New Cycleway, Hotops, Queenstown

Quantified Tree Risk Assessment

Date:	26th March 2021
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Brief:	A new cycleway is proposed to be constructed in part through Queenstown Gardens. As part of this project a group of trees that forms the edge of a larger stand is proposed to be removed from the Gardens near Hotops Lane. This memorandum is a desktop exercise to assess the proposal and the effect on any remaining trees, including any increase in the risk posed by the trees.

1. Introduction

1.1. Tend Trees Limited have been engaged by Queenstown Lakes District Council (QLDC) to assess the effects of the proposed removal of part of a stand of Douglas fir trees in the Queenstown Gardens. The trees are proposed to be removed to facilitate the construction of a new cycleway that passes through the Queenstown Gardens.

1.2. The assessment is a desk top exercise based on the information provided by QLDC. The assessment will use the Quantified Tree Risk Assessment (QTRA) methodology to give an understanding of the likely increase in tree failure rates and any associated risk.

2. Appendices

Appendix 1 – Photoset.

3. Site Details

3.1. The subject trees are located in the Queenstown Gardens in an area between Hotops Lane, Coronation Drive and Horn Creek, Queenstown.

3.2. The following aerial image Figure 1 shows the area, the trees proposed to be removed and those being assessed.

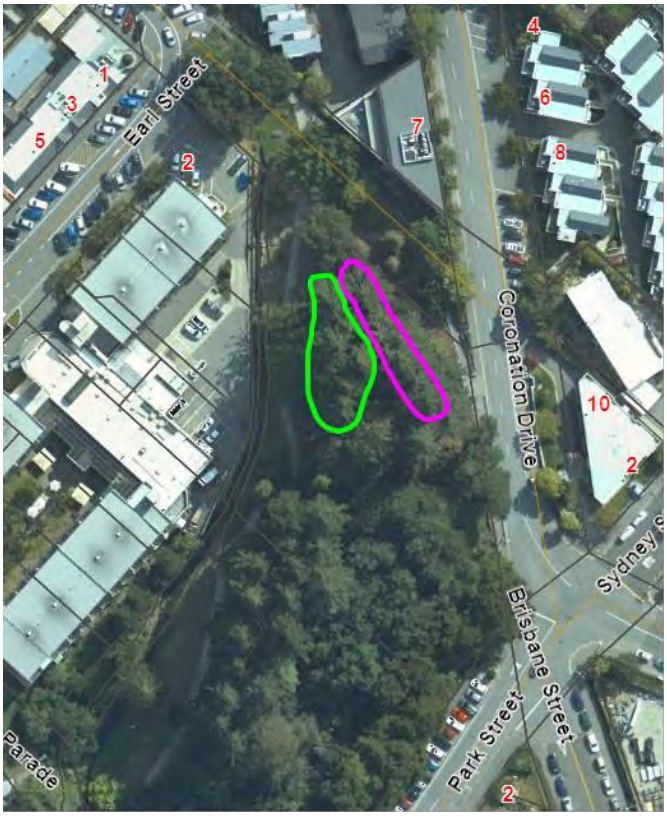

Figure 1: The group of Douglas fir proposed to be removed circled in purple, with those proposed to remain circled in green.

4. Scope and Limitations

4.1. The trees have not been inspected on site. The assessment is based solely on aerial images and photographs provided by QLDC. This report will be reviewed by QLDC.

4.2. All the site specific information was provided by QLDC.

5. Duty of Care

5.1. When managing trees or being responsible for trees on a site, there is a duty of care placed on the tree owner to ensure that:

- insofar is reasonably practical, people and property are not exposed to unreasonable levels of risk from tree failure.
- reasonable care is taken to avoid acts or omissions that cause a reasonably foreseeable risk of injury/harm to persons or property.

5.2. 'A reasonably foreseeable risk of harm' reflects the potential for healthy and structurally sound trees to occasionally fail and the practical limitations encountered when identifying any asymptomatic defects that may cause the failure of a tree or its constituent parts.

5.3. The duty placed on a landowner generally varies depending on their resources. The owner of a small private property may only be expected to seek expert advice when they notice some obvious issues with their tree or trees, where as a land manager with a significant tree population and resources would be expected to carry out regular risk assessments and take appropriate action.

6. Trees and Risk

6.1. Every day we encounter risks in all our activities, and the way we manage those risks is to make choices. We weigh up the costs and benefits of the risk to determine whether it is acceptable, unacceptable, or tolerable.

6.2. The risk posed by trees is inherently low when compared to many other daily tasks, for example driving a car, drinking alcohol, or playing sport.

7. Quantified Tree Risk Assessment

7.1. The Quantified Tree Risk Assessment (QTRA) method enables a range of approaches from the broad assessment of large collections of trees to, where necessary, the detailed assessment of an individual tree.

7.2. The QTRA output is termed the Risk of Harm and is a combined measure of the likelihood and consequences of tree failure considered against the baseline of a lost human life within the coming year.

7.3. To determine the Risk of Harm the following is carried out:

- An analysis of the land use within the failure footprint of the tree in terms of its vulnerability to an impact and its likely occupation
- The likely consequences of an impact based on the size of the tree or branch and the vulnerability of the target i.e. what the tree or branch will fall on
- An estimate of the probability or likelihood that the tree or branch will fail within the coming 12 months (based on prevailing weather conditions for the geographical location). This produces the Probability of Failure or PoF.

7.4. The PoF ranges from 7, a healthy normal tree/branch with no features that may cause an elevated likelihood of failure to PoF 1, a tree that is expected to fail within the next 12 months.

Target Ranges

7.5. As part of the land use analysis, the value of likely occupation of the failure footprint of the tree is determined. The following figure shows the QTRA target ranges.

Target Range	Property (repair or replacement cost)	Human (not in vehicles)		Vehicle Traffic (number per day)	Ranges of Value (probability of occupation or fraction of $2 900 000)
1	$2 900 000 – >$290 000 (£1 500 000 – >£150 000)	**Occupation:**	Constant – 2.5 hours/day	26 000 – 2 700 @ 110kph (68mph)	1/1 – >1/10
		Pedestrians & cyclists:	720/hour – 73/hour	32 000 – 3 300 @ 80kph (50mph)	
				47 000 – 4 800 @ 50kph (32mph)	
2	$290 000 – >$29 000	**Occupation:**	2.4 hours/day – 15 min/day	2 600 – 270 @ 110kph (68mph)	1/10 – >1/100
		Pedestrians & cyclists:	72/hour – 8/hour	3 200 – 330 @ 80kph (50mph)	
				4 700 – 480 @ 50kph (32mph)	
3	$29 000 – >$2 900	**Occupation:**	14 min/day – 2 min/day	260 – 27 @ 110kph (68mph)	1/100 – >1/1 000
		Pedestrians & cyclists:	7/hour – 2/hour	320 – 33 @ 80kph (50mph)	
				470 – 48 @ 50kph (32mph)	
4	$2 900 – >$290	**Occupation:**	1 min/day – 2 min/week	26 – 4 @ 110kph (68mph)	1/1 000 – >1/10 000
		Pedestrians & cyclists:	1/hour – 3/day	32 – 4 @ 80kph (50mph)	
				47 – 6 @ 50kph (32mph)	
5	$290 – >$29	**Occupation:**	1 min/week – 1 min/month	3 – 1 @ 110kph (68mph)	1/10 000 – >1/100 000
		Pedestrians & cyclists:	2/day – 2/week	3 – 1 @ 80kph (50mph)	
				5 – 1 @ 50kph (32mph)	
6	$29 – $2	**Occupation:**	<1 min/month – 0.5 min/year	None	1/100 000 – 1/1 000 000
		Pedestrians & cyclists:	1/week – 6/year		

Vehicle, pedestrian and property Targets are categorised by their frequency of use or their monetary value. The probability of a vehicle or pedestrian occupying a Target area in Target Range 4 is between the upper and lower limits of 1/1 000 and >1/10 000 (column 5). Using the VOSL $2 900 000, the property repair or replacement value for Target Range 4 is $2 900- >$290.

Figure 2: Target ranges taken from the QTRA Practice Note V5.

Tolerability of Risk Framework

7.6. The Tolerability of Risk framework (ToR) (HSE 2001) is a widely accepted approach to reaching decisions on whether risks are broadly acceptable, unacceptable, or tolerable.

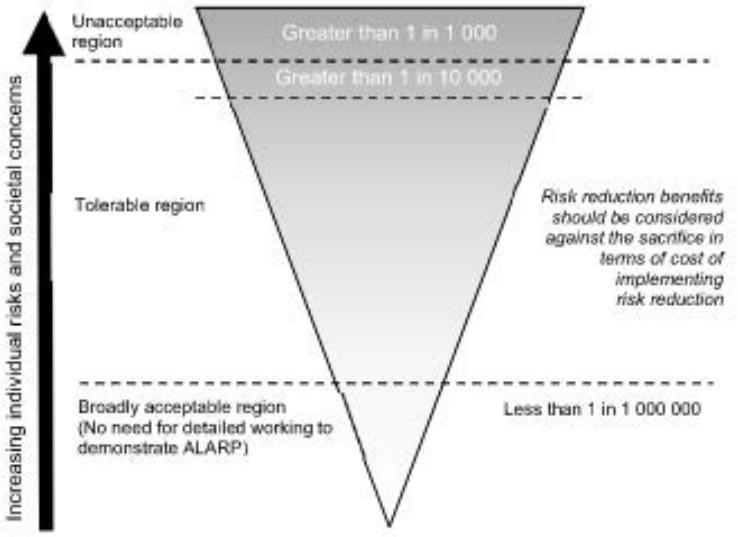

Fig. 1. Adapted from the Tolerability of Risk framework (HSE 2001).

Figure 3: The Tolerability of Risk Framework taken from the QTRA Practice Note V5.

7.7. When considering tolerable risk, a risk/benefit analysis should be carried out i.e., are the benefits of controlling any risk sufficient to outweigh the costs of any control measures. Some risks from the Broadly Acceptable region cross into the tolerable region. These risks may not require any action, because any risk reduction work would be disproportionate to the cost. These costs can be both financial and environmental. This concept is referred to as being As Low As Reasonably Practicable (ALARP).

7.8. Some risks are simply unacceptable to society regardless of the benefits provided. However, other risks are so insignificant they are regarded as being broadly acceptable in the context of daily life.

7.9. In between these boundaries are risks that will generally be tolerated by society if the risk is managed in a way that makes it as low as reasonably practical (ALARP).

7.10. To help with decision making the QTRA method provides some advisory risk thresholds. These are shown in the following Figure 4.

Thresholds	Description	Action
	Unacceptable Risks will not ordinarily be tolerated	• Control the risk
1/10 000		
	Tolerable (where imposed on others) Risks are tolerable if ALARP	• Assess costs and benefits of risk control • Control the risk only where a significant benefit might be achieved at reasonable cost • Review the risk
1/1 000 000		
	Broadly Acceptable Risk is already ALARP	• No action currently required • Review the risk

Figure 4: QTRA Advisory Risk Thresholds

8. QTRA results

8.1. Information provided by Queenstown Lakes District Council gives the average pedestrian use at the nearest track counter on Marine Parade as and average of 2,307 per day for 2021. This equates to approximately 96 pedestrians per hour giving a QTRA Target Range of 1. This is likely to increase after the proposed cycleway is installed and COVID 19 travel restrictions are reduced or removed. Data from previous years supports the assumed increase in usage.

9. Discussion and Comments

9.1. The removal of the edge of stand trees often results in the internal trees being subjected to increased wind exposure. As these have not been previously exposed to the increased wind load they have not had the opportunity to adapt and therefore have an increased likelihood of failure.

9.2. As trees are subjected to new wind events, they adapt their structure through a process known as thigmomorphogenesis[1]. This process can take many years therefore when trees are suddenly exposed to new winds (e.g., through the removal of existing shelter) their structure has not had time to adapt which leads to an increased likelihood of falling. This can be in the form of increased branch failures or in some instances, whole tree failure.

9.3. While it is not possible to predict which trees from a group of newly exposed trees will fall, it is likely that one or more of these trees will fail during the next high wind event or even moderate wind events.

[1] the response of plant cells to mechanical stimulation. For example, the thigmomorphogenetic response of trees in windy environments is to grow shorter, with thicker trunks and stronger roots.

9.4. Trees generally fall during weather events that are consider abnormal, however it should be noted that trees exposed to new wind loading can and do fall during normal or prevailing weather conditions.

9.5. When removing trees from groups or planted areas considerations should therefore be given to any increase in the likelihood of failure of any trees that are to remain. In some cases, it is best to look for an existing opening in the forest canopy or an exposed edge and remove trees up to that point. There may be a wind load change in this situation, but it is lessened by the existing edge and the tolerance of those trees to wind exposure.

9.6. Aerial imagery and photographs provided by QLDC have identified a possible natural canopy gap. This can be seen in the following aerial image Figure 5.

Figure 5: Existing natural canopy edges marked in green.

9.7. It is understood that the trees marked in orange are proposed to be removed.

9.8. Removal of the entire group with the area marked in red would leave only trees that are already edge trees and used to the associated wind load.

9.9. In addition to exposing trees to new wind load the cycleway is proposed to be constructed in the root zone of the trees that are currently proposed to remain. When carry out construction near trees it is important to consider their root zones.

9.10. The most effective way to ensure retained trees are protected during construction is to measure and understand the root zones around the trees and to physically mark the area clearly. This area is then monitored and supervised by a Works Arborist to ensure that no construction activity causes detrimental effects to retained trees. The following measurements are key to establishing these protected areas.

Tree Protection Zones (TPZ)

9.11. The Tree Protection Zone (TPZ) is considered an area where restricted activities apply to all contractors working on site. An arborist would consider the trees in their current location and establish the TPZ as a maximum encroachment distance without the supervision of a Works Arborist. This is a critical measure put in place to protect the tree parts most vulnerable to damage in a development environment, the roots, trunk, and branches.

9.12. The TPZ would need to be clearly defined and must be communicated to all contractors working on the site.

9.13. Work can be carried out within the TPZ, but under strict protocols with a Works Arborist.

Structural Root Zones (SRZ)

9.14. In addition to the TPZ, the Structural Root Zone (SRZ) should be considered. The SRZ is the area of root zone required for tree stability. In general, it is only calculated when major encroachments into the TPZ are proposed. There is to be no encroachment into the SRZ.

9.15. The proposed cycle way requires excavation and works within the root zone of trees to remain. An examination of the photographs provided shows these proposed works within the Structural Root Zone (SRZ) of trees to be retained. The following photograph 1 is an example of this.

9.16. Photograph 1 shows the trees marked with a red cross on the right which are currently proposed to be removed (circled in purple in Figure 1). Trees on the left-hand side, are currently proposed to be retained (circled in green in Figure 1.).

9.17. The wooden marker post indicates the downhill edge of the proposed cycleway, which is the closest edge to the trees proposed to be retained. Earthworks and construction activity are proposed on the uphill side of the wooden post.

Photograph 1: Some of the trees proposed to be removed.

10. Conclusion

10.1. The current proposed cycleway has not fully considered the effects of the project on the trees which have been highlighted for retention. Further consideration needs to be given to both the effect of the physical construction and the removal of existing trees.

10.2. Based on the current proposal the project would expose the remaining trees to new wind loading increasing their likelihood of failure and the risk they pose to the public.

10.3. The current proposed alignment would also encroach into the structural root zone, compromising their structural integrity.

10.4. While an on-site risk assessment has not been undertaken, based on the information provided and the author's knowledge of tree structure, it is likely thar the current proposal will result in an unacceptable level of risk posed by the trees proposed to remain.

11. Recommendations

11.1. A full arboricultural impact assessment should be undertaken on the proposed cycleway which gives full consideration to the effects of the proposed cycleway and associated tree removals.

11.2. Natural canopy gaps should be looked for and tree removal should be carried up to these points, an example of which is shown in Figure 5.

11.3. A Tree Protection Management Plan should be developed to ensure the effects of the construction works are managed to best avoid detrimental effects to the trees identified for retention. This should be carried out by an Arboricultural Consultant trained, experienced and competent in construction activity within the root zone of trees.

11.4. All physical tree work should be carried out by an arboricultural contractor that meets QLDC's requirements, inclusive of health and safety, insurance and pruning standards.

11.5. The tree work should be in line with current industry best practice and the Minimum Industry Standards (MIS). The following non-exhaustive list of MIS documents should be followed:

- MIS300 - Safe Tree Work
- MIS303 Tree Dismantling 2nd ed.
- MIS308 - Tree Pruning
- MIS313 - Tree Health & Maintenance
- MIS315 Chainsaw Operation and Tree Felling

11.6. When carrying out tree pruning or removal, the arboricultural contractor shall take the necessary precautions to prevent injury to people and damage to property.

11.7. The trees at the site should be re-assessed for the risk they pose to people or property after the removals have been carried out. This risk assessment should be carried out by someone trained and competent to do so using a recognised tree risk assessment methodology.

12. Appendices

Appendix 1 - Photoset