Arboricultural Inventory and Report

For:
Bosa Waterfront Landing
Laurelwood Road -Squamish, BC

Submitted to:
Athena Noonan
Development Coordinator C/O:
Bosa Properties Inc.

Date: January 23, 2020
Revised: February 17,2021

Submitted by:

DIAMOND HEAD
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SAFE CERTIFIED

The following Diamond Head Consulting staff conducted the on-site tree inventory and prepared or reviewed the report.

All general and professional liability insurance and staff accreditations are provided below for reference.

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ISA Certified Arborist (PN-1920A)
ISA Tree Risk Assessment Qualified (TRAQ)
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Please contact us if there are any questions or concerns about the contents of this report.

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General Liability: Northbridge General Insurance Corporation - Policy #CBC1935506, $10,000,000
Errors and Omissions: Lloyds Underwriters – Policy #1010615D, $1,000,000

Scope of Assignment:

Diamond Head Consulting Ltd. (DHC) was retained to complete an arboricultural assessment to supplement the proposed development application for Bosa Waterfront Landing. This report contains an inventory of on site trees and summarizes management recommendations with respect to future development plans and construction activities. This report is produced with the following primary limitations, detailed limitations specified in Appendix 8:

1) Our investigation is based solely on visual inspection of the trees during our last site visit. This inspection is conducted from ground level. We do not conduct aerial inspections, soil tests or below grade root examinations to assess the condition of tree root systems unless specifically contracted to do so.

2) Unless otherwise stated, tree risk assessments in this report are limited to trees with a *high* or *extreme* risk rating in their current condition, and in context of their surrounding land use at the time of assessment.

3) The scope of work is primarily determined by site boundaries and scope provided by the client. Only trees specified in the scope of work were assessed.

4) Beyond six months from the date of this report, the client must contact DHC to confirm its validity because site base plans and tree conditions may change beyond the original report's scope. Additional site visits and report revisions may be required after this point to ensure report accuracy for the municipality's development permit application process. Site visits and reporting required after the first submission are not included within the original proposal fee and will be charged to the client at an additional cost.

The client is responsible for:

- Reviewing this report to understand and implement all tree **risk**, removal and protection requirements related to the project.
- Understanding that we did not assess trees off the subject property and therefore cannot be held liable for actions you or your contractors may undertake in developing this property which may affect the trees on neighboring properties.
- Obtaining a tree removal permit from the relevant municipal authority prior to any tree cutting.
- Obtaining relevant permission from adjacent property owners before removing off-site trees and vegetation.
- Obtaining a timber mark if logs are being transported offsite.
- Ensuring the project is compliant with the tree permit conditions.
- Constructing and maintaining tree protection fencing.
- Ensuring an arborist is present onsite to supervise any works in or near tree protection zones.

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1.0 Introduction

1.1 Site Overview and Land Use Changes

The subject site is a heavily disturbed cleared area located between the Mamquam Blind Channel and the Sea to Sky highway (Figure 1) in Squamish, BC. Formerly a sawmill location, the site has been cleared for construction, aside from a vegetated strip along the Mamquam Channel. **This arborist assessment is limited to this riparian area, which was delineated in the field and with orthophoto.** This area is a typical pioneer deciduous dominated stand common to riparian areas, dominated by Red Alder (*Alnus rubra*), Black Cottonwood (*Populus Tremuloides ssp. trichocarpa),* and Bigleaf Maple (*Acer macrophyllum*. There is a dense understory layer of invasive blackberry, which has limited site access and complete assessment of many trees. A major component of the soil is decaying organic wood material from the previous sawmill. This is a very poor substrate for tree stability, and trees in this poor soil will have very unstable roots.

The subject site is being developed into a higher density mixed use development. This will include various sized structures and roads, as well as a park dedication in the riparian area. Site regarding is required for flood hazard mitigation, which will require the removal of on-site trees where regrading is required. This clearing will create a new linear edge adjacent the Mamquam Channel. This linear strip between the development and the water will remain crown land, with trees retained. Trees within the crown land are included in this report and have been assessed for hazard. A windthrow assessment was conducted for this retention strip to provide information for the land manager of this strip.

1.2 Report Objective

This report has been prepared to inform development, and includes trees that met the following requirements:

- Trees with a stem diameter at breast height (DBH, measured at 1.4 m above grade) greater than 20 cm, measured for a single stem or cumulatively for multi-stemmed trees;
- All trees meeting the above size threshold inside the riparian area

No neighbouring trees had root zones that encroached onto the assessment area, and therefore no off-site trees have been included.

Figure 1. Waterfront Landing in context of the surrounding landscape and infrastructure.

2.0 Process and Methods

Conor Corbett of DHC visited the site on July 26, 2018. A subsequent visit was conducted by Ian Maclachlan of DHC on June 10, 2019. The following methods and standards are used throughout this report.

2.1 Tree Inventory

Trees on site and trees shared with adjacent properties were marked with a numbered tag and assessed for attributes including: species; height measured to the nearest meter; and, diameter at breast height (DBH) measured to the nearest centimeter at 1.4 m above grade. The general health and structural integrity of each tree was assessed visually and assigned to one of five categories: *excellent; good; moderate; poor; or dying/dead*. Descriptions of the health and structure rating criteria are given in Appendix 4.

2.2 Tree Risk Assessment

Tree risk assessments were completed following methods of the ISA Tree Risk Assessment Manual[1] published in 2013 by the International Society of Arboriculture, which is the current industry standard for assessing tree risk. This methodology assigns risk based on the likelihood of failure, the likelihood of impact and the severity of consequence if a failure occurs. Only on-site and crown hazard trees that had *high* or *extreme* risk ratings in **their current condition and in context of their surrounding land use** were identified and reported in section 3.2. Appendix 5 gives the likelihood and risk rating matrices used to categorize tree risk. DHC recommends that on-site trees be re-assessed for risk after the site conditions change (e.g. after damaging weather events, site disturbance from construction, creation of new targets during construction or in the final developed landscape).

2.3 Tree Protection and Replacement

Tree Protection Zones were calculated for each tree according to industry best practices, but may be modified based on professional judgement of the project arborist to accommodate species specific tolerances and site specific growing conditions.

[1] Dunster, J.A., Smiley, E.T., Matheny, N. and Lilly, S. (2013). Tree Risk Assessment Manual. *International Society of Arboriculture*. Champaign, Illinois.

3.0 Findings: Tree Inventory and Risk Assessment

3.1 Tree Inventory

A total of 283 trees have been assessed and included in this report. 177 are recommended for removal, and 106 are recommended for retention.

Trees On-site – Stand 1

Many of the trees on the subject site had similar attributes: poor health, immature, pioneer deciduous trees. These are Alder, Cottonwood, and Bigleaf Maple between 20-40 cm that have poor health. These trees were not inventoried individually, but rather aggregated into a group "stand 1." These trees were surveyed and tagged individually, and are located on the tree management plan that accompanies this document. Below we have a table summarizing the tree by tag and retention recommendation. There are a total of 138 trees in "Stand 1," of which 63 are recommended for removal. The remaining 75 are recommended for retention, most of which are located in the riparian area along the Mamquam Blind Channel. The complete summary of Stand 1 trees by tag and retention recommendation is in Appendix 2.

Trees On-site – Individual Trees

Individual trees that required additional information were inventoried individually. These include larger trees, trees with higher retention value, unique species relative to the site, or trees that could be potentially hazardous in the future.

A total of 31 trees are recommended for retention. 114 are recommended for removal. A majority of the removals are due to site regrading required for flood hazard mitigation.

The tree inventory is summarized in Table 1 and the complete tree inventory is given in Appendix 1.

Table 1. Tree retention and removal summary

Tree Species	Health and Structure				Recommendation		
	Good	Moderate	Poor	Dead/Dying High Risk	Remove	Retain	Total
On-site and shared trees							
Black Cottonwood		2		4	6		**6**
Red Alder		17	57	24	75	23	**98**
Big -Leaf Maple	9	12	5		22	4	**26**
Bitter Cherry		1	2		3		**3**
English Oak	2	1			2	1	**3**
Sitka Spruce	1	1		1	1	2	**3**
Western Red Cedar		2	4		5	1	**6**
Totals	**12**	**36**	**68**	**29**	**114**	**31**	**145**

Trees on Adjacent Properties

Permission is required to remove any trees that are located on any other property not owned by the client (Bosa). The tree survey provided by the legal land surveyor will indicate which trees are located on other properties.

3.2 Tree Risk Assessment

There were two trees on this site that posed a *high* or *extreme* risk at the time of assessment. Note that there are many dead trees that will likely become hazards in the near future. Details for these trees are provided in the tree inventory table.

Table 2: Summary of trees that pose a high or extreme risk at the time of assessment. To meet these criteria there was a probable or imminent likelihood of failure and will impact a target with significant or severe consequences. Trees that meet these criteria are shown in the table below. Residual risk will be discussed for any tree within the table that is not a complete removal.

Tree		Target	Likelihood			Consequences	Risk Rating	Action	Residual Risk
Number	Part to Fail		Failure	Impact	Failure & Impact				
1763	Main Stem	Park User	Imminent	Medium	Likely	Significant	High	Remove	None
1768	Main Stem	Park User	Imminent	Medium	Likely	Significant	High	Remove	None

4.0 Findings: Windthrow Assessment of Retained Trees on Crown Land

There will be a strip of retained trees on crown land along the Mamquam Channel in the north of the site once re-grading is complete. These trees will be exposed to new wind forces as a result of site clearing, which may increase likelihood of failure of these trees. While many of these trees may not be "High" or "Extreme" hazard according to the Tree Risk Assessment Qualification methodology, that does not imply that they are stable and will not fail.

The stand-level windthrow likelihood evaluation assesses the likelihood that trees will fail from the newly proposed stand edge. The factors contributing to the risk of windthrow, and the likelihood of windthrow were assessed according to the BC Forest and Range Evaluation Program Windthrow Assessment Procedures (Form - FS712-1A – see Appendix 6) and informed by the guidance the Windthrow Handbook for British Columbia Forests (Stathers et al. 1994). Both documents were designed for forest edges in a forestry setting, however the concepts and standards can be applied to urban settings and are considered standards for assessing windthrow in BC. The factors that were accounted for and affect the stability of a forest edge include:

- Topographic exposure to wind
- Stand stability
- Soil anchorage
- Treatment influence

The assessment of these factors is used to categorize the likelihood of windthrow. Based on the findings of the assessment, recommendations to reduce windthrow from these edges can be made, including feathering edges and spiral pruning to reduce the trees' sail area.

The prevailing winds in this area are typically strongest and most frequent from the south. This area is located on flat ground. Much of the site has been cleared, originally for industrial use. New construction in the previous cleared areas to the south has recently occurred. Typical wind conditions experienced in Surrey are represented in the wind rose diagram in Figure 2.

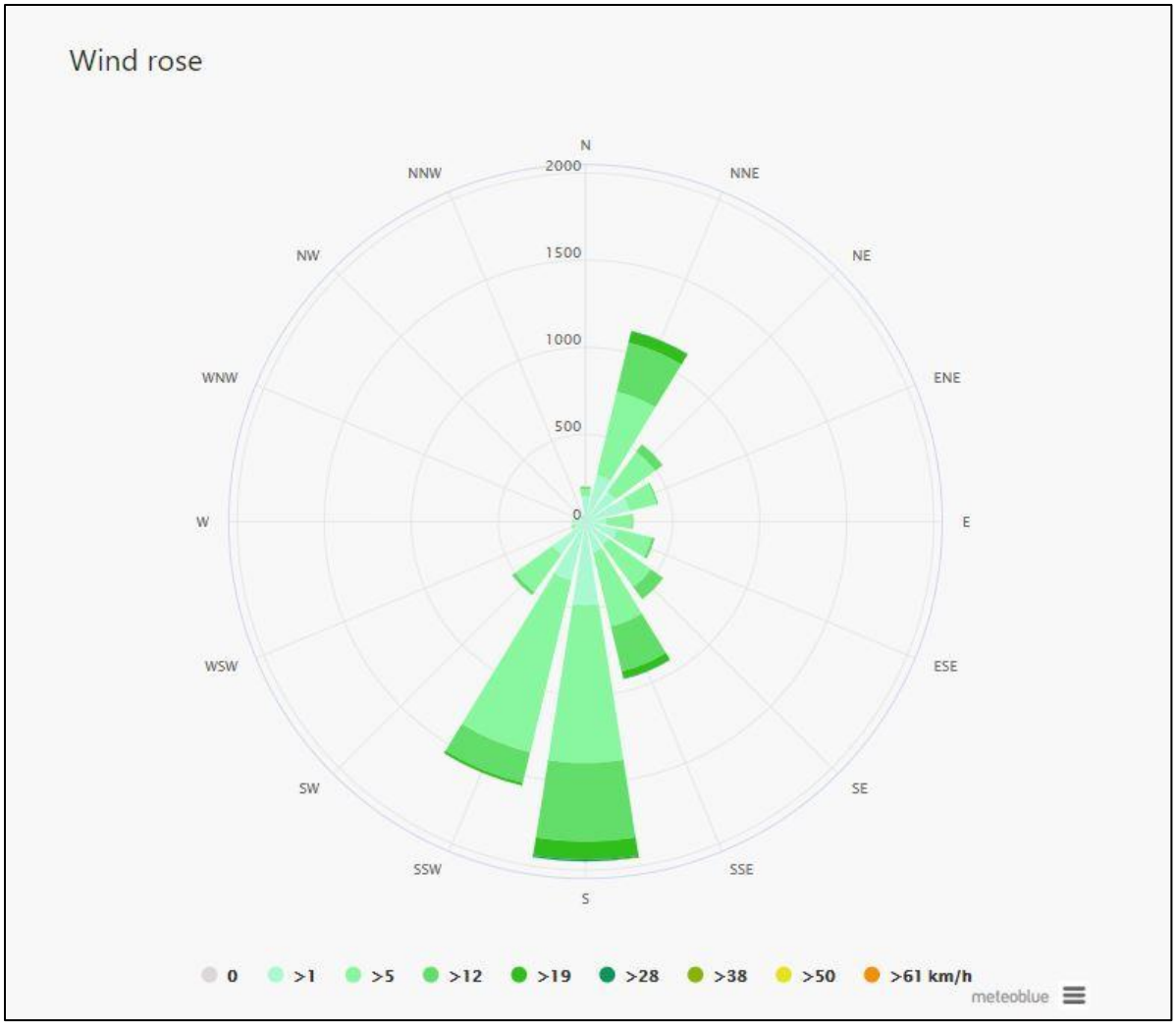


Figure 2. Windrose for Squamish

Windthrow Assessment for retained strip trees

Conor Corbett, RPF, TRAQ has completed this assessment. The following legislation and standards have been adhered to through this assessment:

1. Windthrow Handbook for British Columbia Forests (Stathers et al. 1994)
2. BC Forest and Range Evaluation Program Windthrow Assessment Procedures (Form - FS712-1A)

3.

Table 2. Summary of Windthrow Assessment

Contributing Factors	Comments	Hazard Class
Topography and Wind Force: *The position of a site within the context of regional topography affects how prevailing winds will put force on the trees. Typical wind speeds and directions are considered relative to the site.*		
Topography, exposure to wind, typical storm direction	• In the lower mainland that wind storms occur annually with wind speed up to 70 km/hr. Stronger storms that tend to cause high levels of windthrow have been found to occur every 3 years. • The prevailing winds in this area are typically strongest and most frequent from the south (see wind rose diagram in Figure 1.) • The retained strip is located on a channel that connect with the ocean in Howe Sound 1.5 km south. There is likely a wind funneling effect from this channel. • Tree removals to the south will expose these trees to new wind forces.	Low (1 - very wind sheltered) Moderate (2 - intermediate) High (3 - very wind exposed)
Stand Stability: The ability for a stand of trees to withstand wind storms is dependent on a number of characteristics including the stand structure and density, tree height, live crown ratio and trunk taper. These factors help to determine if the trees are adapted to wind loads.		
Stand structure and density	• The stand has a moderate density. The trees have moderate taper and live crown ration.	Low (1 - very stable)
Tree stem strength, height, sail area and leverage	• Trees have mostly poor health and structure, many trees are in decline or are dead.	Moderate (2 - neutral) High (3 - very unstable)
Soils and Anchorage: The strength of how well trees are anchored to the ground depends on the natural rooting characteristics of the species as well as soil characteristics such as texture, compaction, effective rooting depth, moisture and the cohesion of the soil profile. There are limitations to evaluating these factors without digging into the soil profile.		
Root anchorage (soil depth, texture, moisture)	• Soils are heavily disturbed in this area from the previous industrial land use. Many of the trees are rooting in decomposed woodchips forming a poor rooting medium. Many of these trees are currently showing natural root plate failures.	Low (0 - unrestricted) Moderate (1 - neutral) High (2 - very restricted)
Other Indicators: Observations such as construction impacts or historic windthrow that may influence windthrow risk.		
Evidence of historic windthrow	• There is evidence of previous windthrow throughout the stand.	High
Treatment: Considerations for how the proposed harvesting strategy will change wind loading on the stand edge or retained trees.		

Contributing Factors	Comments	Hazard Class
Influence of proposed tree clearing	• The proposed development will remove the trees southeast of the proposed edge. This tree removal will mainly increase the effect of winds from a southeasterly direction. The proposed clearing is expected to moderately increase the wind loading of the new stand edge. • The boundary will be exposed to southeasterly, which are the moderately frequent wind directions in the area.	None (no susceptible timber) Low (minimal increase) Moderate (moderate increase) High (large increase)

Table 3 summarizes the windthrow likelihood based on the BC Forest and Range Windthrow Assessment Form FS712-1A and considering the factors outlined above

Table 3. Summary of windthrow likelihood from the BC Forest and Range Windthrow Assessment Form

Component Score	High	Moderate	Low	None
Topographic Hazard	3	2	1	0
Stand Hazard	3	2	1	0
Soil Hazard	2	1	0	0
Stand Treatment Hazard	6	4	2	0
Score	**12**			

Windthrow Likelihood	Score
Very High	14
High	12-13
Moderate	10-11
Low	6-9
Very low	<6
None	None

The forested area inside the retained area has trees with poor structure. The soil in the area is poor, with tree failure evident throughout the current stand. A new edge will be created through clearing for site regrading for flood hazard, exposing the stand to new wind forces. The proximity to Howe Sound and the nearby channel increases the windthrow risk. The overall windthrow risk post clearing will be High. However, the biophysical risk before removals is also high. The high risk is driven mostly by the current biophysical characteristics of the stand, rather than the creation of a new edge. Nevertheless, that risk will persist after clearing.

Tree failures are expected to occur in this retained strip after clearing. However, it is highly likely that most of these failures will fail into the stand, and not into the adjacent park. It is not likely that trees will fail during normal conditions, but during high winds associated with winter storms. Therefore, despite the elevated high windthrow risk, these trees should not be considered *High Risk* according to TRAQ as the likelihood of striking a person in this area is low. High risk trees are discussed above in 3.2. The proposed development and park dedication may present an opportunity to remove and replace these trees with species more suitable and stable in wind, however the ultimate decision to remove or replace these trees is with the District of Squamish.

5.0 Discussion and Summary

5.1 Trees On-site

The trees on-site are typical of pioneer deciduous stands in the broader landscape, with soils that have been severely disturbed and modified from previous use. The poor condition of many of these trees is to be expected. Most of the vegetation in the riparian area is shrubby trees and invasive blackberry, also typical of disturbed sites. The poor soil substrate, coupled with the proposed flood regrading, greatly reduces the options for retaining trees. Despite some trees being in good health, many cannot be retained due to the required regrading.

Trees have been classified into four types. Firstly, trees that are currently meet the TRAQ criteria as *High Hazard* have been identified. These trees are hazardous in the context of a public park, and should be removed. Secondly, trees that are in very poor or unstable condition that are expected to develop into *High Hazard* trees have also been identified. These trees should also be removed. The third class of trees are the trees that require removal due to the flood hazard mitigation regarding. The fourth class of trees are those trees that are part of the retention strip alongside the Mamquam Channel. These trees have an elevated risk of failure due to the increased windthrow hazard from adjacent site clearing. These trees are not considered *High Hazard* according to TRAQ, but there is a higher chance of tree failure due to increased winds. Removal and replacement with more stable trees may be an option for these trees, however this will ultimately be at the discretion of the District of Squamish.

Appendix 1 Complete Tree Inventory Table

The complete tree inventory below contains information on tree attributes. Tree Protection Zones are measured from the outer edge of a tree's stem. If using these measurements for mapping the tree protection zone, ½ the tree's diameter must be added to the distance to accommodate a survey point at the tree's center. Where tree protection fencing is proposed to vary from the minimum municipal TPZ, comments will be included in the Retention/TPZ comments and shown on the Tree Retention and Removal Plan.

*TPZ is the tree protection zone size defined by the project arborist.

Tree Tag	Tree Species	DBH (cm)	Tree Height (m)	Comment	Health and Structure Ratings	Retain/Remove	Retention Comments	TPZ (m)
530	Black Cottonwood	54	21	Top has 3 limbs emerging- 4 m in length	Moderate	Remove	Conflicts with flood hazard regrading	3.2
531	Red Alder	58	18	Could not access. Codom at 1.6m with inclusion. Faces SE about 9m	Moderate	Remove	Conflicts with flood hazard regrading	3.5
532	Red Alder	44	15	Slight lean to NW	Moderate	Remove	Conflicts with flood hazard regrading	2.6
533	Red Alder	42	8	Partial root failure with sem correction. At edge of slough.	Poor	Remove	Conflicts with flood hazard regrading	2.5
575	Red Alder	30	20	Roots severed on east side by road. Was hit by excavator at base. Cracked stem. Remove if targets nearby	Poor	Retain	Windthrow	1.8
576	Red Alder	41	20	Codominant stem at 3 m with moderate inclusion. Leans to east with scar at 1.8 m.	Poor	Retain	Windthrow	2.5
577	Red Alder	44	15	Codominant stem at 3m with severe inclusion. Heavy lean over	Poor	Retain	Windthrow	2.6

Tree Tag	Tree Species	DBH (cm)	Tree Height (m)	Comment	Health and Structure Ratings	Retain/Remove	Retention Comments	TPZ (m)
				water to east.				
578	Western Red Cedar	52	17	Candelabra at base with 579 amongst. Healthy crown	Poor	Retain	Windthrow	3.1
579	Red Alder	32	18	Codominant stem at 9 m with moderate inclusion	Poor	Retain	Windthrow	1.9
581	Sitka Spruce	70	0	Dead tree- cable at 3m for log booms	Dead	Remove	Future Hazard	4.2
582	Red Alder	38	10	Two stems at 2 m southern stem alive. Cavity at 7 m. Dead top.	Poor	Retain	Windthrow	2.3
1631	Big-Leaf Maple	32	17	Small snag hung up in tree, slight asymmetry in crown. Stem forks at 4 m, union appears sound	Good	Remove	Conflicts with flood hazard regrading.	1.9
1632	Big-Leaf Maple	31	17	Edge tree. Root zone disturbance appears moderate. Single stem. Good form.	Moderate	Remove	Conflicts with flood hazard regrading	1.9
1634	Black Cottonwood	37	21	Failed at root plate.	Dead	Remove	Future Hazard	2.2
1635	English Oak	30	16	Oak in middle of mostly native stand. Edge exposed north, slightly asymmetric crown, otherwise good health and structure	Good	Retain	Windthrow	1.8
1638	Big-Leaf Maple	34	19	Group of four trees close, crown asymmetric with minor phototropic leans	Moderate	Retain	Windthrow	2
1639	Red Alder	41	17	Major phototropic lean north, large failed laterals with likely decay in wounds.	Poor	Retain	Windthrow	2.5
1640	Red Alder	34	19	Group of four trees close, crown asymmetric with minor	Moderate	Retain	Windthrow	2

Tree Tag	Tree Species	DBH (cm)	Tree Height (m)	Comment	Health and Structure Ratings	Retain/Remove	Retention Comments	TPZ (m)
				phototropic leans. Stem divides at 8 m with acute union				
1641	Western Red Cedar	41	19	Group of four trees close, crown asymmetric	Moderate	Remove	Conflicts with civil infrastructure	2.5
1642	Red Alder	40	16	Deformed crooked stem. large failed laterals with likely decay in wounds.	Poor	Retain	Windthrow	2.4
1643	Red Alder	40	19	Major phototropic lean north, roots disturbed by flooding. Dead snag leaning on stem.	Poor	Retain	Windthrow	2.4
1644	Big-Leaf Maple	40	17	Asymmetric crown, good vigor	Moderate	Retain	Windthrow	2.4
1645	Red Alder	43	16	Deformed stem, dead laterals.	Poor	Retain	Windthrow	2.6
1646	Big-Leaf Maple	53	16	Flooding has eroded root area, tree is heavily leaning north and with imminent failure, will fall in channel	Poor	Retain	Windthrow	3.2
1647	Red Alder	47	20	Asymmetric crown, dead laterals.	Poor	Retain	Windthrow	2.8
1648	Red Alder	40	16	Asymmetric crown, lean north. Roots heavily disturbed by flooding erosion.	Poor	Retain	Windthrow	2.4
1649	Red Alder	35	20	Asymmetric and high crown, epicormic shoots.	Poor	Retain	Windthrow	2.1
1650	Red Alder	32	18	Asymmetric crown, uncorrected lean south	Poor	Remove	Conflicts with civil infrastructure	1.9
1651	Red Alder	32	16	Major decay column at base, removal recommended if targets change	Poor	Retain	Windthrow	1.9

Tree Tag	Tree Species	DBH (cm)	Tree Height (m)	Comment	Health and Structure Ratings	Retain/Remove	Retention Comments	TPZ (m)
1652	Red Alder	37	19	Asymmetric crown, good health.	Moderate	Retain	Windthrow	2.2
1653	Red Alder	30	17	Asymmetric crown lean north	Moderate	Retain	Windthrow	1.8
1654	Red Alder	30	18	Asymmetric crown, large failed lateral with decay in wound	Moderate	Retain	Windthrow	1.8
1655	Red Alder	37	18	Major dieback in crown tree in decline	Poor	Retain	Windthrow	2.2
1656	Red Alder	32	16	Major blackberry at base, dbh estimated not tagged. Crown appears healthy	Moderate	Retain	Windthrow	1.9
1658	Bitter Cherry	28	15	Mechanical damage to stem, soil compaction in rootzone	Poor	Remove	Conflicts with flood hazard regrading	1.7
1661	Red Alder	120	18	Three stems from base, all 40 cm DBH from acute unions. Dieback in crown. Light pole three m south	Poor	Remove	Conflicts with flood hazard regrading	7.2
1662	Alder (A. rubra)	34	18	Phototropic lean north	Moderate	Remove	Conflicts with flood hazard regrading	2
1667	Red Alder	37	17	Dense blackberry, dbh estimated and not tagged. Major Dieback in crown, tree in decline, decay cavities in stem.	Poor	Remove	Conflicts with flood hazard regrading	2.2
1669	Western Red Cedar	34	15	Unable to access due to dense blackberry, dbh estimated, not tagged. Slight dieback in crown likely due to shading	Moderate	Remove	Conflicts with civil infrastructure	2
1671	Sitka Spruce	53	22	Dominant in stand. Minor dieback from shading, but overall good health and	Good	Retain	Windthrow	3.2

Tree Tag	Tree Species	DBH (cm)	Tree Height (m)	Comment	Health and Structure Ratings	Retain/Remove	Retention Comments	TPZ (m)
				structure				
1673	Big-Leaf Maple	48	21	Tree appears stressed with twiggy dieback and foliage decline.	Poor	Retain	Windthrow	2.9
1675	Sitka Spruce	66	20	Root zone heavily disturbed by seasonal flooding. Two stems from 2 m, acute union	Moderate	Retain	Windthrow	4
1676	Maple (A. macrophyllum)	48	20	Wide spreading crown, good health and structure	Good	Remove	Conflicts with flood hazard regrading	2.9
1677	Red Alder	80	18	Three stems from base, 30 30 and 20 cm dbh. Unions moderate and acute. Large mechanical damage on one stem, crowns slightly declining	Poor	Retain	Windthrow	4.8
1678	Red Alder	32	15	Dieback in canopy	Poor	Retain	Windthrow	1.9
1679	Red Alder	32	18	In contact with adjacent undersized maple	Poor	Remove	Conflicts with flood hazard regrading	1.9
1680	Red Alder	34	15	Heavily disturbed rooting area due to season floods, uncorrected lean	Poor	Retain	Windthrow	2
1681	Red Alder	38	15	Recent exposure, some twiggy dieback	Moderate	Remove	Conflicts with flood hazard regrading	2.3
1682	Red Alder	36	20	Recent exposure, rooting affected by seasonal flood however upper stem has corrected lean	Moderate	Remove	Conflicts with flood hazard regrading	2.2
1683	Red Alder	32	16	Edge tree. Root plate lifting on	Poor	Remove	Conflicts with	2

Tree Tag	Tree Species	DBH (cm)	Tree Height (m)	Comment	Health and Structure Ratings	Retain/Remove	Retention Comments	TPZ (m)
				south side. Leans 10 degrees north east.			flood hazard regrading	
1686	Big-Leaf Maple	30	18	Good health and structure	Good	Remove	Conflicts with flood hazard regrading	1.8
1687	Red Alder	45	16	Two stems from base, wide union is strong. Recently exposed with minor twiggy dieback.	Moderate	Remove	Conflicts with flood hazard regrading	2.7
1688	Red Alder	40	18	Exposed roots, failure possible. Tree appears stressed with thinning crown and dead laterals	Poor	Retain	Windthrow	2.4
1693	Maple (A. macrophyllum)	30	10	Dense blackberry. Unable to access, dbh estimated and not tagged. Two stems, 15 cm dbh. Edge tree, Healthy crown, good structure	Good	Remove	Conflicts with flood hazard regrading	1.8
1702	Red Alder	20	10	Asymmetrical to north east. Partly suppressed.	Poor	Remove	Conflicts with flood hazard regrading	2
1703	Big-Leaf Maple	23	12	Top of bank. 2 m from asphalt.	Good	Remove	Conflicts with civil infrastructure	2
1704	Red Alder	23	12	NA.	Dying	Remove	Future Hazard	2
1705	Big-Leaf Maple	26	12	Top of bank. Minor debris at base.	Good	Remove	Conflicts with civil infrastructure	2
1706	Bitter Cherry	24	15	Asymmetrical to east.	Moderate	Remove	Conflicts with flood hazard regrading	2

Tree Tag	Tree Species	DBH (cm)	Tree Height (m)	Comment	Health and Structure Ratings	Retain/Remove	Retention Comments	TPZ (m)
1707	Red Alder	24	12	At top of bank.	Moderate	Remove	Conflicts with flood hazard regrading	2
1708	Red Alder	29	13	At top of bank.	Poor	Remove	Conflicts with flood hazard regrading	2
1709	Red Alder	29	13	At top of bank. Leans 8 degrees north over channel.	Poor	Remove	Conflicts with flood hazard regrading	2
1710	Red Alder	29	11	At top of bank. Leans 2 - 3 degrees north over channel.	Moderate	Remove	Conflicts with flood hazard regrading	2
1711	Red Alder	74	11	At top of bank. Two stems. One leans 15 degrees north over channel.	Poor	Remove	Conflicts with flood hazard regrading	4.4
1712	Red Alder	80	13	On bank. Three stems. One leans 45 degrees north over channel.	Poor	Remove	Conflicts with flood hazard regrading	4.8
1713	Red Alder	32	12	Dense blackberry, dbh estimated and not tagged. Major Dieback in crown, tree in decline.	Poor	Remove	Conflicts with flood hazard regrading	1.9
1714	Black Cottonwood	24	14	Large rocks piled to base.	Moderate	Remove	Conflicts with flood hazard regrading	2
1715	Red Alder	28	13	On bank. Heavy curing lean east. Drip line radius 8 m east.	Poor	Remove	Conflicts with flood hazard regrading	2
1716	Red Alder	26	13	On bank. Slight lean north over channel.	Poor	Remove	Conflicts with flood hazard regrading	2

Tree Tag	Tree Species	DBH (cm)	Tree Height (m)	Comment	Health and Structure Ratings	Retain/Remove	Retention Comments	TPZ (m)
1717	Red Alder	26	16	Failed at root plate. Hung-up in 1718.	Poor	Remove	Conflicts with flood hazard regrading	2
1718	Red Alder	26	16	Holding up 1717.	Poor	Remove	Conflicts with flood hazard regrading	2
1719	Red Alder	43	17	Partial root plate failure with 10 degree lean corrected mid-stem.	Poor	Remove	Conflicts with flood hazard regrading	2.6
1720	Red Alder	41	17	Partial root plate failure with 10 degree lean corrected mid-stem.	Poor	Remove	Conflicts with flood hazard regrading	2.5
1722	Red Alder	29	16	Narrow crown, moderate taper.	Moderate	Remove	Conflicts with flood hazard regrading	2
1723	Big-Leaf Maple	21	12	Partly suppressed. Top lost.	Moderate	Remove	Conflicts with flood hazard regrading	2
1724	Red Alder	37	16	Edge tree. Crown asymmetrical to east.	Moderate	Remove	Conflicts with flood hazard regrading	2.2
1725	Red Alder	42	16	Edge tree. Crown asymmetrical to east.	Poor	Remove	Conflicts with flood hazard regrading	2.5
1726	Red Alder	32	16	Arching stem to north east. Drip line radius 7 m north east.	Poor	Remove	Conflicts with flood hazard regrading	2
1727	Red Alder	52	17	Lean to west corrected mid-stem.	Poor	Remove	Conflicts with flood hazard regrading	3.1

Tree Tag	Tree Species	DBH (cm)	Tree Height (m)	Comment	Health and Structure Ratings	Retain/Remove	Retention Comments	TPZ (m)
1728	Red Alder	60	16	Pile of large boulders to base. Two similar sized stems from acute union at base, both lean 10 degrees east. Drip line radius 8 m east.	Poor	Remove	Conflicts with flood hazard regrading	3.6
1729	Red Alder	21	16	Pile of large boulders to base. Narrow taper. Leans 10 degrees east.	Poor	Remove	Conflicts with flood hazard regrading	2
1730	Red Alder	26	16	Growing out of log. Narrow taper. Leans 10 degrees east.	Poor	Remove	Conflicts with flood hazard regrading	2
1731	Red Alder	23	16	Narrow taper. Leans 5 degrees east.	Poor	Remove	Conflicts with flood hazard regrading	2
1732	Red Alder	25	16	Partly suppressed. Narrow taper. Leans 5 degrees north.	Poor	Remove	Conflicts with flood hazard regrading	2
1733	Red Alder	58	21	Dominant tree. Leans 8 degrees north. Large crown.	Moderate	Remove	Conflicts with flood hazard regrading	3.5
1734	Red Alder	26	16	Narrow taper. Leans 5 degrees west.	Poor	Remove	Conflicts with flood hazard regrading	2
1735	Red Alder	23	16	Narrow taper. Leans 5 degrees east.	Poor	Remove	Conflicts with flood hazard regrading	2
1736	Red Alder	24	16	Narrow taper. Upright.	Poor	Remove	Conflicts with flood hazard regrading	2
1737	Red Alder	38	14	NA.	Dying	Remove	Future Hazard	2.3

Tree Tag	Tree Species	DBH (cm)	Tree Height (m)	Comment	Health and Structure Ratings	Retain/Remove	Retention Comments	TPZ (m)
1738	Red Alder	51	21	Dominant tree. Crown asymmetrical to east. Foliage thin.	Poor	Remove	Conflicts with flood hazard regrading	3.1
1739	Big-Leaf Maple	22	12	Symmetrical crown.	Moderate	Remove	Conflicts with flood hazard regrading	2
1740	Red Alder	21	14	NA.	Dying	Remove	Future Hazard	2
1741	Big-Leaf Maple	26	13	Mechanical damage to structural root. Symmetrical crown.	Moderate	Remove	Conflicts with flood hazard regrading	2
1742	Big-Leaf Maple	30	13	Crown asymmetrical to south. Healthy.	Moderate	Remove	Conflicts with flood hazard regrading	2
1743	Red Alder	21	10	NA.	Dying	Remove	Future Hazard	2
1744	Red Alder	21	14	Long advanced decay column.	Dying	Remove	Future Hazard	2
1745	Red Alder	28	15	Moderate stem sweep to north.	Poor	Remove	Conflicts with flood hazard regrading	2
1746	Bitter Cherry	30	14	Two stems, one subordinate. Moderate basal sweep to north.	Poor	Remove	Conflicts with flood hazard regrading	2
1747	Red Alder	22	10	Large decay column.	Poor	Remove	Conflicts with flood hazard regrading	2
1748	Red Alder	35	13	Heavy crown. Leans south over channel.	Poor	Remove	Conflicts with flood hazard regrading	2.1

Tree Tag	Tree Species	DBH (cm)	Tree Height (m)	Comment	Health and Structure Ratings	Retain/Remove	Retention Comments	TPZ (m)
1749	Red Alder	25	10	Extensive mechanical disturbance in root zone. Strong sweep to east.	Poor	Remove	Conflicts with flood hazard regrading	2
1750	Red Alder	23	10	Extensive mechanical disturbance in root zone. Moderate sweep to east.	Poor	Remove	Conflicts with flood hazard regrading	2
1751	Red Alder	24	15	Leans 10 degrees east. Recently impacted by falling tree, partial root plate failure.	Dying	Remove	Future Hazard	2
1752	Red Alder	23	15	Potential to fail east in future. Will damage maple tree worth retaining if failed west.	Dying	Remove	Future Hazard	2
1753	English Oak	18	14	Root zone disturbance. Minor to moderate mechanical damage to bark on lower stem - will tolerate and recover. Single stem. Good crown form. Foliage a little sparse, probably due to root zone disturbance.	Moderate	Remove	Conflicts with flood hazard regrading	2
1754	English Oak	21	14	Moderate root zone disturbance. Single stem. Good crown form. Foliage healthy.	Good	Remove	Conflicts with flood hazard regrading	2
1755	Red Alder	14	15	Hung-up in dead trees. Will fail north.	Dying	Remove	Future Hazard	2
1756	Red Alder	16	10	Standing dead. Direction of failure unclear.	Dead	Remove	Future Hazard	2
1757	Red Alder	18	11	Standing dead. Direction of failure unclear.	Dying	Remove	Future Hazard	2
1758	Red Alder	19	13	Standing recently dead. Will fail east.	Dying	Remove	Future Hazard	2

Tree Tag	Tree Species	DBH (cm)	Tree Height (m)	Comment	Health and Structure Ratings	Retain/Remove	Retention Comments	TPZ (m)
1759	Red Alder	21	15	Will fail east when dead.	Dying	Remove	Future Hazard	2
1760	Big-Leaf Maple	26	10	Top completely smashed by falling cottonwood. Has no retention value.	Poor	Remove	Conflicts with flood hazard regrading	2
1761	Western Red Cedar	31	12	Formerly in group of three. Extensive root zone disturbance (one tree failed). Has uncorrected lean 8 degrees south, possibly due to root damage on north side. Foliage thinning.	Poor	Remove	Conflicts with flood hazard regrading	2
1762	Western Red Cedar	28	10	Formerly in group of three. Extensive root zone disturbance (one tree failed). Foliage thinning.	Poor	Remove	Conflicts with flood hazard regrading	2
1763	Black Cottonwood	65	26	Extensive root mechanical root zone disturbance has damaged and severed large structural roots. Full, dense crown. Possibly feels like rocking on root plate in the wind. Remove as a priority.	High Risk	Remove	High Risk	3.9
1764	Big-Leaf Maple	28	14	Partly shaded by 1763. Root zone disturbance minor. Good form. Healthy.	Good	Remove	Conflicts with flood hazard regrading	2
1765	Big-Leaf Maple	25	10	Extensive root damage leading to death in most of crown.	Poor	Remove	Conflicts with flood hazard regrading	1.5
1766	Big-Leaf Maple	26	16	All surface roots on north side appear to have been torn. Crown has good form. Appears healthy.	Poor	Remove	Conflicts with flood hazard regrading	1.6

Tree Tag	Tree Species	DBH (cm)	Tree Height (m)	Comment	Health and Structure Ratings	Retain/Remove	Retention Comments	TPZ (m)
1767	Red Alder	16	15	Standing dead. Will fail east.	Dead	Remove	Future Hazard	2
1768	Black Cottonwood	50	26	Extensive root mechanical root zone disturbance has damaged and severed large structural roots. Full, dense crown. Can see and feel root plate moving in wind.	High Risk	Remove	High Risk	3
1769	Black Cottonwood	48	26	Extensive damage to structural roots. 50% crown dieback.	Dying	Remove	Future Hazard	2.9
1770	Western Red Cedar	28	12	Partly suppressed. Root zone disturbance. Crown thin.	Poor	Remove	Conflicts with flood hazard regrading	2
1771	Big-Leaf Maple	20	14	Excavator disturbance in root zone. Narrow taper.	Moderate	Remove	Conflicts with flood hazard regrading	2
1772	Big-Leaf Maple	27	15	Codominant tree. Excavator disturbance in root zone. Moderate taper.	Moderate	Remove	Conflicts with flood hazard regrading	2
1773	Big-Leaf Maple	20	15	Edge tree. Excavator disturbance in root zone. Moderate taper.	Moderate	Remove	Conflicts with flood hazard regrading	2
1774	Big-Leaf Maple	20	15	Edge tree. Excavator disturbance in root zone. Moderate taper.	Moderate	Remove	Conflicts with flood hazard regrading	2
1775	Big-Leaf Maple	28	15	Codominant tree. Excavator disturbance in root zone. Moderate taper.	Moderate	Remove	Conflicts with flood hazard regrading	2
1776	Big-Leaf Maple	27	16	Codominant tree. Excavator disturbance in root zone. Moderate taper.	Good	Remove	Conflicts with flood hazard regrading	2

Tree Tag	Tree Species	DBH (cm)	Tree Height (m)	Comment	Health and Structure Ratings	Retain/Remove	Retention Comments	TPZ (m)
1777	Red Alder	26	15	Codominant tree. Moderate taper. High crown. One medium dead branch at 7 m.	Moderate	Remove	Conflicts with flood hazard regrading	2
1778	Big-Leaf Maple	25	16	Codominant tree. Excavator disturbance in root zone. Moderate taper.	Good	Remove	Conflicts with flood hazard regrading	2
1779	Red Alder	16	15	Excavator disturbance in root zone. Minor lean east.	Dying	Remove	Future Hazard	2
1780	Red Alder	16	15	Excavator disturbance in root zone, and buttress roots tearing. Hung-up in adjacent maple.	Dead	Remove	Future Hazard	2
1781	Red Alder	16	15	Excavator disturbance in root zone. Minor lean north east.	Dying	Remove	Future Hazard	2
1782	Red Alder	16	15	Excavator disturbance in root zone, and buttress roots tearing.	Dead	Remove	Future Hazard	2
1783	Red Alder	28	15	Structural roots smashed by excavator on south side. Root plate moving in wind.	Poor	Remove	Conflicts with flood hazard regrading	2
1784	Red Alder	21	12	Structural roots smashed by excavator on south side. Root plate moving in wind. Partly hung-up in adjacent tree.	Poor	Remove	Conflicts with flood hazard regrading	2
1785	Red Alder	23	14	Excavator disturbance in root zone. Minor damage to stem bark. Leans 8 degrees north east.	Poor	Remove	Conflicts with flood hazard regrading	2
1786	Red Alder	42	12	Two similar sized stems from base. Buttress root torn by excavator on south side. Leans 10 degrees north east.	Poor	Remove	Conflicts with flood hazard regrading	2.5
1787	Red Alder	31	15	Edge tree. Root plate lifting on south side. Leans 10 degrees	Dead	Remove	Future Hazard	2

Tree Tag	Tree Species	DBH (cm)	Tree Height (m)	Comment	Health and Structure Ratings	Retain/Remove	Retention Comments	TPZ (m)
				north east.				
1788	Red Alder	31	15	Edge tree. Root plate lifting on south side. Leans 10 degrees north east.	Dead	Remove	Future Hazard	2
1789	Red Alder	27	15	Completely dead. Leans 15 degrees north east.	Dead	Remove	Future Hazard	2
1790	Red Alder	32	18	Exposed tree in cleared area. Excavator disturbance in root zone.	Dying	Remove	Future Hazard	2
1791	Red Alder	22	16	Exposed tree in cleared area. Excavator disturbance in root zone.	Dead	Remove	Future Hazard	2
1792	Red Alder	30	16	Edge tree. Root plate lifting. Leans 10 degrees north east.	Dead	Remove	Future Hazard	2
1793	Red Alder	30	16	Edge tree. Root plate lifting. Leans 5 degrees north east.	Dead	Remove	Future Hazard	2

Appendix 2 Stand 1 Summary

Trees are in sequential order for ease of locating on accompanying tree management plan.

Tag	Retain / Remove
1609B	Retain
5579	Remove
5581	Remove
5582	Remove
5583	Remove
5584	Remove
5585	Remove
5586	Retain
5587	Retain
5588	Remove
5589	Remove
5591	Remove
5592	Remove
5593	Remove
5595	Remove
5597	Remove
5903	Remove
5904	Retain
5905	Retain
5906	Remove
5907	Remove
5908	Remove
5909	Retain
5910	Retain
5911	Remove
5912	Remove
5913	Retain
5914	Retain
5915	Remove
5917	Remove
5920	Retain
5921	Retain
5922	Retain
5923	Retain
5924	Retain

5925	Retain
5926	Retain
5927	Retain
5928	Retain
5929	Retain
5930	Retain
5931	Retain
5932	Retain
5933	Retain
5934	Retain
5935	Retain
5936	Retain
5937	Retain
5938	Retain
5939	Retain
5940	Remove
5941	Remove
5942	Remove
5944	Remove
5945	Retain
5946	Retain
5947	Retain
5948	Retain
5949	Retain
5950	Retain
5951	Retain
5954	Remove
5955	Retain
5956	Remove
5957	Remove
5958	Remove
5959	Remove
5960	Remove
5961	Retain
5962	Retain
5963	Retain
5964	Retain
5965	Retain
5966	Retain
5967	Retain
5968	Retain

5969	Retain
5970	Retain
5971	Retain
5972	Retain
5973	Retain
5974	Retain
5975	Retain
5976	Retain
5977	Remove
5978	Remove
5979	Remove
5980	Retain
5981	Retain
5982	Retain
5983	Retain
5984	Retain
5985	Remove
5986	Retain
5987	Remove
5988	Retain
5989	Retain
5990	Retain
5992	Remove
5993	Remove
5994	Remove
5995	Remove
5996	Remove
5997	Retain
5998	Retain
5999	Remove
6000	Remove
9000	Remove
9001	Remove
9002	Remove
9003	Remove
9004	Remove
9005	Retain
9006	Retain
9007	Retain
9008	Retain
9009	Remove

9010	Remove
9011	Remove
1610B	Remove
1611B	Remove
1618B	Retain
1620B	Retain
1623B	Retain
1624B	Remove
1631B	Retain
1638B	Retain
1639B	Remove
1641B	Remove
1643B	Remove
1650B	Remove
1653B	Remove
1669B	Remove
1672B	Retain
1681B	Remove
1693B	Remove
1755B	Retain
1782B	Remove

Appendix 3 Site Photographs

Photo 1. Northeastern section of assessment area, limited by rail right of way.

Photo 2. Middle portion of assessment area.

Photo 3. Western portion of assessment area.

Photo 4. Extremely dense blackberry was encountered throughout the site.

Photo 5. Trees on the site tended to poor condition.

Photo 6. Some healthy specimens were also found.

Photo 7. Evidence of historic windthrow.

Photo 8. Heavily disturbed soil from previous industrial use.

Appendix 4 Tree Health and Structure Rating Criteria

The tree health and structure ratings used by Diamond Head Consulting summarize each tree based on both positive and negative attributes using five stratified categories. These ratings indicate health and structural conditions that influence a tree's ability to withstand local site disturbance during the construction process (assuming appropriate tree protection) and benefit a future urban landscape.

Excellent: Tree of possible specimen quality, unique species or size with no discernible defects.

Good: Tree has no significant structural defects or health concerns, considering its growing environment and species.

Moderate: Tree has noted health and/or minor to moderate structural defects. This tree can be retained, but may need mitigation (e.g., pruning or bracing) and monitoring post-development. A moderate tree may be suitable for retention within a stand or group, but not suitable on its own.

Poor: Tree is in serious decline from previous growth habit or stature, has multiple defined health or structural weaknesses. It is unlikely to acclimate to future site use change. This tree is not suitable for retention within striking distance of most targets.

Dying/Dead: Tree is in severe decline, has severe defects or was found to be dead.

Appendix 5 Risk Rating Matrices

Trees with a *probable* or *imminent* likelihood of failure, a *medium* or *high* likelihood of impacting a specified target, and a *significant* or *severe* consequence of failure have been assessed for risk and included in this report (Section 3.2). These two risk rating matrices showing the categories used to assign risk are taken without modification to their content from the International Society of Arboriculture Tree Risk Assessment Qualification Manual.

Matrix 1: Likelihood

Likelihood of Failure	Likelihood of Impacting Target			
	Very Low	**Low**	**Medium**	**High**
Imminent	Unlikely	Somewhat Likely	Likely	Very Likely
Probable	Unlikely	Unlikely	Somewhat Likely	Likely
Possible	Unlikely	Unlikely	Unlikely	Somewhat Likely
Improbable	Unlikely	Unlikely	Unlikely	Unlikely

Matrix 2: Risk Rating

Likelihood of Failure and Impact	Consequences of Failure			
	Negligible	**Minor**	**Significant**	**Severe**
Very Likely	Low	Moderate	High	Extreme
Likely	Low	Moderate	High	High
Somewhat Likely	Low	Low	Moderate	Moderate
Unlikely	Low	Low	Low	Low

Appendix 6 Construction Guidelines

Tree management recommendations in this report are made under the expectation that the following guidelines for risk mitigation and proper tree protection will be adhered to during construction.

Respecting these guidelines will prevent changes to the soil and rooting conditions, contamination due to spills and waste, or physical wounding of the trees. Any plans for construction work and activities that deviate from or contradict these guidelines should be discussed with the project arborist so that mitigation measures can be implemented.

Tree Protection Zones

A Tree protection zone (TPZ) is determined using either dripline or a DBH multiplier to define a radius measured in all directions from the outside of a tree's trunk. It is typically determined according to local municipal bylaw specifications and may be modified based on professional judgement of the project arborist to accommodate species specific tolerances and site specific growing conditions. For retained trees, the TPZ and fencing indicated in this report are proposed as suitable in relation to the level of disturbance proposed on the site plan provided to the project arborist. Arborist consultation is required if any additional work beyond the scope of the plans provided is proposed near the tree. Work done in addition to the proposed impacts discussed in this report may cause the tree to decline and die.

Tree Protection Fencing: Tree protection zones (TPZs) will be protected by Tree Protection Fencing except where site features constrict roots (e.g., retaining walls or roads), where continual access is required (e.g., sidewalks), or when an acceptable encroachment into the TPZ is proposed, in which case the fencing will be modified. Tree Protection Fencing is shown on the Tree Protection Plan and, where it varies from the TPZ, the rationale is described in the inventory table in Section 3.1.

Within a TPZ, no construction activity, including materials storage, grading or landscaping, may occur without project arborist approval. Within the TPZ, the following are tree preservation guidelines based on industry standards for best practice and local municipal requirements:

- No soil disturbance or stripping.
- Maintain the natural grade.
- No storage, dumping of materials, parking, underground utilities or fires within TPZs or tree driplines.
- Any planned construction and landscaping activities affecting trees should be reviewed and approved by a consulting arborist.
- Install specially designed foundations and paving when these structures are required within TPZs.
- Route utilities around TPZs.
- Excavation within the TPZs should be supervised by a consultant arborist.
- Surface drainage should not be altered in such a way that water is directed in or out of the TPZ.

- Site drainage improvements should be designed to maintain the natural water table levels within the TPZ.

Prior to any construction activity, Tree Protection Fencing must be constructed as shown on the Tree Protection Plan. The protection barrier or temporary fencing must be at least 1.2 m in height and constructed of 2" by 4" lumber with orange plastic mesh screening. Tree Protection Fencing must be constructed prior to tree removal, excavation or construction and remain intact for the entire duration of construction.

Tree Crown Protection and Pruning

All heavy machinery (excavators, cranes, dump trucks, etc.) working within five meters of a tree's crown should be made aware of their proximity to the tree. If there is to be a sustained period of machinery working within five meters of a tree's crown, a of line of colored flags should be suspended at eye-level of the machinery operator for the length of the protected tree area. Any concerns regarding the clearance required for machinery and workers within or immediately outside tree protection zones should be referred to the project arborist so that a zone surrounding the crowns can be established or pruning measures undertaken. Any wounds incurred to protected trees during construction should be reported to the project arborist immediately.

Unsurveyed Trees

Unsurveyed trees identified by DHC in the Tree Retention Plan have been hand plotted for approximate location only using GPS coordinates and field observations. The location and ownership of unsurveyed trees cannot be confirmed without a legal surveyed. The property owner or project developer must ensure that all relevant on- and off-site trees are surveyed by a legally registered surveyor, whether they are identified by DHC or not.

Removal of logs from sites

Private timber marks are required to transport logs from privately-owned land in BC. It is property owner's responsibility to apply for a timber mark prior to removing any merchantable timber from the site. Additional information can be found at: http://www.for.gov.bc.ca/hth/private-timber-marks.htm

Regulation of Soil Moisture and Drainage

Excavation and construction activities adjacent to TPZs can influence the availability of moisture to protected trees. This is due to a reduction in the total root mass, changes in local drainage conditions, and changes in exposure including reflected heat from adjacent hard surfaces. To mitigate these concerns the following guidelines should be followed:

- Soil moisture conditions within the tree root protection zones should be monitored during hot and dry weather. When soil moisture is inadequate, supplemental irrigation should be provided that penetrates soil to the depth of the root system or a minimum of 30 cm.
- Any planned changes to surface grades within the TPZs, including the placement of mulch, should be designed so that any water will flow away from tree trunks.

- Excavations adjacent to trees can alter local soil hydrology by draining water more rapidly from TPZs more rapidly than it would prior to site changes. It is recommended that when excavating within 6 m of any tree, the site be irrigated more frequently to account for this.

Root Zone Enhancements and Fertilization

Root zone enhancements such as mulch, and fertilizer treatments may be recommended by the project arborist during any phase of the project if they deem it necessary to maintain tree health and future survival.

Paving Within and Adjacent to TPZs

If development plans propose the construction of paved areas and/or retaining walls close to TPZs, measures should be taken to minimize impacts. Construction of these features would raise concerns for proper soil aeration, drainage, irrigation and the available soil volume for adequate root growth. The following design and construction guidelines for paving and retaining walls are recommended to minimize the long-term impacts of construction on protected trees:

- Any excavation activities near or within the TPZ should be monitored by a certified arborist. Structures should be designed, and excavation activities undertaken to remove and disturb as little of the rooting zone as possible. All roots greater than 2 cm in diameter should be hand pruned by a Certified Arborist.
- The natural grade of a TPZ should be maintained. Any retaining walls should be designed at heights that maintain the existing grade within 20 cm of its current level. If the grade is altered, it should be raised not reduced in height.
- Compaction of sub grade materials can cause trees to develop shallow rooting systems. This can contribute to long-term pavement damage as roots grow. Minimizing the compaction of subgrade materials by using structural soils or other engineered solutions and increasing the strength of the pavement reduces reliance on the sub-grade for strength.
- If it is not possible to minimize the compaction of sub-grade materials, subsurface barriers should be considered to help direct roots downward into the soil and prevent them from growing directly under the paved surfaces.

Plantings within TPZs

Any plans to landscape the ground within the TPZ should implement measures to minimize negative impacts on the above or below ground parts of a tree. Existing grass layer in TPZs should not be stripped because this will damage surface tree roots. Grass layer should be covered with mulch at the start of the project, which will gradually kill the grass while moderating soil moisture and temperatures. Topsoil should be mixed with the mulch prior to planting of shrubs, but new topsoil layer should not be greater than 20 cm deep on top of the original grade. Planting should take place within the newly placed topsoil mixture and should not disturb the original rooting zone of the trees. A two-meter radius around the base of each tree should be left unplanted and covered in mulch; a tree's root collar should remain free from any amendments that raise the surface grade.

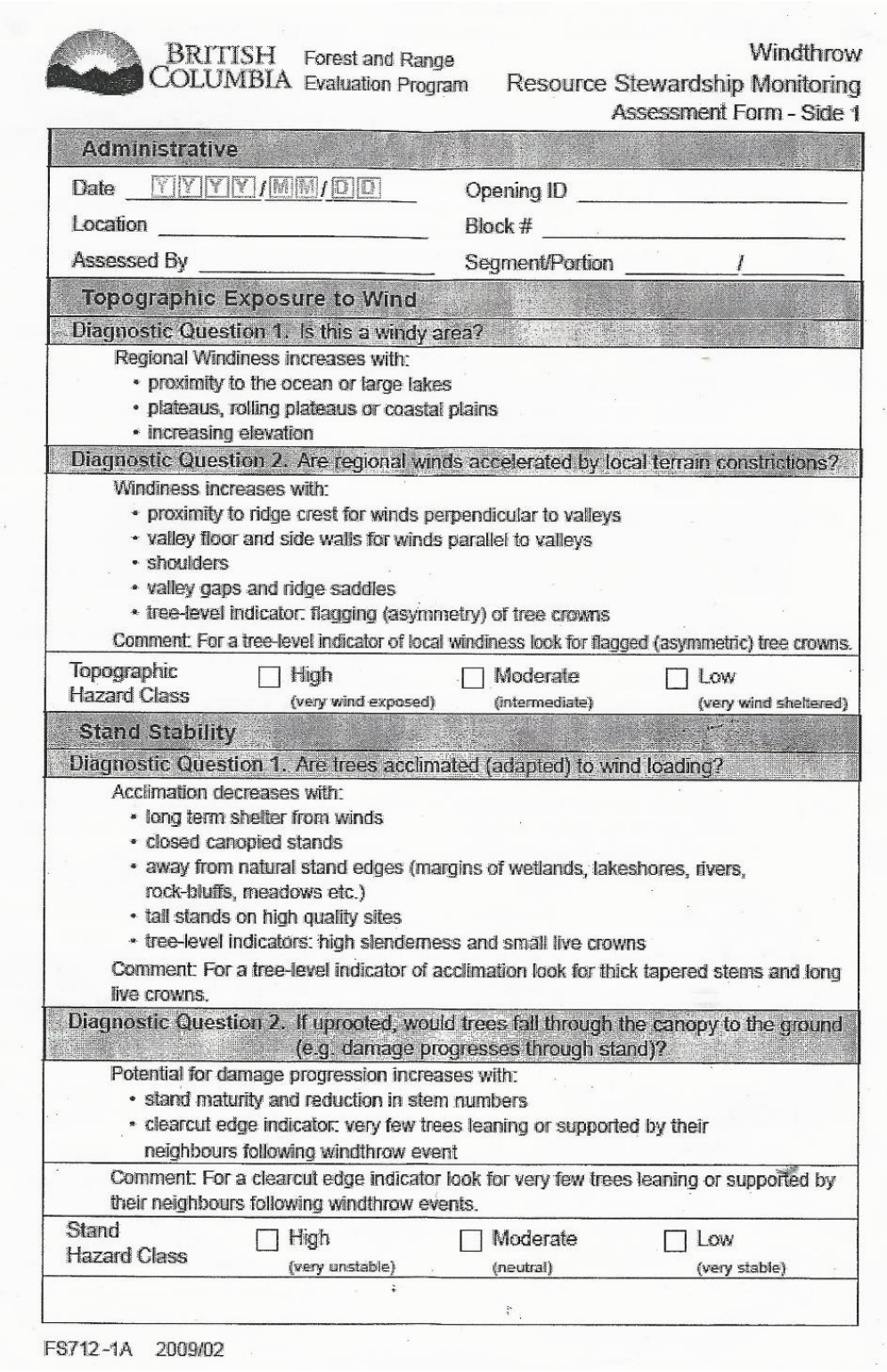
Monitoring during construction

Ongoing monitoring by a consultant arborist should occur for the duration of a development project. Site visits should be more frequent during activities that are higher risk, including the first stages of construction when excavation occurs adjacent to the trees. Site visits will ensure contractors are respecting the recommended tree protection measures and will allow the arborist to identify any new concerns that may arise.

During each site visit the following measures will be assessed and reported on by a consulting arborist:

- Health and condition of protected trees, including damage to branches, trunks and roots that may have resulted from construction activities, as will the health of. Recommendations for remediation will follow.
- Integrity of the TPZ and fencing.
- Changes to TPZ conditions including overall maintenance, parking on roots, and storing or dumping of materials within TPZ. If failures to maintain and respect the TPZ are observed, suggestions will be made to ensure tree protection measures are remediated and upheld.
- Review and confirmation of recommended tree maintenance including root pruning, irrigation, mulching and branch pruning.
- Changes to soil moisture levels and drainage patterns; and
- Factors that may be detrimentally impact the trees.

Appendix 7 Windthrow Hazard Assessment



BRITISH COLUMBIA Forest and Range Evaluation Program

Windthrow
Resource Stewardship Monitoring
Assessment Form - Side 1

Administrative

Date Y Y Y Y / M M / D D Opening ID _____

Location _____ Block # _____

Assessed By _____ Segment/Portion _____ / _____

Topographic Exposure to Wind

Diagnostic Question 1. Is this a windy area?

Regional Windiness increases with:
- proximity to the ocean or large lakes
- plateaus, rolling plateaus or coastal plains
- increasing elevation

Diagnostic Question 2. Are regional winds accelerated by local terrain constrictions?

Windiness increases with:
- proximity to ridge crest for winds perpendicular to valleys
- valley floor and side walls for winds parallel to valleys
- shoulders
- valley gaps and ridge saddles
- tree-level indicator: flagging (asymmetry) of tree crowns

Comment: For a tree-level indicator of local windiness look for flagged (asymmetric) tree crowns.

Topographic Hazard Class ☐ High (very wind exposed) ☐ Moderate (intermediate) ☐ Low (very wind sheltered)

Stand Stability

Diagnostic Question 1. Are trees acclimated (adapted) to wind loading?

Acclimation decreases with:
- long term shelter from winds
- closed canopied stands
- away from natural stand edges (margins of wetlands, lakeshores, rivers, rock-bluffs, meadows etc.)
- tall stands on high quality sites
- tree-level indicators: high slenderness and small live crowns

Comment: For a tree-level indicator of acclimation look for thick tapered stems and long live crowns.

Diagnostic Question 2. If uprooted, would trees fall through the canopy to the ground (e.g. damage progresses through stand)?

Potential for damage progression increases with:
- stand maturity and reduction in stem numbers
- clearcut edge indicator: very few trees leaning or supported by their neighbours following windthrow event

Comment: For a clearcut edge indicator look for very few trees leaning or supported by their neighbours following windthrow events.

Stand Hazard Class ☐ High (very unstable) ☐ Moderate (neutral) ☐ Low (very stable)

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BRITISH COLUMBIA Forest and Range Evaluation Program

Windthrow
Resource Stewardship Monitoring
Assessment Form - Side 2

Soil Anchorage

Diagnostic Question 1. Is root anchorage restricted by an impeding layer, low strength soil, or poor drainage?

Restricted anchorage contributes to instability:

- where local variations in drainage and soil depth restrict rooting in otherwise closed-canopied stands (e.g. in draws and gullies)
- in pockets of higher productivity but with restricted rooting (seepage over basal till or bedrock, riparian zones)
- where root systems are asymmetric along gully sidewalls or on steep slopes.

Comment: For tree-level indicator look for flattened root systems (very restricted) versus deep bowl like root systems (unrestricted).

Diagnostic Question 2. Is this a closed-canopied stand?

Comment: On low quality sites where stands are open-canopied, root-system strength compensates for restricted rooting depth.

Soil Hazard Class ☐ High (very restricted) ☐ Moderate (neutral) ☐ Low (unrestricted)

Treatment

Diagnostic Question 1. Will the proposed harvesting strategy substantially increase wind loading on trees along the stand edge or retained trees?

Post-harvest wind loading increases where:

- fetch increases (wind loading increases linearly as distance across opening increases from 0 to 5 tree lengths, with no further increases after 10 tree lengths)
- boundaries face directly toward damaging winds
- boundaries are exposed to multiple wind directions (boundary projections, small aggregates)
- narrow retained strips or small aggregates
- increasing tree removal in partial cuts

Comment: Observe the orientation of windthrown trees and which boundaries are wind damaged to identify the local direction(s) of damaging winds. It is common to have more than one damaging wind direction in a given location.

Treatment Hazard Class ☐ High (large increase) ☐ Moderate (moderate increase) ☐ Low (minimal increase) ☐ None (no susceptible timber)

Windthrow Likelihood Evaluation

Add Topographic, Stand and Soil Hazard scores to get Biophysical Hazard score, then add Treatment Hazard score to Biophysical Hazard score to get Windthrow Likelihood score. If Treatment Hazard is 'None', then Windthrow Likelihood is 'None'.

Component Scores	High	Moderate	Low	None
Topographic Hazard	3	2	1	-
Stand Hazard	3	2	1	-
Soil Hazard	2	1	0	-
Treatment Hazard	6	4	2	none

Biophysical Hazard (Topographic+ Stand+ Soil Hazard scores):	
Low	<4
Moderate	4-5
High	6-7
Very High	8

Windthrow Likelihood (Biophysical Hazard +Treatment Hazard):	
None	None
Very Low	<6
Low	6-9
Moderate	10-11
High	12-13
Very High	14

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