Tree Structural Integrity Report

SITE:

5 Kewferry Road
Northwood
Middlesex
HA6 2NS

PREPARED FOR:

Mrs Bishop

PREPARED BY:

Mr G Davies *FdSc Arb*
Arboricultural Consultant

BARTLETT PROJECT REFERENCE:

GD/220497

SITE VISIT DATE:

5th October 2022

Bartlett Consulting
Bartlett Tree Experts Ltd
Coursers Farm
Coursers Road
Colney Heath
St Albans
Hertfordshire
AL4 0PG.
www.bartlett.com

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1.0 SCOPE OF REPORT

1.1 Assignment

Bartlett Consulting were instructed by Mrs Bishop on 30th October 2022:

1. To re-attend site and perform a visual tree assessment (VTA) of a single Common Oak (*Quercus robur*) located within the grounds of 5 Kewferry Road following the techniques developed by Mattheck & Breloer (1994).

2. To perform a "Level 3 Advanced Assessment" in accordance with the International Society of Arboriculture's (ISA's) Best Management Practices (BMP) *Tree Risk Assessment* using a the PiCUS® Sonic Tomography to assess the structural integrity of the lower stem.

3. To undertake a qualified tree risk assessment in accordance with the International Society of Arboriculture's (ISA's) Best Management Practices (BMP) *Tree Risk Assessment* (using Level 3 Advanced Assessment techniques) and *Tree Risk Assessment Manual* of the tree part(s) detailed in Assignment Item 2 above.

   After review and discussion with the client, the tree risk assessment will be conducted for the following *target(s)*: Members of the public using the adjacent public footpath, students, teachers and visitors within the school playground and the school building.

4. To provide a written report on the current structural condition of the tree; the level of associated tree risk based on the likelihood of failure and impact to the identified targets detailed above; and to make fully informed management recommendations in accordance with current arboricultural practice and tree health care techniques so that the tree owner (risk manager) can determine their tolerability of risk and take reasonable and proportionate action.

1.2 Background

A previous structural integrity report was carried out by Bartlett Consulting on 23rd September 2010 and more recently in April 2021 in which internal decay has been identified at the base of the tree and a re-assessment was recommended within a two year period. Concern has been raised by local Bartlett Tree Expert Representative Mr Woodham following a recent visit and it was decided that an early re-assessment of the tree would be required.

1.3 Report References

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

- Dunstar, J.A, Smiley. T, Matheny. N, Lilly. S. (2017) *Tree Risk Assessment Manual, Second Edition*. International Society of Arboriculture. Champaign, IL.
- Health & Safety Executive (2001) *Reducing Risk, Protecting People: HSE's Decision-Making Process*
- Lonsdale, D. (1999) *The Principles of Tree Hazard Assessment & Management* Department of the Environment. London.
- Mattheck, C., et. al. (2015) *The Body Language of Trees – Encyclopaedia of Visual Tree Assessment* Karlsruhe Institute of Technology Campus North.
- Rinn, F. (2011) *Basic Aspects of Mechanical Stability of Tree Cross Sections*. Arborist News, February.
- Slater, Dr D (2016) *Assessment of Tree Forks – Assessment of Junctions for Risk Management* Arboricultural Association, The Malthouse, Gloucestershire.

1.0 SCOPE OF REPORT (continued…)

1.4 Report Limitations & Methodologies

This report is restricted to the Common Oak tree detailed in the Assignment above.

Our VTA, Level 3 Advanced Assessment and qualified risk assessment of the Common Oak located at 5 Kewferry Road is based on a single site visit on 5th October 2022. All photographs, samples, and readings, were taken at the time the assessment was performed.

There were no limitations affecting either tree inspection and/or the advanced assessment.

Neither the rooting system, upper main stem, primary branch structure, secondary branch structure nor canopy were assessed using *Level 3 Advanced Assessment* techniques as per the agreement with Mrs Bishop.

Targets and *Occupancy Rates* considered in the tree risk assessment were determined based on a conversation and agreement with Mrs Bishop. Targets considered in this tree risk assessment are members of the public using the adjacent footpath, Students, teachers and visitors within the school playground, school building and residential properties. The *time frame* for the risk assessment is 2 years.

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.

Tree risk ratings are derived from a combination of three factors: the likelihood of failure, the likelihood of the failed tree part impacting a target, and the consequences of the target being struck. These factors are then used to categorize tree risk as extreme, high, moderate or low. The factors used to define your risk rating are identified in this report.

Tools used in the assessment included: a nylon hammer to ‘sound’ the tree and tree parts; a probe to measure the depth of cavities and open wounds, as well as explore soil conditions; and binoculars to observe upper portions of the tree. Tree dimensions were recorded using hand tools such as a laser range finder; diameter tape and measuring tape.

Specifically, Bartlett Consulting employed PiCUS® Sonic Tomography to determine levels of wood density; detect internal decay; and measure levels of residual sound-wood associated with the lower stem of the Common Oak.

This information is solely for the use of the tree owner and manager to assist in the decision-making process regarding the management of their tree or trees. Tree risk assessments are simply tools which should be used in conjunction with the owner or tree manager’s knowledge, other information and observations related to the specific tree or trees discussed, and sound decision making.

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 MODERATE potential for wildlife and ecological associations with the tree subject to this report. Ecological associations are considered to be varied including birds, small mammals and a variety of insects.

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 assessed for nesting birds and other protected species prior to any recommended tree works.

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.

An enquiry was previously conducted by Bartlett Consulting on 13th April 2021 through the London Borough of Hillingdon's interactive mapping website:

https://lbhillingdon.maps.arcgis.com/apps/View/index.html?appid=7b18f60872a94d38a0c9bf1aea032760

2.1 Tree Preservation Order (TPO) Status

TPO 188 - 5-35 Kewferry Rd, Northwood - dated 18.01.1973

2.2 Conservation Area (CA) Status

The site is not located within a designated conservation area

2.3 Tree Management Implications

The Common Oak identified within this report is currently subject to statutory protection, all works as prescribed can only be implemented with the formal consent of London Borough of Hillingdon Council.

This report can be submitted with the TPO 1APP as a supporting document. Bartlett would be happy to submit the TPO 1APP on your behalf, should you wish to proceed with any works arising from this report.

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.

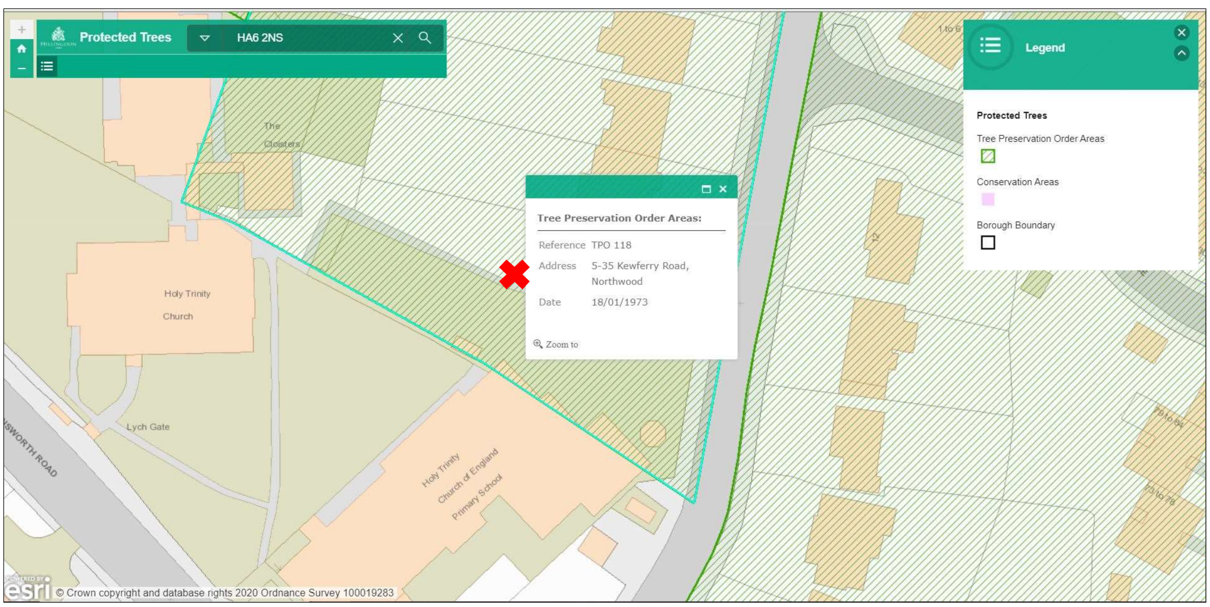


Figure 1: Snipped Image from London Borough of Hillingdon's Website Showing Location of TPO Common Oak (Red X)

3.0 TREE & SITE DETAILS

Species	Common Oak *(Quercus robur)*			
Stem Diameter at 1.5 metres height	1370 millimetres			
Age	MATURE (200+ years)			
Tree Height (metres)	23			
Crown Spread (metres)	**N** 10.0	**E** 10.0	**S** 9.0	**W** 12.0
Vitality	Vigorous regrowth forming from previous pruning works			
Location	Located within the private residential rear garden of 5 Kewferry Road, adjacent to the southern boundary.			
Targets	1. People: General public using the footpath immediately south of main stem within crown spread; [Occasional Occupancy] 2. People: Students, staff and visitors using the adjacent playground 2.5 m south of the main stem within crown spread; [Occasional to frequent occupancy] 3. Buildings: School building 15.0 m south & residential buildings 10.0 m east of main stem within 1x tree height; [Constant occupancy]			
Rooting Environment	1. Impervious hardstanding of footpath and school playground coving approximately 50% 2. Maintained grassed lawn and shrub bedding areas covering approximately 30% 3. Impervious hardstanding patio and footprint of building within approximately 20%			
Surface Roots / Buttresses	1. Prominent buttress development to all quadrants, most notable to north, east and west 2. Fungal brackets forming to the south-east and south-west between buttressing, identified as *Ganoderma pfeifferi* 3. Poor resonance returned when sounded to south-east and south-west quadrants with good resonance returned when sounded around the remaining base 4. Southern buttressing in contact with boundary fence resulting in slight movement of the fence panel			
Main Stem	1. Poor resonance when sounded to the south-eastern quadrant up to 2.0m on the main stem with good resonance returned beyond this height and around the remaining stem up to a height of 2.5 m 2. Epicormic regrowth establishing at 2.0 m on the main stem 3. Single stem specimen with significant lateral branches establishing beyond height of 4.0 m 4. Multiple co-dominant leaders forming from union at 8.0m			
Crown	1. Previous branch removals throughout crown resulting in fully and partially occluded wounds on the main stem and primary scaffold limbs. 2. Suspected decay within historical wounds that are yet to fully occlude 3. Recently crown reduced (30th August 2021) resulting in significant regrowth from pruning points			
Assessment	PiCUS® Sonic Tomography at 530 millimetre test plane			

4.0 FUNGAL, DISEASE OR INSECT PATHOGEN

4.1 Beeswax Fungus (*Ganoderma pfeifferi)*

The presence of a fungal fruiting body identified to be *Ganoderma pfeifferi* is found to be developing at the base of the Common Oak.

Type: Parasitic & Saprobic

Appearance: A woody hoof or shelf like bracket sometimes occurring in overlapping tiers. Dull copper varnish like wax upper surface, which melts under flame and can be scratched off with a knife. The margin and pore-bearing underside initially white in active growth becoming yellow over time and later brown once in maturity.

Type of Decay: Although technically a white rot the affected wood contains brown zones interspersed with yellow pockets spreading into previously sound sapwood.

Area affected: Predominantly lower stem base and roots but can affect the whole tree structure

Season & Persistence: Perennial brackets known to persist for many years. Little is known as to the season of successive growth.

Principle Species: Broadleaf trees especially Beech less frequently on Oak.

Consequence: Decay can become extensive enough to cause wind throw or breakage. Affected trees can also sometime develop extensive bark necrosis in regions colonised by the brackets and this can occasionally kill the tree.

Figure 2: Beeswax Fungus fruiting body attached to the south-western quadrant of the Oak Tree

Green. T & Watson. G. (2011)
Fungi on Trees - An Arborists Field Guide. Arboricultural Association, Stonehouse

5.0 TESTING USING SONIC TOMOGRAPHY (PiCUS®)

PiCUS® testing (Sonic Tomography) enables almost non-injurious testing of decay in trees. Sensor units are attached to adjustable webbing and small nails are driven into the bark to contact the sapwood tissue beneath. Each of the nails is then struck with a test hammer, sending soundwaves through the tree stem, with the soundwave being picked up by the sensor array around the tree stem.

When travelling through solid wood, the soundwaves are uninterrupted and travel quickly; in damaged wood the soundwave will be slowed or forced to travel around features such as an internal cavity. The relative speeds of reception are uploaded onto a data file and processed into a visual image of the interior of the tree stem, using the software provided with the PiCUS® unit. This image displays the different conductivity of the wood in the tree stem, with areas of high velocity and solid wood indicated by brown colours; areas of low velocity and distorted sound waves in violet or blue colours; and areas of unclassified sound waves in green.

This information and representative image are interpreted by Bartlett Consulting based on the visual tree assessment; knowledge of the interaction between the tree species and any potential fungal pathogen(s); any wood decay, degradation, or dysfunction; and the references cited in Section 1.3 above to create an understanding of the internal structure of the tree stem.

Following the VTA, one test was conducted on the Common Oak at 5 Kewferry Road.

Test: When conducting the assessment, after establishing the 53 centimetre height of the test plane, Sensor 1 was positioned on the northern side of the main stem, with the subsequent 23 sensors then spaced at regular intervals at the same height to create a level test plane.

Figure 3: Image of PiCUS Test Plane Conducted on Common Oak

5.0 TESTING USING SONIC TOMOGRAPHY (PiCUS®) (continued…)

5.1 Results of Sonic Tomography (PiCUS®) Test

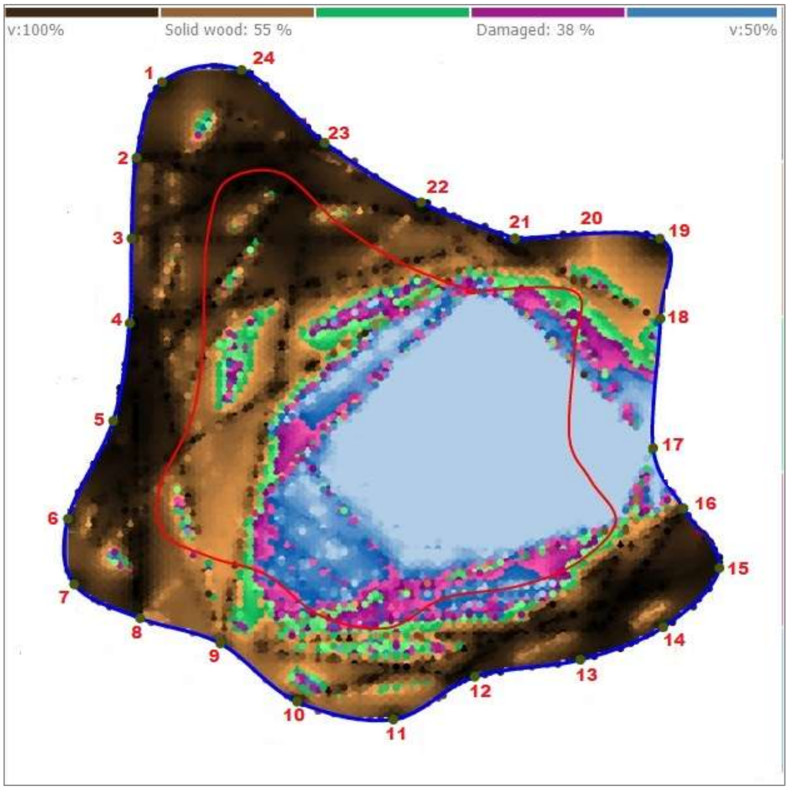


Figure 4: Image of PiCUS® Sonic Tomograph at 53 Centimetres Ht. on Common Oak at 5 Kewferry Rd

The Tomogram depicts that at 53 centimetres above ground level 38% of the wood as indicated by the blue/pink colours returned the slowest rate of soundwave transmittance, whilst 55% as indicated by the brown colour returned the fastest transmittance. The remaining 7% as indicated by the green coloured areas of the image is considered to have moderate rate of soundwave transmittance.

The blue / pink areas with the slowest soundwaves are interpreted as regions where wood is possibly decayed. As can be seen in Figure 4, the blue area has a bias to the southern quadrant. This corresponds with the locations of the fungal fruiting bodies previously attached between sensors 9-10 & 17-18 with very little in way of intact wood within these areas

The surrounding "belt" of green depicted on the image indicate areas of the stem which we interpret as incipient decay.

The circumferential red line within the Tomograph is a notional representation of the "t/R ratio". 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.

From the above image, it can be seen that the residual solid wood at this level falls within the circumferential red line to the north, and north-west aspects with significant amounts of intact and supporting wood. However the intact wood to the southern aspect of the stem falls short of the circumferential red line.

6.0 TESTING USING AN IML-RESI POWERDRILL®

The IML-RESI 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 wood density by measuring the drilling resistance and feed speed, to a nominal depth of 40 centimetres within the stem or branch.

As the Resistance Micro-drill is an invasive method of decay detection, Bartlett Consulting injects Potassium Phosphite into the drilling tunnel to aid the tree compartmentalising the wound and combating fungal decay pathogens when practically possible.

The density of the wood being tested creates resistance to the drill needle, with the results provided on a graphic print-out with the “feed curve” and timber density shown in blue, and the “drill curve” and shaft friction shown in green along the y-axis of the graph line. The depth of the drill is shown along the x-axis of the graph line. Both are shown 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.

6.1 IML-RESI Powerdrill® Testing Locations

A total of eight tests were conducted on the main stem of Oak. at the same level as the PiCUS Sonic Tomography test plane. The test locations where position on or between the sensor locations and these numbers have been used for referencing.

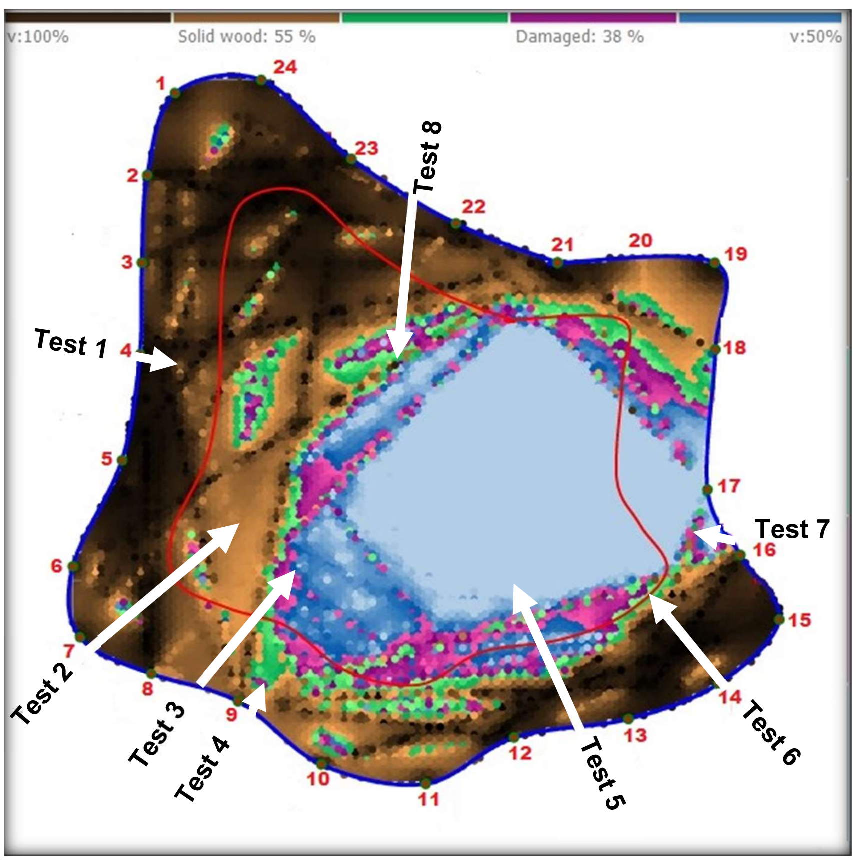
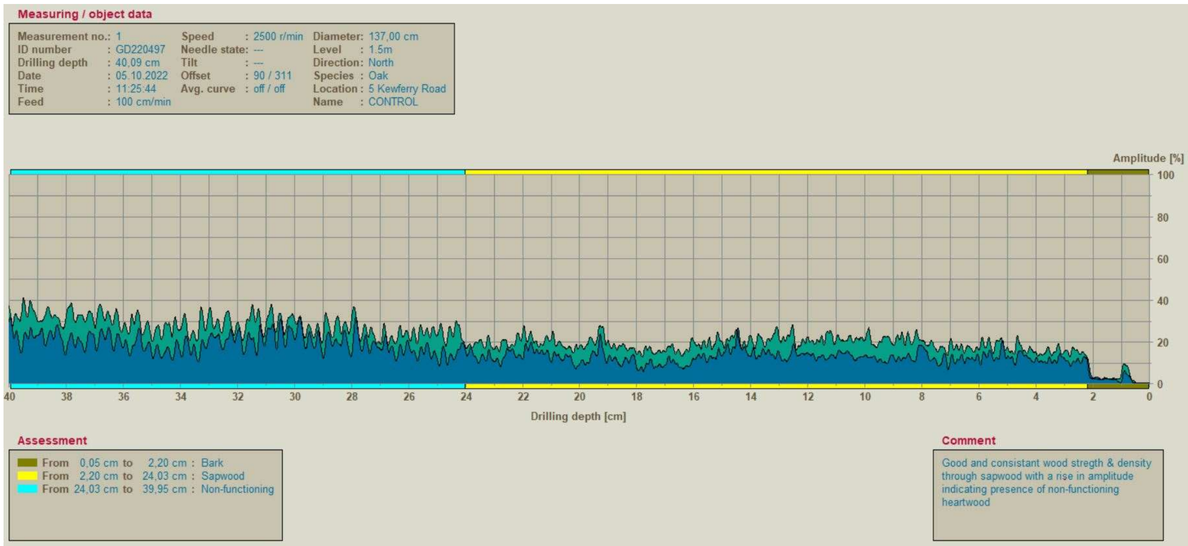


Figure 8: Showing test profile and location of the eight drill test locations

6.0 TESTING USING AN IML-RESI POWERDRILL® (Continued…)

6.2 IML-RESI Powerdrill® Test Results

Control – 1.5 m North



NOTE: The above control test shows all the test data and interpretation, including Object Data, Assessment and Comments. The remaining test results will be cropped to show only the micro-drill assessment to reduce the number of pages within the report. Sections 6.3 & 6.4 below includes a detailed interpretation of the test results.

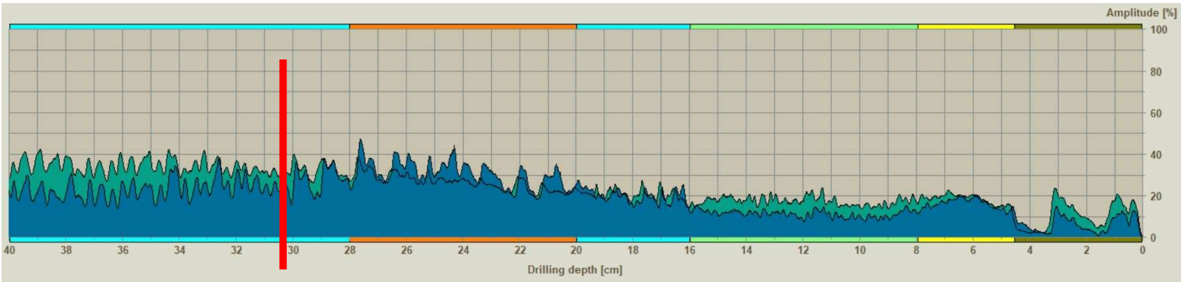
Table 1: Colour Coding of Interpretation

Colour		Description
Brown		Bark
Yellow		Sapwood
Blue		Non-functioning Heartwood
Green		Early-stage Decay
Purple		Advanced Decay
Black		Cavity
Orange		Reaction Zone / Suspect Wood

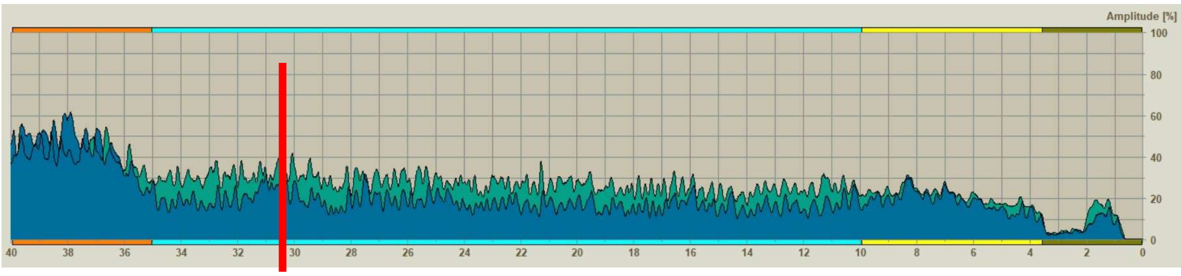
6.0 TESTING USING AN IML-RESI POWERDRILL® (Continued…)

6.2 IML-RESI Powerdrill® Test Results (Continued…)

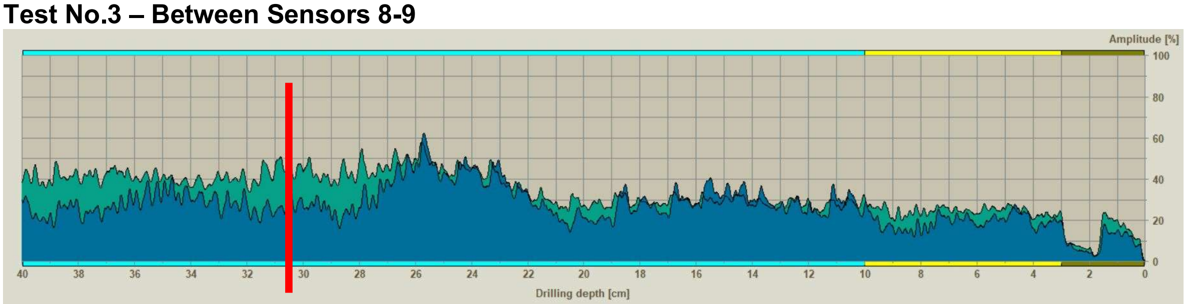
Test No.1 – At Sensor 4



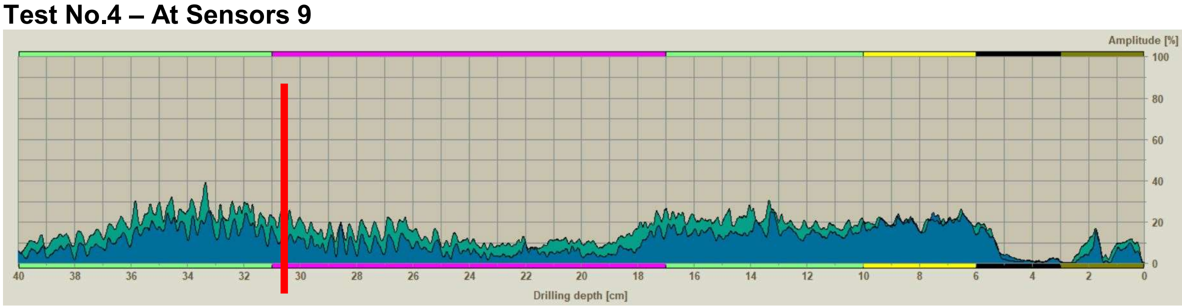
Test No.2 – Between Sensor 7-8



Test No.3 – Between Sensors 8-9



Test No.4 – At Sensors 9

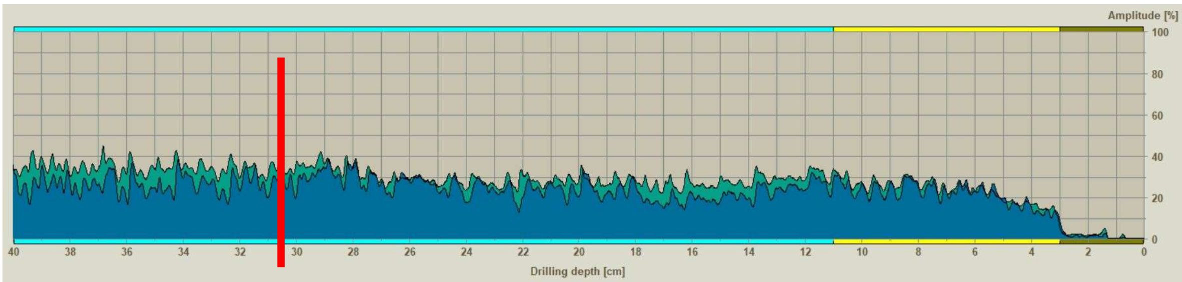


The "t/R ratio", as previously illustrated by the circumferential red line within the Tomogram and discussed in Section 6.4 is represented here by the red line.

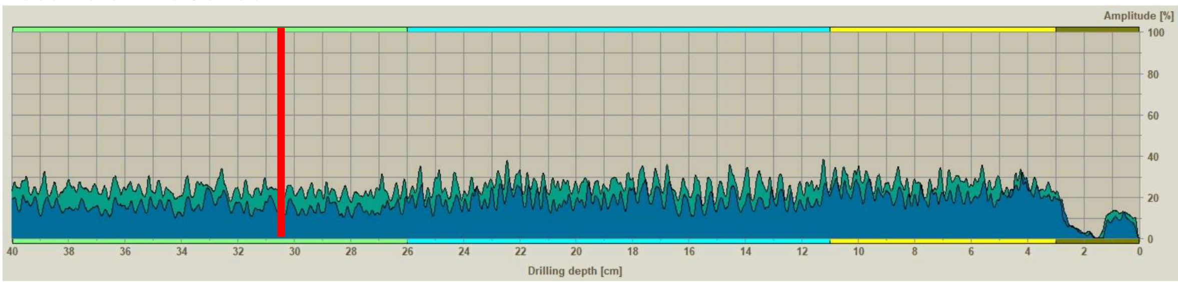
6.0 TESTING USING AN IML-RESI POWERDRILL® (Continued…)

6.2 IML-RESI Powerdrill® Test Results (Continued…)

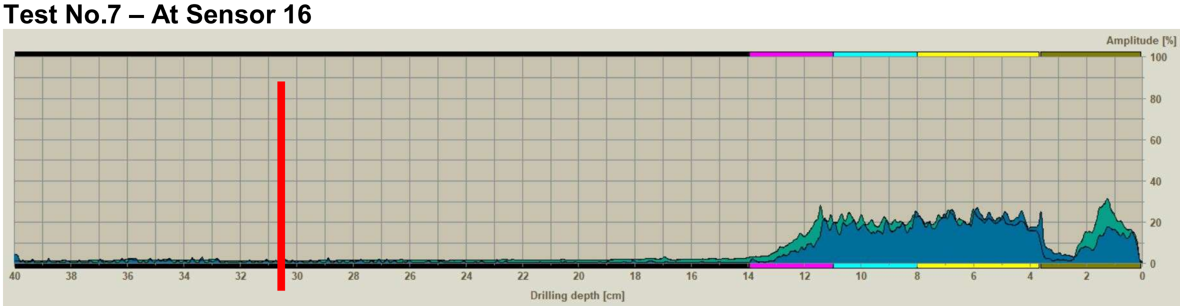
Test No.5 – Between Sensor 12-13



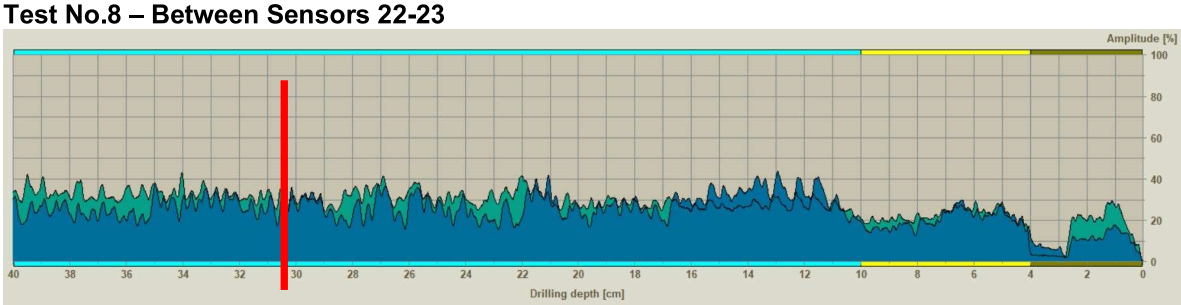
Test No.6 – At Sensor 14



Test No.7 – At Sensor 16



Test No.8 – Between Sensors 22-23



The "t/R ratio", as previously illustrated by the circumferential red line within the Tomogram and discussed in Section 5.1 above is represented here by the red line.

6.0 TESTING USING AN IML-RESI POWERDRILL® (Continued…)

6.3 IML-RESI Powerdrill® Test Result Interpretation

Whilst comparing the eight test results, the IML-RESI Powerdrill® PD400 shows that the general resistance through the zones of vascular tissue and sapwood is initially good and consistent, when compared to the control test, as shown with the blue graph (feed curve). The amplitude is found to be ranging between 20% and 40%, where the differences in wood resistance are better distinguished.

Test No.1
Increasing wood density through the initial sapwood profile, with a noticeable drop in amplitude beyond 8cm and a reduction of the peaks and troughs indicating early stage decay up to 16cm. This profile fails to satisfy the 0.33 Mattheck's t/R ratio.

Test No.2
Increasing wood density throughout sapwood profile followed by a consistent profile through the non-functioning heartwood to a depth of 35cm. Significant increase in resistance beyond 35cm, interpreted as an area of reactive growth. This profile currently satisfies 0.33 Mattheck's t/R ratio.

Test No.3
Increasing wood density through the initial sapwood profile and consistent through the non-functioning heartwood. Increase in resistance beyond 21cm, interpreted as an area of reactive growth. This profile currently satisfies 0.33 Mattheck's t/R ratio.

Test No.4
Increasing wood density throughout sapwood profile. Consistent amplitude and level amplitude beyond 11cm indicating unaffected non-functioning heartwood. This profile currently satisfies the 0.33 Mattheck's t/R ratio.

Test No.5
Lack of resistance within the initial drill profile indicating significant decayed wood or cavity followed by initial wood density through 4cm Sapwood. Early stage decay followed by advance decay through reaming test profile. This profile fails to satisfy the 0.33 Mattheck's t/R ratio.

Test No.6
Increasing wood density throughout sapwood profile, and initial non-functioning heartwood to a depth of 26cm. Reduction within the resistance beyond 26cm interpreted as early stage decay. This profile currently satisfies 0.33 Mattheck's t/R ratio.

Test No.7
Increasing wood density throughout sapwood profile, and initial non-functioning heartwood to a depth of 11cm. Significant drop in resistance at 11cm interpreted as advanced decay. Zero resistance was encountered beyond 14cm indicating cavity. This profile fails to satisfy the 0.33 Mattheck's t/R ratio.

Test No.8
Increasing wood density throughout sapwood profile. Increase within the amplitude beyond 10cm followed by a constancy throughout the remaining test profile indicating unaffected non-functioning heartwood. This profile currently satisfies the 0.33 Mattheck's t/R ratio.

6.0 TESTING USING AN IML-RESI POWERDRILL® (Continued…)

6.4 IML-RESI Powerdrill® Test Result Conclusions

Strength loss can be calculated using the t/R ratio, which is a failure criterion taking the ratio of the remaining thickness of the sound-wood against the external radius of the tree part being tested. 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.

It must be noted however that: this calculation is for trees with internal decay where the stem is still intact, 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.

The below table provides all the t/R calculations for the Common Oak tree:

Height (mm)	Diameter (mm)	Radius (mm)	t/R Ratio = 0.3 (mm)
530	1846	923	307

Position	Residual Sound-wood (mm)	t/R ratio
1	80	×
2	>400	✓
3	>400	✓
4	0	×
5	>400	✓
6	110	×
7	80	×
8	>400	✓

As shown within the table above of the seven test locations conducted at a height of 53cm above ground level, four (4) measurements had sufficient residual wood which satisfied the Mattheck's t/R ratio and failure criteria (0.25)

Taking into account all 8 readings the residual wood measures an approximate average thickness of 252 millimetres at the 1846 millimetre diameter test plane where the stem has a radius of 923 millimetres.

The corresponding t/R ratio is 2.7 which currently fails to satisfy Mattheck's reduced t/R ratio and failure criteria.

7.0 PHOTOGRAPHIC OVERVIEW

Figure 9: Image showing prominent buttressing to the east and western quadrant & location of Fungal Brackets to the south-east highlighted

Figure 10: Image of fungal bracket attached to the south-western quadrant

Figure 11: Image showing Common Oak as viewed from north-western aspect

8.0 CONCLUSIONS

Following visual assessment the tree appeared to be in a fair physiological condition, with vigorous regrowth resulting from previous tree works. There was very little sign of any deadwood throughout the crown however we believe this is regularly cleared due to the location of the tree and the identified target areas.

When considering targets and the subsequent risk our key concern is the proximity of the tree in relation to the school playground, located within 2.5m of the main stem and within the crown spread.

At the conclusion of the advanced assessment using the sonic tomography at the base of the main stem, the results are interpreted as advanced levels of wood decay and degradation with an asymmetrical bias to the south, falling outside the circumferential red line (notional representation of the “t/R ratio”).

When comparison is made with the previous 2021 sonic tomography test result, the decay appears to be progressive, identifying a small reduction in the non-effected and sound structural wood. This can be attributed to the fungal pathogen identified as *Ganoderma pfeifferi,* a persistent white rot decay fungus of which is known to cause selective delignification.

The IML PD400 Resistance Micro Drill was utilised in order to obtain more information as to the state of the effected wood. The results showed four (4) measurements had sufficient residual wood which satisfied the Mattheck’s t/R ratio and failure criteria whilst the remaining four (4) failed to satisfy the criteria.

Both the Sonic Tomography and Resistance Micro Drill results indicate there to be a relatively centralised area of decay although the resistance micro drill identified a greater level of un-affected sound wood to the east and a greater area of damaged wood to the south.

Based on current extent and progressive nature of the internal decay we must conclude that the Common Oak tree is now considered to be at an increased risk of failure.

Furthermore the Common Oak tree is considered to be with a mature state and over time will beginning the natural process of retrenchment in which it would start to drop large limbs as it establishes a smaller and more sustainable crown size.

As the location of the tree and highlighted targets permits this natural process then a proactive management plan will therefore be required.

8.1 Common Oak Tree 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. More detail can be found in Appendix 1 and Appendix 2 below.

Target	Tree Part	Likelihood of Failure	Likelihood of Impact	Failure & Impact	Consequences	Risk Rating
People	Lower Stem	Possible	Medium	Unlikely	Sever	Low
Structures	Lower Stem	Possible	High	Somewhat likely	Significant	Moderate

Using the methods outlined in this report, and the results of the visual and advanced tree assessments of the Lower stem of the Common Oak it is our professional judgment that this tree part currently has an *overall tree risk rating* of ***MODERATE***.

9.0 RECOMENDATIONS

9.1 Common Oak Tree Recommendations

We recommend the following pro-active and re-active tree management operations to address identified tree features and hazards, as well as to mitigate associated tree risk. We recommend that as the "tree risk manager" current risk and residual risk levels are reviewed, and a determination is made with regards to your acceptable tolerability of risk and appropriate tree management.

- Carry out approximate 7.0m – 8.0m reduction in height, with suitable reduction of lateral growth to suit in order to establish a reduced crown volume and mimic natural crown retrenchment.
- Carry out suitable Plant Health Care programme including soils sampling, Root Invigoration™ and use of potassium phospihites to help improve tree vitality

  Residual risk will be reduced to ***low***
  Works to be carried out within **1 year** of this report
  Following the works the tree should be re-inspected in **3 years**

The recommended works will reduce the static (tree mass) loading on the main stem, as well as the dynamic (wind) loading.

Please note that these works will significantly reduce the physiological condition of the tree, through the loss of leaf / canopy area and reduction in photosynthesis. This will in-turn reduce the tree's ability to defend against the fungal pathogen, aiding in further colonisation.

A Plant Health Care programme should be established to help mitigating for the necessary tree works and help the tree to defend against the further spread of decay.

Please note the risk associated with Main Stem failure cannot be reduced beyond low.

We have provided a glossary of terms at the end of this report to help with understanding terminology used within this report, as well as with determining your tree care needs and final risk level.

It is important to understand that tree conditions do change over time, and as such, visual re-assessment is recommended annually and after major storm events.

9.0 RECOMMENDATIONS (Continued…)

9.2 Specification of Tree Works

For your reference we also provide detailed pruning specifications here:

Crown Reduction: Will be carried out in accordance with Section 7.7 of BS3998:2010 by reducing the height and/or lateral branch spread, as detailed in the table above. Pruning cuts will be made by using the selective pruning and 'drop-crotch' methodologies, as described in Section 7.7 and 7.8 of the British Standard and as per Figure 4 of the British Standard.

Pruning Cuts: All cuts will be made to significant lateral growth, and not back to a bud so that only a stubbed branch end remains – in accordance with Figure 02 of British Standard 3998:2010.

Soil Sampling: Collecting soil samples and having them tested helps determine nutrients that may be lacking, unfavourable soil pH values and adequacy of soil organic matter. Through laboratory tests and analyses a prescription and tree species specific health care plan can be created.

Root Invigoration™: The aim of Bartlett's patented Root Invigoration™ Program is to improve soil conditions and the growing environment by promoting efficient root growth and tree vitality. The process includes performing a root collar excavation, "air-tilling" a portion of the root zone with an air-spade to find fine roots, incorporating organic matter and soil amendments and top-dressing with mulch. The area of root system treated can vary tree-by-tree, however we recommend a minimum 4.0 metre radius circle.

Potassium Phosphite: Phosphites stimulate tree vitality leading to root development and development of new tissue. Phosphite based fertilisers have been shown to enhance a tree's defence system which can improve disease resilience and response to fungal pathogens. Phosphites are easily absorbed and moved to all areas of the plant as they are usually formulated as a liquid.

Note: It is essential to get dosage rates correct for the tree, and proper watering techniques must be employed

10.0 LIMITATIONS & DUTY OF CARE

Limitations of Tree Risk Assessments

It is important for the tree owner or tree manager to know, and understand, that all trees pose some degree of risk from failure or other conditions, and as trees are living and dynamic organisms, it is not possible to maintain them free of risk. Some level of risk must be accepted to experience the full range of benefits that trees provide. As such, we reference the National Tree Safety Group (NTSG) publication *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.

The information and recommendations within this report have been derived from the level of tree risk assessment identified in this report, using the information and practices outlined in the *International Society of Arboriculture's Best Management Practices for Tree Risk Assessment*, as well as the information available at the time of the inspection.

However, the *overall tree risk rating*, the mitigation recommendations, or any other conclusions do not preclude the possibility of failure from undetected conditions, weather events, or other acts and/or influences of human or nature on the tree(s). Trees can unpredictably fail even if no defects or other conditions are present. Tree failure can cause adjacent trees to fail resulting in a "domino effect" that impacts *targets* outside the foreseeable *target zone* of this tree. It is the responsibility of the tree owner or manager to schedule repeat or advanced assessments, determine actions, and implement follow up recommendations, monitoring and/or mitigation.

Bartlett Consulting and Bartlett Tree Experts can make no warranty or guarantee whatsoever regarding the safety of any tree, trees, or parts of trees, regardless of the level of tree risk assessment provided, the risk rating, or the residual risk rating after mitigation. Bartlett Consulting and Bartlett Tree Experts cannot accept any liability in connection with these 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.

The information in this report should not be considered as making safety; legal; architectural; engineering; landscape architectural; nor land surveying advice, nor any other professional advice.

This information is solely for the use of the tree owner or tree manager to assist in the decision-making process regarding their duty of care, tolerability of risk, and management of their tree or trees. Tree risk assessments are simply tools which should be used in conjunction with the owner or tree manager's knowledge, other information and observations related to the specific tree or trees discussed, and sound decision making.

All recommendations made by Bartlett Tree Experts will be based on the defects that are present and detectable at the time of the inspection or assessment, and the commonly accepted industry practices for reducing or minimising the risks associated with the trees, and are meant to assist the owner/client with the decision-making process regarding the trees. Tree conditions, though, can change, and some features/hazards may not be present or detectable through the inspection process. As such, Bartlett Tree Experts can make no guarantees or warranties of any kind that all features/hazards will be detected; nor can Bartlett Tree Experts accept any liability in any manner whatsoever for any damage caused by any tree on this property, whether the tree was assessed or not, or whether any recommendations to mitigate risk were followed or not.

Therefore, to the fullest extent permitted by law, the owner/client agrees to indemnify and hold harmless Bartlett Tree Experts from any third party law suits or claims based on the past, present, or future conditions of the owner/client's trees, or decisions made by the owner/client regarding the trees, or injuries or damages caused by any future tree or tree part failures, which are under the ownership and control of the owner/client, that Bartlett Tree Experts may suffer as the result of any negligent action, inaction, or decisions made by the owner/client regarding the trees. Such obligations shall not be construed to negate, abridge, or otherwise reduce any other right or obligation of indemnity which would otherwise exist as to any party or person described in this paragraph.

10.0 LIMITATIONS & DUTY OF CARE (continued…)

Tree Owner's Duty of Care

A tree owner has a duty of care to ensure that all visitors, guests, employees, etc. to their land shall be safe from harm, and that there is no exposure to risks to that visitor's health and safety. This duty of care means that reasonable care must be taken to avoid acts or omissions that could be reasonably foreseen, leading to harm.

This duty must also be reasonable, proportionate, and reasonably practicable when managing tree risk. Therefore, the tree owner can take a balanced approach to manage the risk, retain the many benefits trees provide, and not waste resources on unnecessary tree management.

Tolerability of Risk

Some level of risk must be accepted to experience the full range of benefits that trees provide, and an evaluation of what is reasonable to balance the benefit of trees and the risk they pose should be undertaken by the tree owner.

Risks which are considered tolerable are risks which the tree owner, visitors, guests, employees, and the wider public are prepared to accept to secure the associated tree benefits. However, tolerable risks come with expectations, such as the trees being properly assessed; control measures being in place; residual risk as low as reasonably practical; and the risk rating is periodically reviewed.

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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(s).

Should you have any further questions or concerns, please do not hesitate to contact us again.

REPORT CLASSIFICATION: Tree Structural Integrity Report

REPORT STATUS: Final

REPORT COMPLETED BY: Mr G Davies *FdSc Arb*
Arboricultural Consultant

SIGNATURE:

DATE: **11/10/2022**

REPORT REVIEWED BY: Mr James Percy-Lancaster
Senior Arboricultural Consultant

SIGNATURE:

DATE: **12/10/2022**

APPENDIX 1 – Tree Risk Assessment Glossary

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.

Tree risk assessment has a unique set of terms with specific meanings. Definitions of all specific terms may be found in the International Society of Arboriculture's *Best Management Practice for Tree Risk Assessment*. Definitions of some of these terms used in this report are as follows:

Classification	**Description of Likelihood of Failure** (As per Dunster, Smiley, Matheny, Lilly 2017)
Improbable	The tree or tree part is not likely to fail during normal weather conditions, and may not failure in extreme weather conditions, within the specified time frame.
Possible	Failure may be expected in extreme weather conditions, but it is unlikely during normal weather conditions, within the specified time frame.
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.

Targets are people, property, or activities that could be injured, damaged or disrupted by a tree failure.

Likelihood of Impact may be categorized as high meaning that a failed tree or tree part will most likely impact a target; medium meaning the failed tree or tree part is as likely to impact the target as not; low meaning that the failed tree or tree part is not likely to impact a target; and very low meaning that the likelihood of a failed tree or tree part impacting the specified target is remote.

Consequences of a known target being struck may be categorized as severe meaning that impact could involve serious personal injury or death, damage to high-value property, or disruption to important activities; significant meaning that the impact may involve property damage of moderate to high value, considerable disruption, or personal injury; minor meaning that impact could cause low to moderate property damage, small disruptions to traffic or a communication utility, or very minor injury; and negligible meaning that impact may involve low-value property damage or disruption that can be replaced or repaired, and do not involve personal injury.

Risk Level	**Description of Risk** (As per Dunster, Smiley, Matheny, Lilly 2017)
Extreme Risk	Failure is *imminent*, impact & failure is *very likely*, and the consequences of the failure are *severe*. Mitigation will be a high priority or targets must be temporarily controlled.
High Risk	Impact & Failure is *likely* to *very likely* with *significant* consequences; or consequences are *severe* and the Impact & Failure is *likely*. Mitigation measures should be taken.
Moderate Risk	Impact & Failure is *likely* to *very likely* with *minor* consequences; or consequences are *significant* to *severe* with a *somewhat likely* Impact & Failure. Mitigation will be determined by tolerance of risk.
Low Risk	Consequences are either negligible or minor, with corresponding Impact & Failure ratings of either unlikely or somewhat likely respectively. Mitigation may be desirable but not strictly necessary.

Overall Tree Risk is the highest individual risk identified for the tree.

Residual Risk is the level of risk the tree should pose after the recommended mitigation

APPENDIX 2 – Tree Survey & Assessment Glossary

The scientific study of tree hazard evaluation and assessment is not an exact science, and there is still much to learn with constantly developing technology, research, and calculations. Most limitations of tree hazard evaluation arise from uncertainties with trees and the loads to which the trees are subjected.

The three levels of tree evaluation and assessment employed by Bartlett Consulting are those defined in the International Society of Arboriculture's (ISA) *Best Management Practices for Tree Risk Assessment* and *ANSI A300 Tree Risk Assessment Standard*. All three levels are described below, along with the basic limitations of each.

I. Level 1 Limited Visual Assessment

A *Level 1 Limited Visual Assessment* (also referred to as a Hazard Survey or Negative Tree Survey) is a visual assessment from a specific perspective of an individual tree or a population of trees near specified targets. These assessments are conducted to identify obvious defects or specified tree conditions (such as dead trees) as agreed with the client and tree owner / manager.

A *Level 1 Limited Visual Assessment* is typically performed from a pre-defined and specified perspective (i.e., from the pavement, street, car parking area(s), woodland edge, etc.), and typically of one side of the tree from that specified perspective. The specified tree or trees are visually assessed to identify tree features, defects, or specific conditions constituting a hazard which result in a likelihood of failure of probable or imminent and would impact the specified target(s).

Level 1 Limited Visual Assessments are typically performed to quickly assess large populations of trees to identify trees with the highest likelihood of failure ratings in the population, or trees that are recommended for higher level of assessment.

A *Level 1 Limited Visual Assessment* typically includes:

1. Identifying the location and/or selection criteria of trees to be assessed.
2. Determining and documenting the most efficient route to be taken.
3. Determining and documenting the method of visual assessment (e.g. walk-by, drive-by).
4. Recording the location of, and assessing the condition of, tree(s) of concern from the defined perspective meeting the predefined criteria (e.g. dead trees, broken branches).
5. Evaluating the risk (a risk rating is optional).
6. Identifying trees needing a higher level of assessment (*Level 2 Basic or Level 3 Advanced*) and/or priority corrective action.
7. Submitting risk mitigation recommendations and/or report.

Limitations of *Level 1 Limited Visual Assessments*

As the least thorough means of assessment, tree features and/or conditions may not be visible as the inspection is from a particular viewpoint; not all tree features and observations may be visible or apparent at different times of the year; climbers, undergrowth, basal growth, etc. will not be removed inhibiting the inspection; and the inspection may not be adequate enough to make a risk mitigation recommendation. Residual risk designations for trees are not included.

APPENDIX 2 – Tree Survey & Assessment Glossary (continued…)

II. Level 2 Basic Visual Assessment

A *Level 2 Basic Visual Assessment* is a more detailed visual inspection of a tree and its surrounding site, and a synthesis of the information collected. It requires complete inspection around a tree including the site and ground conditions / growing environment; visible buttress roots; main stem(s); and branches (as defined in the International Society of Arboriculture's (ISA) *Best Management Practices for Tree Risk Assessment* and *ANSI A300 Tree Risk Assessment Standard*).

A *Level 2 Basic Visual Assessment* allows for all aspects of the tree(s) to be surveyed and removal of climbers, undergrowth and basal growth. The crown, branches, stem(s), and buttress roots of the specified tree(s) are all assessed to look for notable features including any defect, decay, dysfunction or other structural weakness, as well as assessing the overall health and vitality of the tree(s). A *Level 2 Basic Visual Assessment* will include the use of hand-tools such as a sounding hammer; depth probe; binoculars; and a measuring tape / laser range finder to record tree dimensions; and possibly a trowel to uncover buttresses. Recommendations for trees that need a higher level of assessment are typically included.

A *Level 2 Basic Visual Assessment* typically includes:

1. Locating and identifying the tree or trees to be assessed.
2. Determining the *targets* and *target zone* for the tree or branches of concern.
3. Reviewing the site history and conditions, and species failure profile.
4. Assessing the potential load on the tree and its parts.
5. Visually assessing general tree health based on observable features at the time.
6. Completing the tree inspection and assessment using tools listed above.
7. Recording all details and observations.
8. Analysing all captured field data to determine the *likelihood of failure* and *consequences of failure* to complete a tree risk assessment.
9. Developing mitigation options, recommending a further Level 3 Advanced Assessment, if deemed necessary, and estimating *residual risk* for each mitigation option.
10. Producing and submitting the report, including when appropriate, advice on re-inspection intervals.

Limitations of Level 2 Basic Visual Assessments

This visual assessment will only include details and information on tree features and conditions that can be detected from a ground-based inspection on the day of the assessment, using the tools listed in the introduction above. The extent of some internal decay, as well as the type of wood decay, and below ground or high canopy features or conditions may be difficult to observe, determine or assess.

APPENDIX 2 – Tree Survey & Assessment Glossary (continued…)

III. Level 3 Advanced Assessment

A *Level 3 Advanced Assessment* is performed to provide detailed information about specific tree parts, conditions or features, targets, or site conditions. A *Level 3 Advanced Assessment* typically incorporates all aspects of a *Level 2 Basic Visual Assessment* and is usually conducted after a *Level 2 Basic Visual Assessment* with client approval.

Specialized equipment, data collection and analysis, and/or expertise are typically required for these advanced assessments to provide detailed and in-depth information about a specific tree parts, conditions or features, and the likelihood of failure, previously identified in a *Level 2 Basic Visual Assessment*.

A *Level 3 Advanced Assessment* typically includes:

1. Locating and identifying the tree or trees to be assessed.
2. Determining the *targets* and *target zone* for the tree part of concern.
3. Reviewing and updating the *Level 2 Basic Visual Assessment* data as necessary.
4. Completing the advanced assessment using methods and/or techniques as determined necessary and appropriate by the Arborist, and as defined in the Scope of Work.
5. Interpreting and analysing the advanced assessment data and information to update and revise the *likelihood of failure* and *consequences of failure* in order to complete a tree risk assessment.
6. Developing mitigation options and estimating *residual risk* for each mitigation option.
7. Producing and submitting the report, including when appropriate, advice on re-inspection intervals.

Limitations of Level 3 Advanced Assessments

Using technology, methodologies and equipment listed below always involves a degree of uncertainty as well as limitations in use. Furthermore, most data is not an accurate measure, but a qualified or quantified estimation.

Arborists employing advanced assessment equipment and technology must have an advanced knowledge of the application and use of the various equipment (e.g., when and where it is appropriate for use and which method); in-depth knowledge of decay fungi and host tree species relationships; training and experience in interpreting data; and likelihood of failure assessment

APPENDIX 2 – Tree Survey & Assessment Glossary (continued…)

III. Level 3 Advanced Assessment (continued…)

Methods of Advanced Assessment

Procedure	Methodology
Aerial Tree Inspection (evaluation of tree structure within crown)	• visual inspection from within the tree crown or from a lift • unmanned aerial vehicle (UAV) photographic inspection • decay testing of branches
Detailed Target Analysis	• property value • use and occupancy statistics • potential disruption of activities
Detailed Site Evaluation	• history evaluation • soil profile inspection to determine root depth • soil mineral and structural testing
Decay Testing	• increment boring • drilling with small-diameter bit • resistance-recording drilling • single path sonic (stress) wave • sonic / impulse tomography • electrical impedance tomography • radiation (radar, X-ray) • advanced analysis for pathogen identification
Tree Health Evaluation	• tree ring analysis (in temperate zone trees) • shoot length measurement • detailed health/vigour analysis • starch assessment
Root Inspection and Evaluation	• root and root collar excavation • root decay evaluation • ground-penetrating radar • sonic / impulse tomography
Storm / Wind Load Analysis	• detailed assessment of tree exposure and protection • computer-based estimations according to engineering models • wind reaction monitoring over a defined interval
Measuring & Assessing the Change in Tree Lean	• visual documentation • plumb line • digital spirit level
Load Testing	• hand pull • measured static pull • measured tree dynamics

Note: All levels of tree inspection, evaluation and assessment consider visible, and detectable, tree observation, conditions, and features in proximity to the known and/or assigned targets of the tree or trees being assessed. Regardless of the level selected, any tree risk assessment will be limited to the tree or trees selected, and the detectable conditions at the time of the defined and assigned assessment. The client should also recognize that not all defects will be detectable, and not all failures can be predictable