

Arboricultural Assessment



GREENSCENZ

ENHANCING AND PROTECTING
LIVING ENVIRONMENTS

Site Address:	St Omer Park Lake Esplanade Queenstown
Client:	Queenstown Lakes District Council
The Proposal:	Arboricultural assessment of mature poplar trees growing within St Omer Park utilising resistograph tests

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1.0 Introduction

- 1.1 *GreensceneNZ Limited* has been engaged by *Queenstown Lakes District Council (QLDC)* to carry out an arboricultural assessment to determine the structural integrity of 26 mature poplar trees growing within St Omer Park, Queenstown.
- 1.2 This arboricultural assessment is required following a recent tree failure event of a mature Lombardy poplar (*Populus nigra* 'Italica') that caused damage to property.
- 1.3 The purpose of this report is to provide an arboricultural assessment and recommendations based on visual tree inspections and resistograph tests that were undertaken to evaluate the form, structural integrity, signs of injuries and/or ill health, defects and identified health and safety concerns relating to the poplar trees.
- 1.4 This report provides details of hazard evaluations of poplar trees where significant defects have been found to be present and adjacent targets. This report provides recommendations attributable to the poplar trees.
- 1.5 The visual tree inspections and resistograph tests were carried out between 18th and 23th January 2014. Details pertaining to individual trees, relevant comments and recommendations are contained in Appendix A of this report.
- 1.6 A tree location plan depicting the approximate growing location of the subject trees is included within Appendix B of this report.
- 1.7 Examples of resistograph tests results are contained within Appendix C of this report. A full copy of the results of all resistograph tests undertaken have been submitted in electronic form along with the original copy of this report.
- 1.8 Please note that all measurements and percentages detailed within this report are an approximation only.

2.0 Site Description

- 2.1 Twenty-six mature poplar trees are growing within St Omer Park, which bounds Lake Esplanade to the north and Lake Wakatipu to the south. St Omer Park is a popular recreational facility which is enjoyed by tourists and local residents alike. The park also serves as a thoroughfare between the eastern end of Lake Esplanade and the Fernhill Road / Glenorchy-Queenstown Road roundabout.
- 2.2 The most abundant poplar species within St Omer Park are the 21 Lombardy poplars that form a discontinuous stand of trees growing within the eastern aspect of the park and a contiguous row of trees within the western aspect of the park. The poplars are a prominent feature of St Omer Park and are a strong visual element within the lake-front and Lake Esplanade area. The poplars are also highly visible from the western extent of the Queenstown township.
- 2.3 St Omer Park is a relatively exposed site, especially within the eastern aspect of the park where large mature trees are less abundant. The site experiences a wide range of weather conditions, especially strong winds, snow, ice and rain, and conditions most commonly associated with a mountainous climate.

- 2.4 Given the local terrain, it is likely that wind funnelling occurs in and around the park due to the exposed southern aspect that bounds Lake Wakatipu and the more built-up area at the foot of Ben Lomond to the north. The western aspect of St Omer Park has a greater abundance of trees which will dampen the force of strong winds.
- 2.5 St Omer Park experiences a high frequency of foot traffic, as well as vehicles used for general maintenance of the area. This high use has resulted in soil compaction in large areas of the park and, combined with a shallow soil profile, it is likely that this is subjecting the surrounding trees to associated stresses.

3.0 Hazard Analysis

- 3.1 Hazards associated with trees are present if there are targets – conversely, if there are no targets, then it can be considered that there are no hazards. A target is something of value within the impact area (sometimes termed ‘fall zone’) of a tree, should the whole or part of the tree fail and fall. Risk is defined as the probability of something adverse occurring. The degree of risk inherent in individual trees varies according to factors such as form, health, species, structure, growing conditions, location, etc. Hazards associated with trees generally involve the potential of harm to persons and/or property from a tree, or part of a tree, failing and falling.
- 3.2 St Omer Park contains many targets due to the high-profile/high use nature of the site. St Omer Park bounds the major throughway for vehicular traffic entering Queenstown from Glenorchy and the suburb of Fernhill. Given the majority of the poplar trees that are the subject of this report overhang Lake Esplanade, with frequent use of the carriageway for through traffic and parking, the target rating is considered to be high.
- 3.3 St Omer Park itself is utilised as a public thoroughfare and a recreational facility for tourists and residents, giving a high frequency of foot traffic within the park. The playground, benches, barbeque facilities and toilets have elevated the target rating, as occupation duration within the fall zone of the subject trees is increased by the presence and ongoing use of such facilities in these locations.
- 3.4 Along the northern side of Lake Esplanade are a series of commercial sites and residential dwellings. The recent failure of a Lombardy poplar within the eastern aspect of St Omer Park has identified the fact that these buildings can be considered to be targets, given they are located within the ‘fall zone’ of a number of trees growing within the park.
- 3.5 A number of the poplar trees exhibit signs of previous limb failure. It is likely, given the generally fast-growing, relatively short-lived nature of the species, that future limb and/or whole tree failure will continue to occur within this group of trees, i.e. such failures will occur from time to time and with increased frequency as the trees age. The most likely scenario is for limb and/or whole tree failure to occur during severe weather events.
- 3.6 In many cases, trees often give warning signs before they fail and this can be in the form of dead wood, poor branch unions, fungal fruiting bodies etc (Mattheck and Breloer, 1994). However, it is difficult to determine tree failure due to the presence of internal decay without the use of specialised decay detecting equipment such as a resistograph.
- 3.7 Given the Lombardy poplar’s relatively short lifespan, the Lombardy poplars of St Omer Park are considered to be coming to the end of their useful life expectancy and are starting to succumb to problems associated with over-mature trees. Evidence of this consideration has already manifested itself in the tree failure event that occurred on the 17th January 2014.

4.0 Tree Assessment Methods

- 4.1 The trees have been assessed using two methods; visual tree assessment (VTA) and resistograph testing.
- 4.2 The VTA method employed involves a ground-based visual inspection of the trees to identify current vitality and potential defects. This method is based on the identification of external symptoms that the tree highlights by the presence of abnormalities in the wood interior, even where there are no cavities or evidence of decay (e.g. fungi that grow on woody tissues). It is possible through the recognition of these symptoms to signal the presence of physical and mechanical defects within a tree's structure.
- 4.3 The VTA survey is carried out considering the tree in its entirety, its morphology, its appearance and its biomechanical characteristics, using indicators such as swellings, bark characteristics, biotic factors and species specific characteristics.
- 4.4 As well as employing the VTA method, the trees are assessed internally (in this instance with a resistograph) to locate any defects and its axial expansion within the assessed area.
- 4.5 The resistograph is a device originally invented by two German engineers in 1985 to locate decay in utility poles by measuring drill resistance. The device was further developed and evolved in to the resistograph that is in use today for the internal location and assessment of tree decay.
- 4.6 The resistograph drives a fine needle into the wood and measures drill resistance as it rotates. The drill is between 1.0mm - 1.5mm in diameter and 300mm or 500mm length. The drill resistance concentrates at the tip which is between 2mm – 3mm in diameter. During drilling of a resistograph test, a chart is produced which depicts the profile of wood from which, structural integrity, growth rates and areas of decay can be assessed (Rinn *et al.* 1996).
- 4.7 The resistographic chart produced during drilling is read from right to left. The point of entry of the drilling needle is on the right of the chart. Resistographic charts are recorded in centimetres along the x (horizontal) axis and percentage of amplitude along the y (vertical) axis.
- 4.8 Resistograph tests were carried out on 26 poplar trees growing within St Omer Park. Resistograph tests were carried out by drilling the root flares of the trees at an approximate 45° angle. A minimum of 4 drills shots were taken on each tree using the four point compass position (north, east, south and west).

Limitations

- 4.9 Given the resistograph needle is only able to drill up to 300mm and (depending on the version of resistograph used in the testing) 500mm into the stem, it was not possible to ascertain whether hollows were present within the heartwood of trees due to their large diameter trunks. However, the resistograph readings give an indication of the structural integrity of trees in relation to the all important wall thickness of the trunk of the drilled specimens.

5.0 Arboricultural Assessment

- 5.1 A total of 21 Lombardy poplars (*Populus nigra* 'Italica'), 1 grey poplar (*Populus x canescens*) and 4 black poplar trees (*Populus nigra*) were assessed using visual tree assessments and resistograph tests. Please refer to Appendix A for a description, comments and resistograph analysis for each individual tree surveyed. Appendix B of this report contains the indicative growing locations of the subject trees. Examples of the resulting resistograph data is contained in Appendix C of this report.

Lombardy Poplar - Assessment

- 5.2 The Lombardy poplar trees are the most abundant species of poplar within St Omer Park. The assessed Lombardy poplar trees are mature specimens, many of which, according to local opinion, are believed to be over 100 years old. There is anecdotal concern over the structural integrity of the trees from members from the general public after a large Lombardy poplar failed on 17th January 2014 causing damage to property.
- 5.3 The Lombardy poplar is a variety of the black poplar (*Populus nigra*); so-called because it originates from the Lombardy region of Northern Italy (Tebbs, 1984). The Lombardy poplar spread worldwide in the eighteenth century (Wood, 1994) and was introduced into New Zealand during the 1830's as a shelter and amenity tree on farms and public places (National Poplar and Willow Users Group, 2007).
- 5.4 The Lombardy poplar is a rapidly growing tree with a distinctively columnar shape, often with a buttress base (Wood, 1994) and attains a height of 30 metres (100ft) (Tebbs, 1984). The Lombardy poplar is a shallow rooted tree but stabilises itself by forming a large root plate and stiff buttresses (Mattheck and Breloer, 1994).
- 5.5 The 21 Lombardy poplars are generally of a similar age and form. Trees growing in the eastern aspect of the park tended to be of a larger stature than individuals within the western end of St Omer Park suggesting that, possibly, the trees may be a little older. There is little variation in overall height between the Lombardy poplars; within a matter of metres difference between individuals.
- 5.6 A visual tree assessment of the Lombardy poplars revealed all specimens to be in generally good health, bearing very little visible outward indications of poor health or significantly compromised structural integrity. Crown health of all the trees surveyed was generally good. Foliage displayed good leaf colouration and lustre, with little or no chlorotic or necrotic leaves present. No significant tip die-back was observed from ground level in any of the tree canopies or indeed any symptoms that could suggest root disorders. Many individuals exhibited abundant foliage, up to 90% live crown ratio (the volume of leaves in comparison to the tree as a whole) in many of the trees.
- 5.7 A prominent characteristic of the Lombardy poplar trees are the large buttress roots. The species generally forms buttress roots on the windward side of the tree, especially when growing on high water table sites (Mattheck and Breloer, 1994). It was noted that the trees are most exposed to southerly winds coming across from Lake Wakatipu. In this case, large buttress roots that extend several metres upwards into the main stem have formed predominantly on the southern side of the assessed trees in order to optimise their form to adapt to exposure to strong winds. It is believed that the trees are less exposed on their northern and western sides due to nearby structures and other trees growing within the park.

- 5.8 The Lombardy poplar as a species has a restricted rooting depth and anchors itself in a way that tropical trees balance themselves on wet land by means of their giant buttress roots (Mattheck and Breloer, 1994). Despite the Lombardy poplar tree's buttress root form, like other members of the genus, the wood is weak and is prone to breaking (Wood, 1994). The tree is resistant to root delamination and if it does fail it is usually because of extensive butt-rot (Mattheck and Breloer, 1994).
- 5.9 The Lombardy poplar that recently failed in the eastern aspect of St Omer Park is considered to be consistent with the age and form of the neighbouring trees of the same species within the park, being an approximately 30 metre high veteran tree. A previous report compiled in 2007 that assessed the poplar trees within St Omer Park suggested that the subject tree was in good condition at the time of the assessment.
- 5.10 Many of the trees have notable visual and structural defects attributed to the natural form and growth habit of the Lombardy poplar as a species. The most common defects include incidences of co-dominant or multiple stems growing approximately 2 metres to 6 metres from the base of the trees. This is extremely common in the Lombardy poplar due to its natural tendency for branches to grow in an upright to a near vertical position.
- 5.11 Co-dominant stems are not ideal from a structural perspective as the unions between branches are comparatively weaker than branches growing at wider angles to the parent stem. Due to the narrow angle of which co-dominant stems often form, they're frequently associated with bark inclusion as the stems have nowhere else to grow except against each other. Despite the observed twin or multi-stemmed trees, many of the assessed specimens were not afflicted by included bark that would be considered to be of a hazardous nature.

Lombardy Poplars – Resistograph Analysis

- 5.12 The resistograph tests carried out on the Lombardy poplar trees revealed results that are somewhat contrary to the visual appearance of the trees. Cavities and pockets of decay were found in almost all of the assessed specimens. In general, cavities were more abundant within the sections of the lower trunk between the buttress roots, however, cavities were also found in the buttress roots themselves.
- 5.13 The resistograph results revealed that cavities were found in random locations within the Lombardy poplars. Figures 1 and 2 contained in Appendix C represent the low amplitude readings obtained from several Lombardy poplars that indicate the presence of decay.

Grey Poplar - Assessment

- 5.14 One mature grey poplar is growing within the eastern aspect of St Omer Park at what is essentially the undefined eastern entrance to the park. The grey poplar is native to Europe and is a hybrid between the white poplar (*Populus alba*) and the aspen (*Populus tremula*) widely naturalised from cultivation (Coombes, 1992). With its unusual grey-white and pronounced lenticels, the subject grey poplar is an attractive and prominent feature tree in the eastern aspect of St Omer Park.
- 5.15 The subject grey poplar is comprised of a stout single stem that divaricates into multiple leaders approximately 2 metres above the base. The branch unions of the main stems are tight, resulting in included bark. This included bark from the main lateral branches has extended to the base of the trunk, forming fissures which may have been caused by shear stress within the tree. However, it is unlikely that these fissures have affected the structural integrity of the tree. The trunk of the grey poplar is comparatively more rounded compared with the adjacent Lombardy poplars, however, some small buttress trunk flares have formed on the south-western side of the trunk indicating that the tree has optimised its form to adapt to wind load.

- 5.16 The grey poplar has a restricted root zone due to its proximity to Lake Esplanade and the footpath approximately 2 metres away from the base of the tree. It is estimated that approximately 40% of the tree's root zone is growing under pavement. Girdling roots were observed within the eastern side of the main trunk which may be attributed to a restricted root zone.
- 5.17 The grey poplar exhibits a rounded canopy with good foliar density and leaf colour. Some minor tip die-back and dead twigs were observed within the upper canopy of the tree and whether this is a consequence of soil compaction or the pavement over the root zone is unclear. The tree bears a moderately unbalanced crown where there is a more abundant branch network and foliar density within the north-eastern aspect of the canopy. The unbalanced crown coincides with the subtle north-easterly lean within the trunk, which is attributable to strong, south-westerly winds.

Grey Poplar – Resistograph Analysis

- 5.18 Results of the resistograph tests showed that the structural integrity of the trunk is generally sound. The resistograph readings showed small areas of low resistance represented by a dip within the amplitude. This may indicate small pockets of decay or internal cracks within the heartwood of the tree as depicted by Figure 5 in Appendix C of this report. Overall, the resistograph readings for the grey poplar did not signal any major concerns pertaining to the structural integrity of tree at the time of inspection.

Black Poplars - Assessment

- 5.19 Four black poplar trees are growing within the western aspect of St Omer Park and are a continuation of the contiguous row of the Lombardy poplars. Two of the trees are fully mature, large specimens; whilst the last two trees on the western end of the stand are considered to be early mature specimens. The black poplars are growing in close proximity to other trees within St Omer Park. Density of mature trees is much higher within the western aspect of the park compared with the eastern end of St Omer Park.
- 5.20 The black poplar trees are assessed as being in generally good health with fair form (although the form varies between trees). The subject trees are displaying form considered to be typical of trees with a close proximity planting arrangement. The close proximity of other trees has resulted in displaced canopy development and leaning trunks. This does not detract from the overall qualities of the group as a whole, as the combined canopies along with other trees make a significant contribution to the general amenity of the site.
- 5.21 The branch structure of the black poplars in comparison to the Lombardy poplars is considered to be generally good, in that this species is not as afflicted with issues pertaining to included bark or narrow branches unions as the other species. One notable observation was the presence of heavy lateral branches which has detracted from an archetypical tree form in some of the black poplars. This is likely to be a consequence of phototropic responses resulting from close proximity planting of other trees.

Black Poplar – Resistograph Analysis

- 5.22 The resistograph tests showed that the structural integrity of the trunks was generally good. Some resistograph readings showed small areas of low resistance indicating possible areas of decay or internal cracks. Overall, the resistograph readings for the black poplars did not signal any major concerns pertaining to the structural integrity of trees at the time of inspection.

Arboricultural Assessment - Overview

- 5.23 It is recommended that the trees be managed in a manner that minimises risk to persons and property, as well as taking into consideration the intrinsic value that the trees provide to the surrounding area. This can be in the form of combined selected tree removals and crown reductions, coupled with a replacement planting scheme.
- 5.24 Upon reviewing the results of the resistograph tests, the VTAs and the trees' growing locations in relation to the surrounds/target ratings, it is considered appropriate that four of the assessed Lombardy poplar trees be removed and the remaining Lombardy poplars crown reduced to minimise the canopy 'leaver arm' effect on the trees, as well as decrease the risk of 'wind throw'. Given their over-mature status, the results of the assessments and the impact that the crown reduction works will have on the remaining Lombardy poplars, future total tree removal and appropriate replacement planting should be considered.
- 5.25 Overall, the VTA and resistograph test readings for the grey poplar and the four black poplar did not signal any major concerns with regard to their structural integrity at the time of inspection. In general, the trees have been assessed as being in good condition and should be retained. An annual inspection of the trees should be undertaken.

6.0 Conclusions

- 6.1 A total of 21 Lombardy poplars, 1 grey poplar and 4 black poplars growing in St Omer Park, Queenstown have been assessed to determine current tree health status and the presence of internal decay. The tree inspections were carried out using a combination of visual tree inspections and resistograph tests.
- 6.2 The visual tree assessments revealed the trees, in general, to be in good health, however, the resistograph tests showed the presence of decay to varying degrees in virtually all of the Lombardy poplar trees. A greatly reduced level of decay was present in the grey poplar and black poplar trees.
- 6.3 The potential risk to persons and/or property from part or whole Lombardy poplar tree failure is of concern due to the frequent use of the target areas (St Omer Park, Lake Esplanade and adjoining buildings/structures). Risk to persons and/or property from part or whole grey poplar and black poplar tree failure is considered to be low.
- 6.4 Given the current age of the Lombardy poplars, combined with their short lifespan, it is assessed that the trees are over-mature. Problems associated with old age are beginning to manifest themselves in the form of cavities and heartwood decay. The extent of this manifestation was revealed by the tree failure event that occurred on 17th January 2014.
- 6.5 It is recommended that a programme to manage the Lombardy poplars decline be implemented. This programme should involve the removal of identified high risk trees and a management plan to phase out the remaining Lombardy poplars. The management of the Lombardy poplars should take into account the intrinsic value the trees provide to the surrounding environment, complemented by a replacement tree planting scheme.
- 6.6 Management of the grey poplar and black poplar trees should involve standard arboricultural tree management practices, as well as appropriately spaced and ongoing tree inspections.

7.0 Recommendations

- 7.1 The four Lombardy poplars (identified as Tree Nos.1, 3, 4 and 5 in the Arboricultural Assessment report by GreensceneNZ Limited dated January 2014) located within the eastern aspect of St Omer Park should be removed to ground level.
- 7.2 A management plan should be developed that details the staged removal of the remaining Lombardy poplars within St Omer Park and the requirement to undertake suitable replacement planting, both undertaken over an extended timeframe.
- 7.3 The management plan should include the crown reduction of the remaining Lombardy poplar trees by approximately 1/3 of their existing height/bulk and detail a suitable timeframe and plan for their complete removal.
- 7.4 It is recommended that a programme of regular inspections of the Lombardy poplar trees that are to be reduced be carried out by a suitably qualified and experienced Arborist so any signs of ill health, structural issues and/or changes to their condition/hazard rating can be identified and appropriately managed. These inspections should be carried out on an annual basis, as well as after extreme weather events up until the trees' complete removal.
- 7.5 It is recommended that a replacement planting programme using more robust, longer lived species be undertaken to mitigate any long term effects that may arise as a result of the removal of the Lombardy poplars growing within St Omer Park.

References

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APPENDIX A – TREE DETAILS

Notes:

Trees are numbered in the order that they are encountered when walking the following route:
Starting with the first large Lombardy poplar tree on the left by the lake edge as you enter the eastern aspect of the site, travelling in a westerly direction through St Omer Park.

Key:**Tree No:**

All trees are numbered from east to west

Species:

Common name and botanical name are given

Height and Girth:

Height is visually estimated in metres. Girth is the circumference of the tree and is measured in millimetres at approximately 1.4 metres above ground level

Target Description:

Describes targets at risk from tree failure, taking into account the size of each tree.

Occupancy Rate:

Describes that rate of occupancy: rare, occasional, frequent or constant.

Comments:

Describes the condition of the crown, branches, trunk, roots and root collar of the tree and defects that may be present within the identified parts, and general comments relating to the trees

Resistograph Analysis:

Comments on significant findings from resistograph tests

Recommendations:

Describes recommendations for management of each tree

Tree No.	Species	Height (m) and Girth (mm)	Target Description	Occupancy Rate	Tree Assessment and Comments	Resistograph Analysis	Recommendations
1.	Lombardy poplar <i>Populus nigra</i> 'Italica'	30 6000	Park and footpath Carriageway Guest house	Frequent Frequent Frequent	Tree growing by lake edge. Good crown health and foliar density, 90% live crown ratio. Single trunk becoming multi-stemmed. Co-dominant stems and tight branch unions present within crown. Suspected heart wood decay. Trunk forms large buttress roots	Decay detected within western side of tree	Remove to ground level
2.	Grey poplar <i>Populus x canescens</i>	20 4500	Park and footpath Carriageway	Frequent Frequent	Single stemmed tree becoming multi-stemmed 2m from base. Good crown health despite minor tip die-back, 80% live crown ratio. Some girdling roots present within the root collar	Minor cavity detected within northern side of tree	Dead wood prune Monitor/inspect tree annually or following a severe storm
3.	Lombardy poplar <i>Populus nigra</i> 'Italica'	30 4500	Park and footpath Carriageway Parked cars Motel	Frequent Frequent Frequent Constant	Single stemmed tree becoming multi-stemmed 3m from base. Good crown health, 80% live crown ratio. Co-dominant stems and tight branch unions present within crown and trunk. Tree growing adjacent to the Lombardy poplar that failed on the western side. Tree bears an approx 5° lean to the north	Decay detected within northern side of tree	Remove to ground level
4.	Lombardy poplar <i>Populus nigra</i> 'Italica'	30 4000	Park and footpath Carriageway Parked cars Guesthouse	Frequent Frequent Frequent Constant	Single stemmed tree becoming multi-stemmed 4m from base. Good crown health, 90% live crown ratio. Prominent buttress roots especially on southern aspect of tree. Suspected heart wood decay. Pavement over 40% of root zone. Tree growing in close proximity to Tree No.4	Decay detected within southern side of tree	Remove to ground level
5.	Lombardy poplar <i>Populus nigra</i> 'Italica'	30 5000	Park and footpath Carriageway Parked cars Guesthouse	Frequent Frequent Frequent Constant	Single stemmed tree becoming multi-stemmed 4m from base. Good crown health, 80% live crown ratio. Prominent buttress roots especially on southern aspect of tree. Suspected heart wood decay. Pavement over 35% of root zone. Tree growing in close proximity to Tree No.4	Decay detected within southern and eastern side of tree	Remove to ground level

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6.	Lombardy poplar <i>Populus nigra</i> 'Italica'	30 5000	Park and footpath Carriageway Parked cars Hotel	Frequent Frequent Frequent Constant	Single stemmed tree becoming multi-stemmed 3m from base. Good crown health and foliar density, 90% live crown ratio. Pavement over 50% of root zone. Tree growing in close proximity to Tree No.7 which has influenced the form of the crown	Decay detected within the northern and western side of tree	Crown reduce as part of a tree management and removal program. Monitor/inspect tree annually or following an extreme weather event
7.	Lombardy poplar <i>Populus nigra</i> 'Italica'	30 6000	Park and footpath Carriageway Parked cars Hotel	Frequent Frequent Frequent Constant	Single stemmed tree, good crown health and foliar density, 90% live crown ratio. Pavement over 50% of root zone. Tree growing in close proximity to Tree No.6 which has influenced the form of the crown	Decay detected within southern side of tree	Crown reduce as part of a tree management and removal program. Monitor/inspect tree annually or following an extreme weather event
8.	Lombardy poplar <i>Populus nigra</i> 'Italica'	30 3500	Park and footpath Carriageway Parked cars Residential dwellings	Frequent Frequent Frequent Constant	Single stemmed tree, good crown health and foliar density, 90% live crown ratio. Pavement over 40% of root zone. Tree growing in close proximity to Lake Esplanade	Decay detected within southern and western side of tree	Crown reduce as part of a tree management and removal program. Monitor/inspect tree annually or following an extreme weather event
9.	Lombardy poplar <i>Populus nigra</i> 'Italica'	30 4000	Park and footpath Carriageway Parked cars Residential dwellings	Frequent Frequent Frequent Constant	Single stemmed tree, good crown health and foliar density, 80% live crown ratio. Pavement over 40% of root zone. Tree growing in close proximity to Lake Esplanade	Decay detected within northern side of tree	Crown reduce as part of a tree management and removal program. Monitor/inspect tree annually or following an extreme weather event
10.	Lombardy poplar <i>Populus nigra</i> 'Italica'	30 5000	Park and footpath Carriageway Parked cars Residential dwellings	Frequent Frequent Frequent Constant	Single stemmed tree becoming multi-stemmed 3m from base. Good crown health, 90% live crown ratio. Suspected heart wood decay. Pavement over 40% of root zone. Tree growing in close proximity to Lake Esplanade	Decay detected within southern and western side of tree	Crown reduce as part of a tree management and removal program. Monitor/inspect tree annually or following an extreme weather event

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11.	Lombardy poplar <i>Populus nigra</i> 'Italica'	30 5000	Park and footpath Playground Carriageway Parked cars Residential dwellings	Frequent Frequent Frequent Frequent Constant	Single stemmed tree, good crown health, 85% live crown ratio. Suspected heart wood decay, minor swelling in trunk. Pavement over 50% of root zone. Tree growing in close proximity to Lake Esplanade and is part of a contiguous row of trees within the western aspect of the park	Decay detected within the northern and southern side of tree	Crown reduce as part of a tree management and removal program. Monitor/inspect tree annually or following an extreme weather event
12.	Lombardy poplar <i>Populus nigra</i> 'Italica'	30 5000	Park and footpath Playground Carriageway Parked cars Residential dwellings	Frequent Frequent Frequent Frequent Constant	Single stemmed tree becoming multi-stemmed 6m from base. Good crown health, 80% live crown ratio. Suspected heart wood decay. Pavement over 50% of root zone. Tree growing in close proximity to Lake Esplanade and is part of a contiguous row of trees within the western aspect of the park	Decay detected within southern side of tree	Crown reduce as part of a tree management and removal program. Monitor/inspect tree annually or following an extreme weather event
13.	Lombardy poplar <i>Populus nigra</i> 'Italica'	27 3000	Park and footpath Playground Carriageway Parked cars Residential dwellings	Frequent Frequent Frequent Frequent Constant	Single stemmed tree, good crown health, 75% live crown ratio. Younger tree compared with others. Pavement over 50% of root zone. Tree growing in close proximity to Lake Esplanade where part of its trunk on the northern side has enveloped a section of the kerb. Tree is part of a contiguous row of trees within the western aspect of the park	Decay detected within western side of tree	Crown reduce as part of a tree management and removal program. Monitor/inspect tree annually or following an extreme weather event
14.	Lombardy poplar <i>Populus nigra</i> 'Italica'	27 4500	Park and footpath Playground Carriageway Parked cars Residential dwellings	Frequent Frequent Frequent Frequent Constant	Single stemmed tree, good crown health, 75% live crown ratio. Pavement over 50% of root zone. Tree growing in close proximity to Lake Esplanade and is part of a contiguous row of trees within the western aspect of the park. Burls present within trunk	Decay detected within eastern side of tree	Crown reduce as part of a tree management and removal program. Monitor/inspect tree annually or following an extreme weather event
15.	Lombardy poplar <i>Populus nigra</i> 'Italica'	26 4500	Park and footpath Playground Carriageway Parked cars Residential dwellings	Frequent Frequent Frequent Frequent Constant	Single stemmed tree, good crown health, 80% live crown ratio. Pavement over 50% of root zone. Tree growing in close proximity to Lake Esplanade and is part of a contiguous row of trees within the western aspect of the park. Burls present within trunk	Decay detected within southern side of tree	Crown reduce as part of a tree management and removal program. Monitor/inspect tree annually or following an extreme weather event

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16.	Lombardy poplar <i>Populus nigra</i> 'Italica'	25 2800	Park and footpath Playground Carriageway Parked cars	Frequent Frequent Frequent Frequent	Single stemmed tree, good crown health, 80% live crown ratio. Tree is a younger specimen compared with others. Pavement over 40% of root zone. Tree growing in close proximity to Lake Esplanade and is part of a contiguous row of trees within the western aspect of the park.	No decay present in area of the tree that was tested	Crown reduce as part of a tree management and removal program. Monitor/inspect tree annually or following an extreme weather event
17.	Lombardy poplar <i>Populus nigra</i> 'Italica'	25 3200	Park and footpath Table and BBQ Playground Carriageway Parked cars Backpackers	Frequent Occasional Frequent Frequent Frequent Constant	Single stemmed tree, good crown health, 85% live crown ratio. Tree is a younger specimen compared with others. Pavement over 35% of root zone. Tree is part of a contiguous row of trees within the western aspect of the park.	Decay detected within southern side of tree	Crown reduce as part of a tree management and removal program. Monitor/inspect tree annually or following an extreme weather event
18.	Lombardy poplar <i>Populus nigra</i> 'Italica'	30 4000	Park and footpath Table and BBQ Carriageway Parked cars Backpackers	Frequent Occasional Frequent Frequent Constant	Single stemmed tree, good crown health, 85% live crown ratio. Pavement over 35% of root zone. Pronounced buttress roots, burls at the base of trunk. Tree is part of a contiguous row of trees within the western aspect of the park.	Decay detected within western side of tree	Crown reduce as part of a tree management and removal program. Monitor/inspect tree annually or following an extreme weather event
19.	Lombardy poplar <i>Populus nigra</i> 'Italica'	28 4000	Park and footpath Carriageway Parked cars Backpackers	Frequent Frequent Frequent Constant	Single stemmed tree, good crown health, 85% live crown ratio. Pavement over 35% of root zone. Pronounced buttress roots, cracks and hollows at the base of trunk. Tree is part of a contiguous row of trees within the western aspect of the park.	Decay detected within western side of tree	Crown reduce as part of a tree management and removal program. Monitor/inspect tree annually or following an extreme weather event
20.	Lombardy poplar <i>Populus nigra</i> 'Italica'	27 4500	Park and footpath Carriageway Parked cars Backpackers	Frequent Frequent Frequent Constant	Single stemmed tree, good crown health, 80% live crown ratio. Pavement over 35% of root zone. Tree is growing adjacent to a large giant sequoia tree (<i>Sequoiadendron giganteum</i>). Tree is part of a contiguous row of trees within the western aspect of the park.	Decay detected within western side of tree	Crown reduce as part of a tree management and removal program. Monitor/inspect tree annually or following an extreme weather event

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21.	Lombardy poplar <i>Populus nigra</i> 'Italica'	28 4500	Park and footpath Carriageway Parked cars Backpackers	Frequent Frequent Frequent Constant	Single stemmed tree, good crown health, 70% live crown ratio. Tree divaricates into 3 main leaders. Pavement over 35% of root zone. Tree is growing adjacent to a large giant sequoia tree (<i>Sequoiadendron giganteum</i>). Tree is part of a contiguous row of trees within the western aspect of the park	Decay detected within eastern and western side of tree	Crown reduce as part of a tree management and removal program. Monitor/inspect tree annually or following an extreme weather event
22.	Lombardy poplar <i>Populus nigra</i> 'Italica'	28 4000	Park and footpath Carriageway Parked cars	Frequent Frequent Frequent	Single stemmed tree, good crown health, 80% live crown ratio. Pavement over 35% of root zone. Tree is growing adjacent to a large giant sequoia tree (<i>Sequoiadendron giganteum</i>). Tree is part of a contiguous row of trees within the western aspect of the park	Decay detected within northern and eastern side of tree	Crown reduce as part of a tree management and removal program. Monitor/inspect tree annually or following an extreme weather event
23.	Black poplar <i>Populus nigra</i>	25 4500	Park and footpath Carriageway Parked cars	Frequent Frequent Frequent	Single stemmed tree, good crown health, 80% live crown ratio. Pavement over 35% of root zone. Typical form	No decay present in area of the tree that was tested	Dead wood/ maintenance prune. Monitor/inspect tree annually or following a severe storm
24.	Black poplar <i>Populus nigra</i>	25 4000	Park and footpath Carriageway Parked cars Toilets	Frequent Frequent Frequent Occasional	Single stemmed tree. Good crown health, 80% live crown ratio. Pavement over 35% of root zone. Tree bears a 10° lean to the north, likely attributed to phototropic responses associated with moderate tree cover. Heavy lateral limb growing to the north-east	No decay present in area of the tree that was tested. Wood most dense on the western side of the tree	Dead wood/ maintenance prune. Monitor/inspect tree annually or following a severe storm
25.	Black poplar <i>Populus nigra</i>	15 1400	Park and footpath Carriageway Parked cars Toilets	Frequent Frequent Frequent Occasional	Single stemmed early mature tree. Good crown health, 80% live crown ratio. Pavement over 20% of root zone. Girding roots at base. Superficial sub-surface root damage from foot traffic	No decay present in area of the tree that was tested.	Dead wood/ maintenance prune. Monitor/inspect tree annually or following a severe storm
26.	Black poplar <i>Populus nigra</i>	15 1500	Park and footpath Carriageway Car park Toilets	Frequent Frequent Frequent Occasional	Single stemmed early mature tree. Good crown health, 80% live crown ratio. Pavement over 30% of root zone. Tree bears a 15° lean to the north, likely attributed to phototropic responses associated with moderate tree cover. Heavy lateral limb growing to the north-east. Superficial sub-surface root damage from foot traffic	Minor pocket of decay in eastern side of tree	Dead wood/ maintenance prune. Monitor/inspect tree annually or following a severe storm

APPENDIX B – TREE LOCATION PLANS







APPENDIX C - RESISTOGRAPH READINGS EXAMPLES

Please note: The resistograph readings are read from right to left

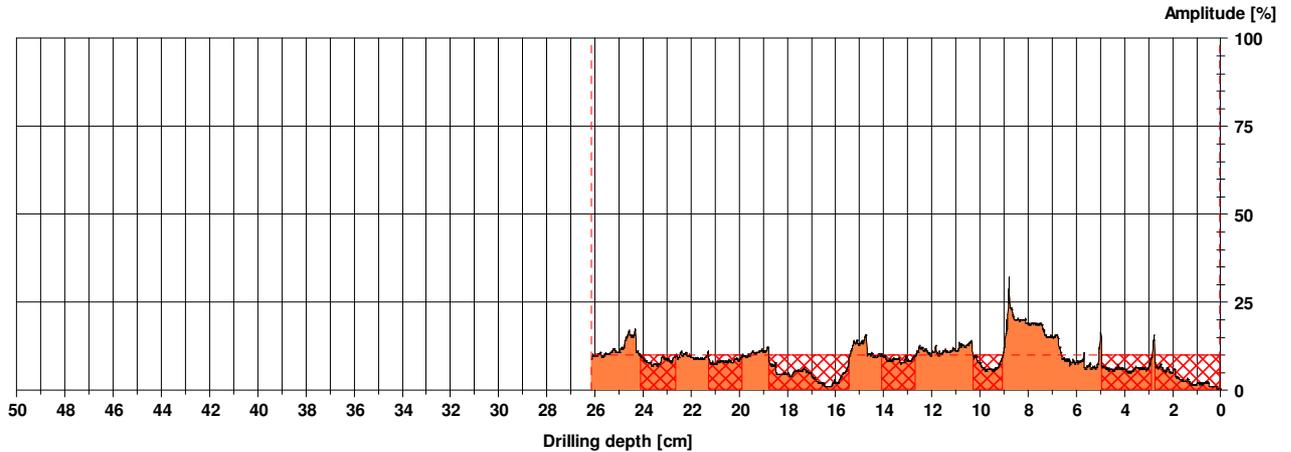


Figure 1: Tree No.1 - Lombardy poplar drilled on the western side of the tree. The readings show a generally low amplitude. The red cross hatch areas indicate decay

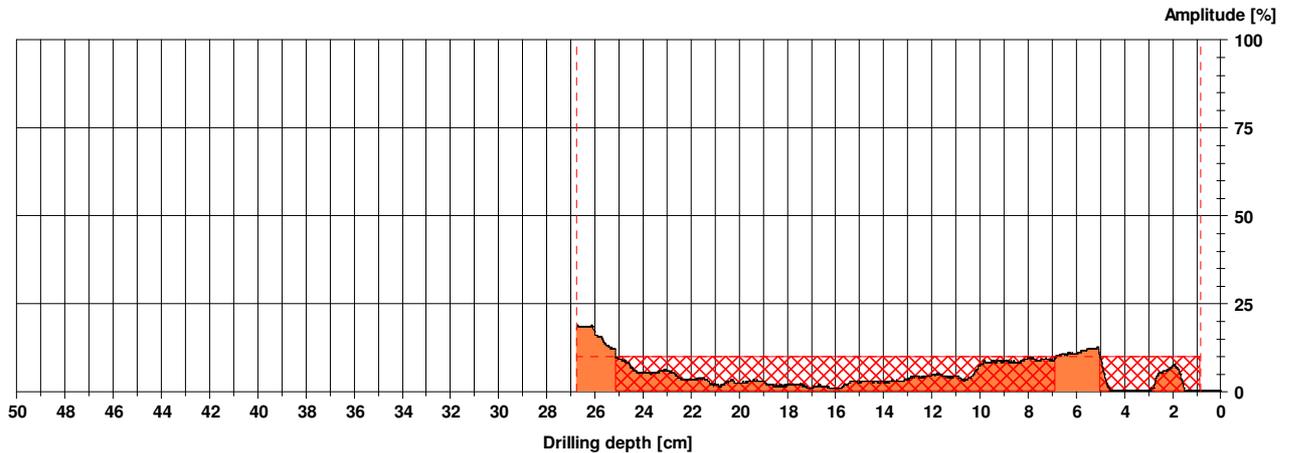


Figure 2: Tree No.9 - Lombardy poplar drilled on the northern side of the tree. This is an example of a reading that shows a considerable amount of decay present within the wood – as depicted by the low amplitude of the graph. The red cross hatch areas show the extent of the decay

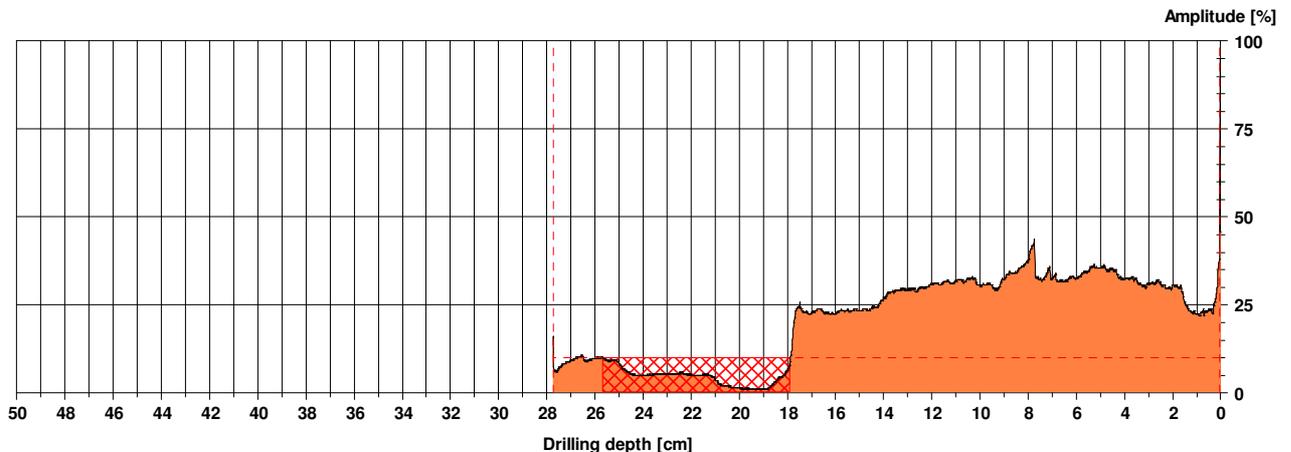


Figure 3: Tree No.3 - Lombardy poplar drilled on the northern side of the tree. The readings show a higher amplitude indicating structurally sound wood followed by a sudden dip in amplitude approximately 180mm within the tree which indicates an area of decay

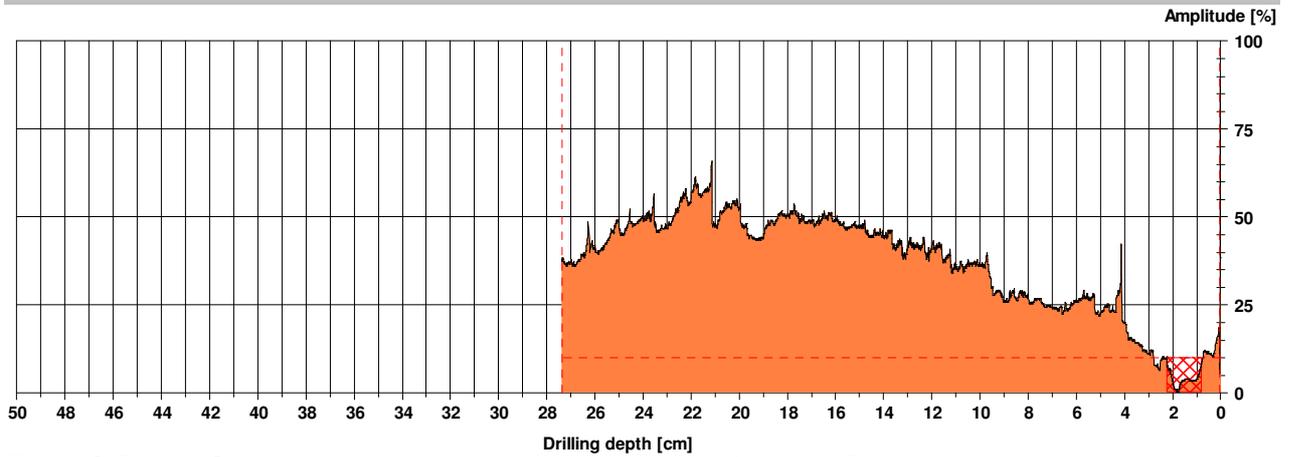


Figure 4: Tree No.3 - Lombardy poplar drilled on the western side of the tree. The readings show a high amplitude which is indicative of structurally sound wood

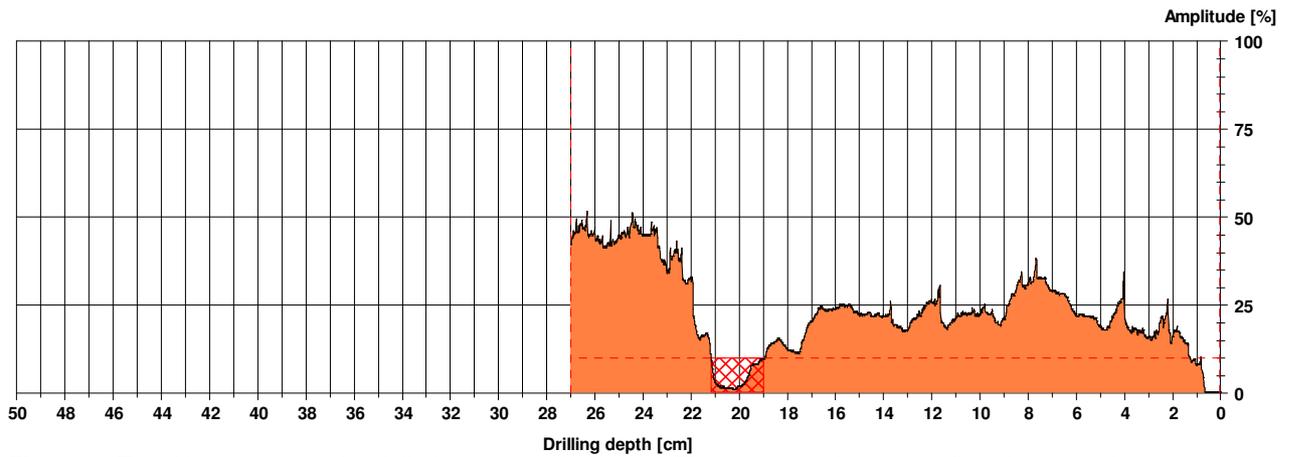


Figure 5: Tree No.2 - grey poplar drilled on the northern side. The readings show a small cavity approximately 200mm inside the tree

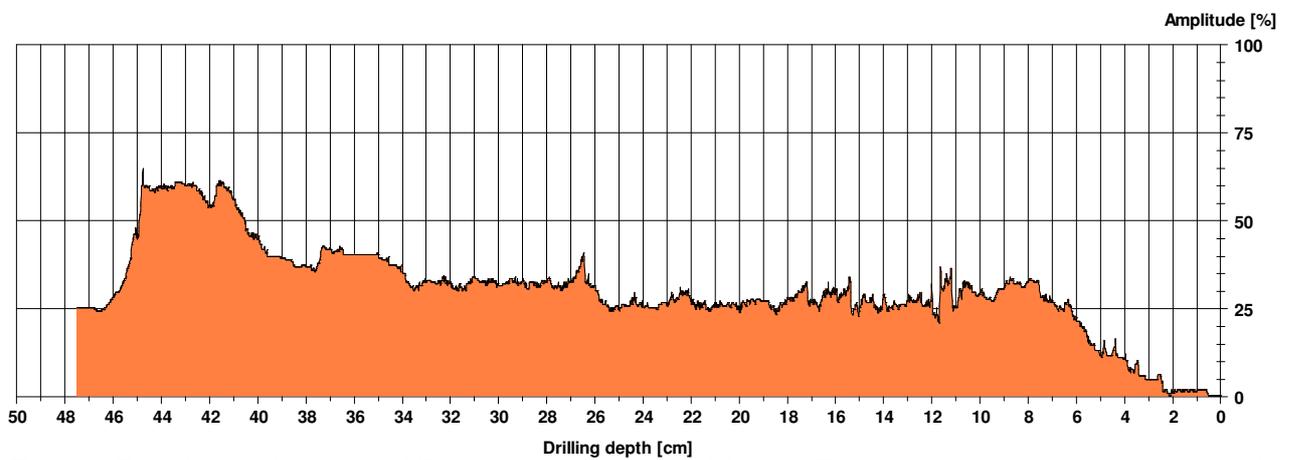


Figure 6: Tree No.23 - black poplar drilled on the southern side of the tree. The readings show a high amplitude which is indicative of structurally sound wood