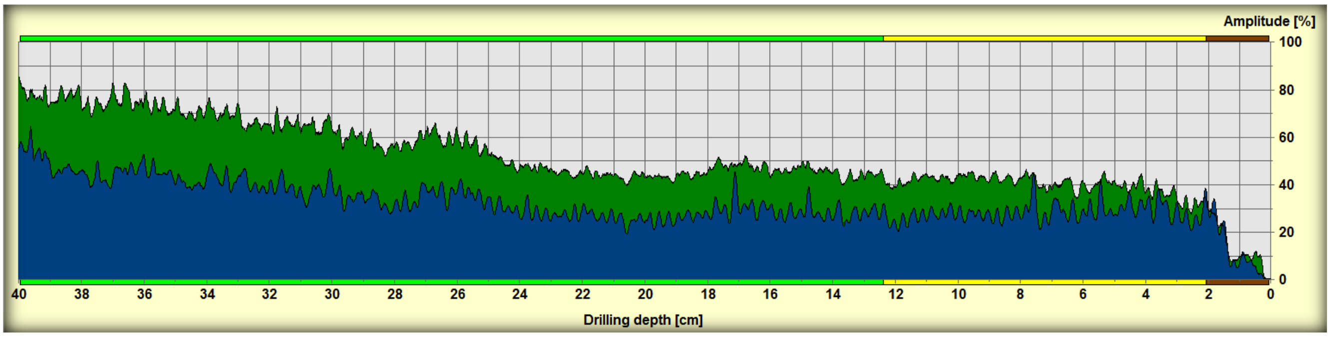
Test 6; South/East – North/West



Test 7; South/West – North/East



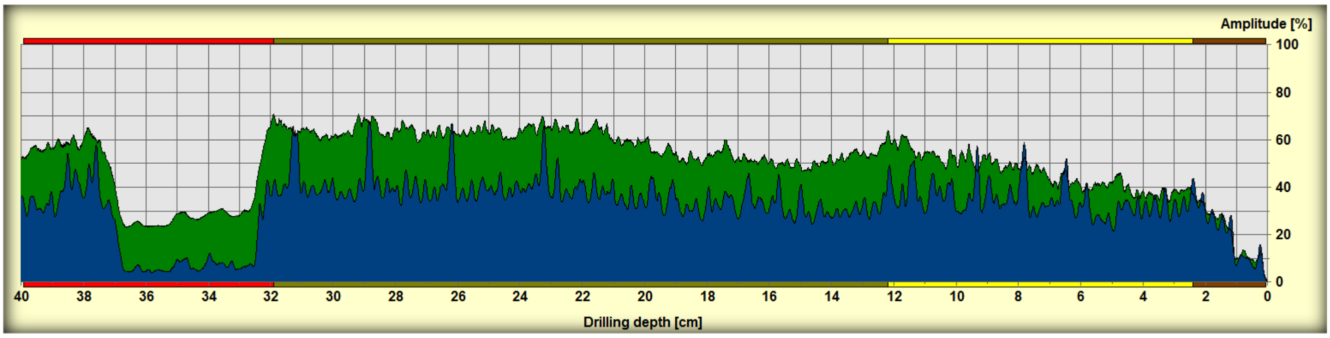
Test 8; North/West – South/East



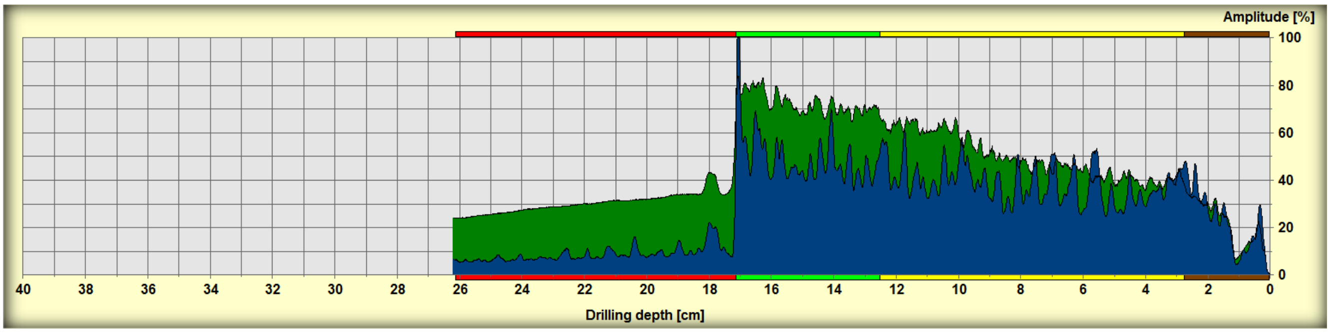
6.0 TESTING USING A RESISTANCE MICRO-DRILL (Continued…)

6.4 Resistance Micro-drill Test Results obtained from 1500 mm above ground level

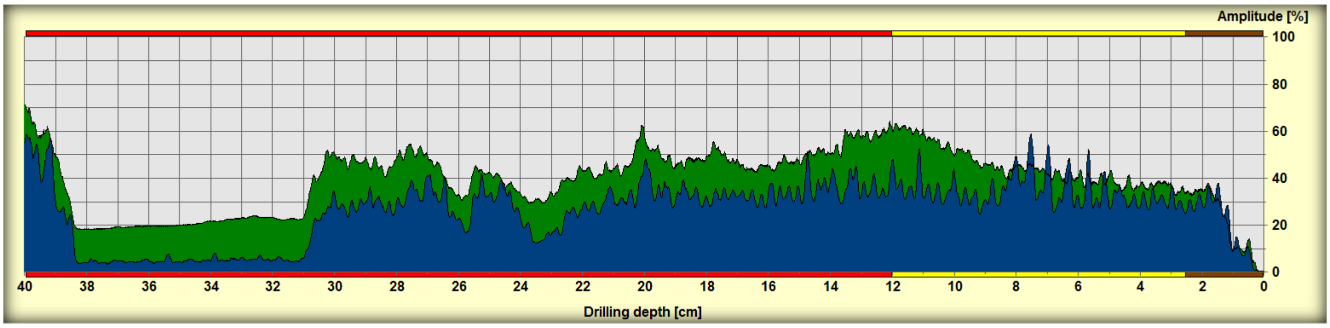
Test 9; North/East – South/West



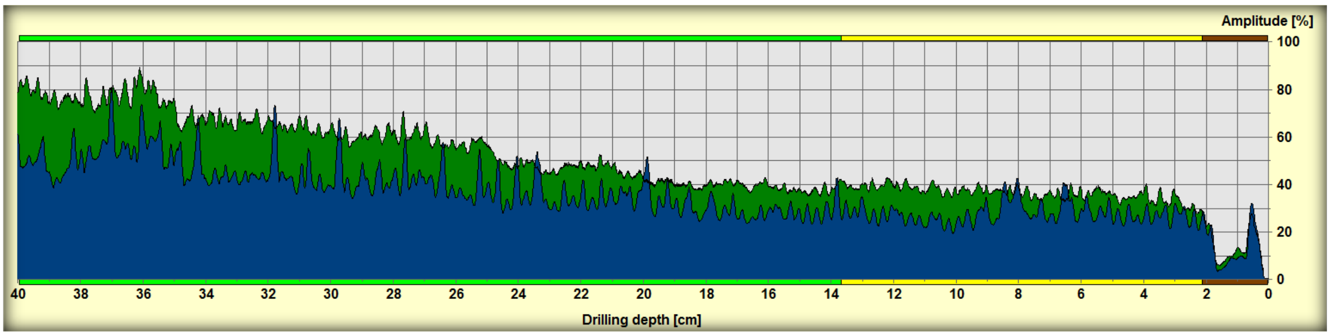
Test 10; South/East – North/West



Test 11; South/West – North/East



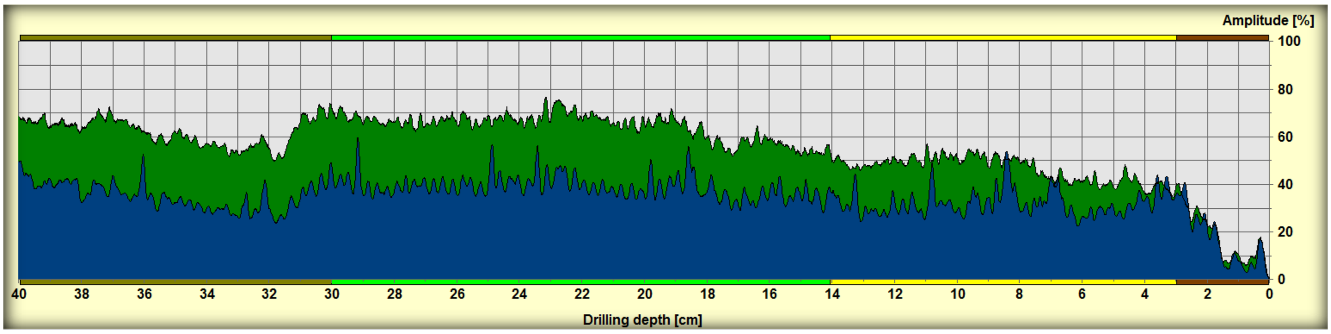
Test 12; North/West – South/East



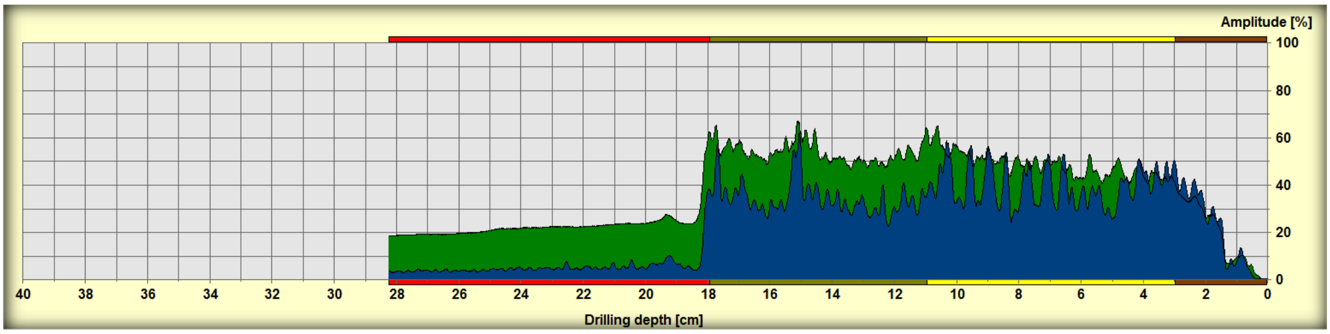
6.0 TESTING USING A RESISTANCE MICRO-DRILL (Continued…)

6.5 Resistance Micro-drill Test Results obtained from 2000 mm above ground level

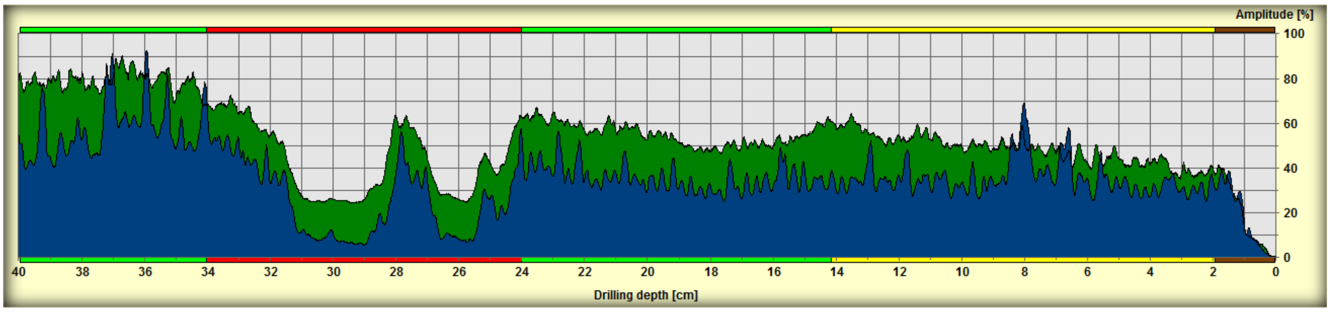
Test 13; North/East – South/West



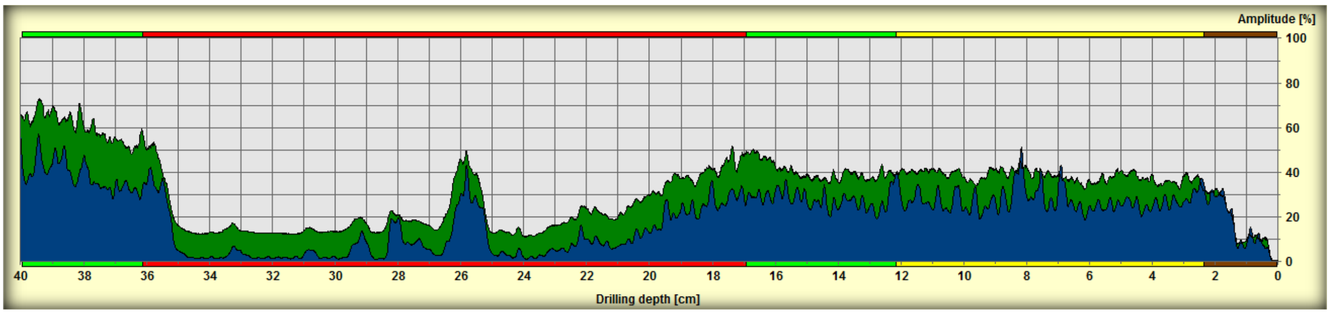
Test 14; South/East – North/West



Test 15; South/West – North/East



Test 16; North/West – South/East



6.0 TESTING USING A RESISTANCE MICRO-DRILL (continued…)

6.6 Resistance Micro-drill Results Interpretation

Whilst comparing the sixteen test results, the Resistance Micro-drill (IML RESI PD400) shows that the general resistance through the zones of vascular tissue and sapwood are initially good and consistent, as shown with the green graph (drilling curve). The amplitude is found to be ranging between 30% and 60%, where the differences in wood resistance are better distinguished.

Brown represents bark, yellow sapwood, whilst green represents heartwood. Incipient decay is shown in light brown whilst decay is highlighted in red. The 'Automatic Needle Retraction' function was engaged in several instances, where the test fails to conclude to the depth of 400 millimetres. This is an inbuilt safety feature which is employed when the needle encounters a void.

Strength loss can be calculated using the t/R ratio, which is a failure criteria taking the ratio of the remaining thickness of the sound-wood against the external radius of the tree stem. The theory proposed by Mattheck & Breloer (1994) argues that when the remaining solid wood within the main stem of a tree, with a full crown, falls below a ratio of 0.3 then the tree is liable to increased risk of failure. However, it must be noted that this calculation is for trees with internal decay where the stem is still intact, where the decay is centralised and for trees with a full crown. The ratio can be reduced to t/R of 0.25 for trees with a reduced crown area and a centralised area of decay.

Whilst comparing the results as shown within tests 1 to 4 (100 millimetres above ground level), the average thickness of sound wood measurement is calculated to be 31.5 centimetres of penetration, with a corresponding t/R ratio of 0.8 which does satisfy Mattheck's t/R ratio and failure criteria.

Whilst comparing the results as shown within tests 5 to 8 (1000 millimetres above ground level), the average thickness of sound wood measurement is calculated to be 26.0 centimetres of penetration, with a corresponding t/R ratio of 0.7 which does satisfy Mattheck's t/R ratio and failure criteria.

Whilst comparing the results as shown within tests 9 to 12 (1500 millimetres above ground level), the average thickness of sound wood measurement is calculated to be 25.0 centimetres of penetration, with a corresponding t/R ratio of 0.7 which does satisfy Mattheck's t/R ratio and failure criteria.

Whilst comparing the results as shown within tests 13 to 16 (2000 millimetres above ground level, the average thickness of sound wood measurement is calculated to be 20.5 centimetres of penetration, with a corresponding t/R ratio of 0.6 which does satisfy Mattheck's t/R ratio and failure criteria.

7.0 PHOTOGRAPHIC OVERVIEW

Figure 6: Showing the compression fork and adaptive growth below the point of bifurcation

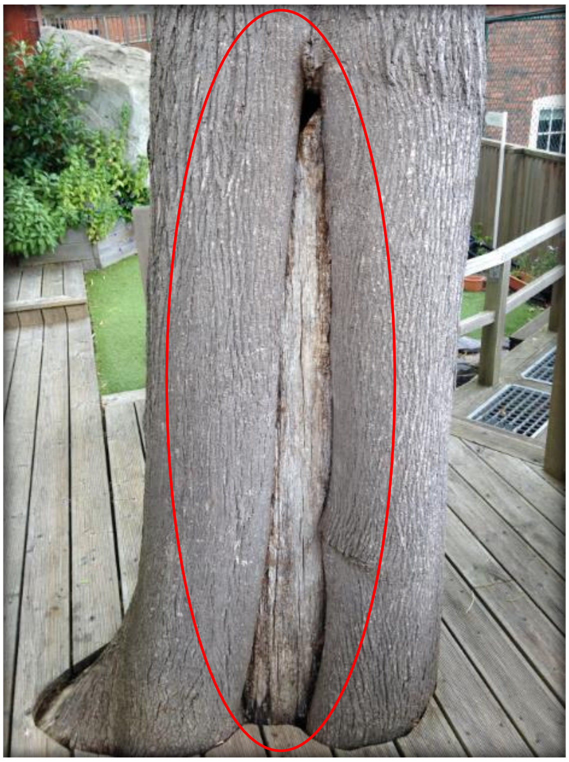


Figure 7: Showing the significant wound and cavity from ground level up to 1.5 metres above.

8.0 DISCUSSIONS & RECOMMENDATIONS

In conclusion, we would advise that the tree structure is somewhat de-graded and the remedial works recommended below will assist in lowering the tree's level of risk but will not eliminate the risk entirely.

The fungal pathogen (*Daedalea unicolor*) is known to be of a persistent action and will to continue to degrade the tree's main stem, buttresses and root system; unfortunately no effective control measures can be taken to stop the pathogenic decay.

Whilst the Resistance Micro-Drill testing was limited to a height of 2.0 metres above ground level. The results obtained confirm the presence of internal decay which progressively worsened with height.

The presence and extent of adaptive growth found below the compression fork and point of bifurcation is of concern, particularly with the known extent of internal decay within the main stem. As such, the main stem is considered to be at an increased risk of fracture.

Upon completion of the risk assessment, following the Level 3 investigations, the likelihood of failure has been categorised as 'Possible', whilst the likelihood of impacting the target is 'High'. The consequences of failure have been categorised as 'Severe' with the identified targets comprising of the main school building and associated classrooms to the north, outdoor multi-use games area (MUGA) to the east, School Caretakers shed/outbuilding to the south and finally a third party property located along Lyndhurst Gardens to the west.

The final risk rating is classified as 'Moderate'.

In order to effectively reduce the tree's risk of failure, the crown must be reduced regularly, as has been conducted previously. This will reduce the tree's wind sail and alleviate the stress exerted upon the decayed rooting system and decayed main stem.

However, the severity of the recommended crown reductions would result in multiple large pruning wounds throughout the crown, further stressing the tree and providing further vectors for pathogenic decay.

It is worth noting that the tree is already considered to be under considerable stress, and the loss of a significant volume of photosynthetic material carries with it an inherent risk of pruning shock, whereby the tree is at an increased risk of entering a spiral of decline, ultimately leading death.

Therefore, if the tree is to be retained, the recommended crown reduction works would also drastically affect the tree's amenity value and in turn reduce its aesthetic appeal. If retained, it will also require re-inspection and a re-evaluation within two years of this assessment.

However, should this level of risk and associated expense be considered unacceptable, the only viable option thereafter would be to fell the tree and replant with an appropriate specimen, if desired.

8.0 DISCUSSIONS & RECOMMENDATIONS (continued…)

Figure 8: Showing the recommended crown reduction, as viewed from the south.

Table 1: Schedule of Tree Works

Tree Reference	Specification of Works
T1 Norway Maple	• Crown reduction by 1.5 metres from the branch tips, (back to previous pruning points). • Crown thin epicormic growth by 20%. • Remove any remaining deadwood throughout crown Or alternatively, • Fell & replant

9.0 RISK ASSESSMENT

Bartlett Consulting uses the International Society of Arboriculture's (ISA) Tree Risk Assessment methodology, referred to as TRAQ. This is a 'qualitative' system which uses a matrix-based combination of ratings, to reach a conclusion of associated risk. The standard Bartlett Consulting time-line within the TRAQ system is three (03) years, unless otherwise stated within the report.

Risk is the combination of the 'likelihood' of an event: in this case the failure of a tree or part of a tree, and the severity of the potential consequences. A hazard is the likely source of harm. The two tables below define both the likelihood and risk levels as per the TRAQ system.

Table 2: Likelihood of Failure

Classification	**Description of Likelihood** (As per Dunster, Smiley, Matheny, Lilly 2013)
Improbable	Failure is not likely during normal weather conditions and may not fail during severe weather conditions, within the specified time frame of three years.
Possible	Failure could occur but is unlikely during normal weather conditions, within the specified time frame of three years.
Probable	Failure may be expected under normal weather conditions, within the specified time frame.
Imminent	Failure has started or is most likely to occur in the near future, even if there is no significant wind, weather, or increased load.

Table 3: Risk Rating

Risk Level	**Description of Risk** (As per Dunster, Smiley, Matheny, Lilly 2013)
Extreme Risk	Failure is imminent, with a high likelihood if impact on people and/or property, with severe consequences.
High Risk	Failure likely to very likely with significant consequences; or failure likely with severe consequences – to impact on people and/or property.
Moderate Risk	Failure likely to very likely with minor consequences; or failure somewhat likely with significant to severe consequences – to impact on people and/or property.
Low Risk	Failure unlikely with negligible consequences; or failure somewhat likely with minor consequences – to impact on people and/or property.
Tree Removal and Tree Surgery	Weakened crown anchor points or root system possible requiring full risk assessment by Arborist and Climber prior to tree works to determine appropriate working methods.

NOTE: Customer Must Make Tree Workers Aware of this Statement

CAUTION: Trees with structurally weak root systems, main stems or branches may not have sufficient structural strength to withstand dismantling works. The weight of people climbing the tree or using the tree branches as load carrying points may increase the load to the point of tree or branch failure. Persons engaged on such works must undertake a thorough risk assessment of the structure of the tree before finalising a working method. Alternative work methods to consider may include the use of crane or mobile elevated platform.

We trust that the contents and recommendations contained within this report were informative, easy to understand and helpful to you, with regards to managing your tree. Should you have any further questions or concerns, please do not hesitate to contact us again.

REPORT CLASSIFICATION:	Tree Health & Structural Integrity Report
REPORT STATUS:	Final
REPORT COMPLETED BY:	James Percy-Lancaster **Arboricultural Consultant**

SIGNATURE: **DATE: 18/07/2016**