Squamish-Lillooet Regional District
Electoral Area C
Community Wildfire Protection Plan
2016 Update

Submitted By:
Tove Pashkowski RPF &
Bruce Blackwell RPF, RP Bio
B.A. Blackwell & Associates Ltd.
North Vancouver, BC

Submitted To:
Ryan Wainwright
Emergency Program Manager
Squamish-Lillooet Regional District
Pemberton, BC

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B.A. Blackwell
& Associates Ltd.

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EXECUTIVE SUMMARY

The Community Wildfire Protection Plan (CWPP) process was created in British Columbia (BC) as a response to the devastating 2003 wildfire in Kelowna. As an integral part of the Strategic Wildfire Prevention Initiative (SWPI), managed and funded through the Union of British Columbia Municipalities (UBCM), CWPPs aim to develop strategic recommendations to assist in improving safety and to reduce the risk of damage to property from wildfires. In 2006, a CWPP for the Squamish-Lillooet Regional District (SLRD) was completed to help guide the Regional District in wildfire risk reduction and mitigation activities.

This document intends to update the 2006 CWPP (and the companion Fuel Management Strategy[1] document), and assess the threat of wildfire within and around the developed portions of Electoral Area C (Area C). While this document is specific to Area C, many of the recommendations should be considered for their relevance and feasibility to implementation across all the Electoral Areas within the SLRD. This update examines the effectiveness of completed work, identifies opportunities for improvement within existing programs, and describes future initiatives.

Since the development of the CWPP in 2006, the SLRD has made progress in implementing recommendations; the most notable actions include implementation of the following[2]:

- Cooperation with BCWS and fuel management consultants to identify, assess, and prescribe fuel management activities on areas of hazardous fuels (Recommendations #2, #15, and #49);
- FireSmart public awareness/ education initiatives, such as delivering FireSmart material at public events (Recommendations #22 and #40);
- Funding for wildfire suppression equipment for local fire departments (Recommendation #36);
- Update website with FireSmart information, BC Wildfire Service links, and other reports and documents regarding the risks associated with wildfire (Recommendation #38); and,
- Supporting wildfire education and training initiatives for isolated communities.

Additionally, the SLRD has implemented fuel management projects within other Electoral Areas: operational fuel management projects have been completed in Electoral Areas A (Upper Bridge River Valley – Gun Lake) and B (Texas Creek, Fountain Valley, and Pavilion Lakes).[3] These projects will not be discussed further as they are outside the scope of the document.

Wildfire management requires a multi-faceted approach for greatest efficacy and risk reduction. As part of this CWPP update, a total of 36 strategic recommendations in five different categories are outlined for the SLRD's Area C. A complete enumeration is displayed in Table 1.

[1] Davies, J. and M. Coulthard. 2006. Squamish-Lillooet Regional District Fuel Management Strategy.

[2] A full enumeration of recommendations and implementation status from the 2006 CWPP can be found in APPENDIX A: STATUS OF 2006 CWPP RECOMMENDATIONS.

[3] http://www.slrd.bc.ca/services/emergency-management/hazards-slrd/natural/wildfires/wildfire-fuel-management

Table 1. Wildfire mitigation recommendations for the SLRD and Area C. Recommendations which are potentially eligible for UBCM/ SWPI funding are identified with an asterisk.

Item	Priority	Recommendation	Estimated Cost to SLRD and possible funding opportunities ($)
Communication and Education - Section 7.1			
Objective: To improve public understanding of fire risk and personal responsibility by increasing resident awareness of the wildfire threat in their community and to establish a sense of homeowner responsibility.			
1	High	• Leverage and expand social media presence (e.g., Facebook, Twitter, etc.) to communicate fire bans, high fire danger days, wildfire prevention initiatives, easily implementable FireSmart activities, and updates on current fires and associated air quality, road closures, and other real time information. Facilitate social media expansion for local Fire Departments to ensure that issues specific to their area are available to their community.	Within current operating budget
2	High	• This report and associated maps to be made publicly available through webpage, social media, and public FireSmart meetings.	Within current operating budget
3*	High	• Regular updates of the CWPP to gauge progress and update the threat assessment for changes in fuels, forest health, land planning, stand structure or changes to infrastructure in the interface. Updates should be completed every 5 - 7 years.	UBCM/ SWPI funding/ Municipal funding (SWPI funds up to 75% of update cost)
4	Moderate	• Upgrade the SLRD website to display or link real time information on fire bans and high fire danger. FireSmart information and wildfire preparedness links and information are currently readily available.	$500
5	Moderate	• Establish a school education program to engage youth in wildfire management. Consult the Association of BC Forest Professionals (ABCFP) and British Columbia Wildfire Service (BCWS) (the zone) to facilitate and recruit volunteer teachers and experts to help with curriculum development and to be delivered in elementary and/or secondary schools. Educational programming can be done in conjunction with programs on fire extinguisher training and should include local fire departments in curriculum development and presentation. Costs to be shared regionally (multiple Electoral Areas, member municipalities, and First Nations).	$2,000
6	Low	• The SLRD should continue to install fire danger rating signs in strategic locations across the study areas. Recreation sites and high-use recreational areas that are not already signed should be targeted first.	$500 - $1,000 per sign

Item	Priority	Recommendation	Estimated Cost to SLRD and possible funding opportunities ($)
Objective: To enhance the awareness of elected officials and stakeholders regarding the resources required to mitigate fire risk.			
7	High	• Establish a Wildfire Suppression Group (N'Quatqua Band, SLRD, MFLNRO, BCWS, Lil'Wat, and forest licensees) to identify wildfire related issues in the area, resource deficiencies, and to allow for a coordinated and cost-sharing approach to wildfire mitigation.	Within current operating budget
8	High	• Create and maintain a spatial database that includes CWPP spatial data for all CWPPs that have been developed on, or include threat assessments and recommendations over, SLRD jurisdiction land. This includes amalgamating spatial data from SWPI/UBCM, RMOW, Lil'Wat Nation, N'Quatqua Band, and SLRD. This database can be used in the regional wildfire mitigation planning for the Wildfire Suppression Group.	$1,500 + maintenance costs (annual or biennial updates)
Communication with Industry – Section 7.1.1			
Objective: To reduce the risk of ignition from industrial sources.			
9	High	• Work with industrial operators to ensure that right-of-ways do not contain fine fuel accumulations (easily cured) prior to the fire season and further are maintained in a low hazard state. Work with industrial operators to ensure that high risk activities, such as right of way mowing, does not occur during high or extreme fire danger times to reduce chance of ignitions. Industrial operators include CN Rail, BC Hydro, licensees, and independent power producers.	Within current operating budget
10	High	• Work with BC Hydro to ensure that hazard trees along distribution lines are assessed regularly. Work with BC Hydro to ensure that transmission line right-of-ways are maintained in a moderate hazard state and dead, fine fuel accumulations do not occur.	Within current operating budget
Structure Protection and Planning – Section 7.2			
Objective: Improve the FireSmart conditions of Area C by increasing FireSmart compliance for critical infrastructure, improving suppression abilities for interface areas, and increasing FireSmart compliance on private property.			
11*	High	• For each study area, facilitate their recognition as a FireSmart community. Recruit champions within each study area/ community to implement local projects. Champions should be trained in FireSmart, have educational materials available to them, and be supported by the Regional District and local fire departments to complete fire hazard mitigation projects.	$2,500 UBCM/SWPI FireSmart funding available
12	High	• Review and monitor critical infrastructure, including stand pipes, for FireSmart compliance regularly. Remove vegetation which may be impeding access or impacting fire hazard.	~$1,000

Item	Priority	Recommendation	Estimated Cost to SLRD and possible funding opportunities ($)
13	Moderate	• Identify and map available water sources (must have adequate supply for suppression purposes during the fire season and be accessible to suppression crews). Identify areas of poor water availability. Enhance the currently existing waterways geospatial database with water availability and accessibility attributes, specific for suppression use.	$1,000
Structure Protection and Planning (WUI Site and Structure Assessments) – Section 7.2.1			
Objective: Encourage private homeowners to voluntarily adopt FireSmart principles on their properties.			
14*	High	• Complete WUI Site and Structure Hazard Assessments for interface homes, make hazard mapping for assessed homes publicly available, and provide informational material to homeowners on specific steps that they can take to reduce fire hazard on their property.	$10 -$12/ home UBCM/SWPI FireSmart funding available
15*	Moderate	• Remove barriers for landowners by providing methods for them to cheaply and easily dispose of the wood and green waste removed from their property. Programs may include scheduled community chipping opportunities, free green/ wood waste drop-off, or scheduled burning weekends. Information on how to obtain burning permits could be made available.	Cost dependent upon program UBCM/SWPI FireSmart funding may be available (depending on program)
Emergency Response and Preparedness – Section 7.3			
Objective: To improve structural and wildfire equipment and training available to SLRD local Fire Departments.			
16	High	• The SLRD to organize and facilitate annual cross training opportunities with MFLNRO BCWS, the Birken Fire Department, and key members of each study area. As part of the training, it is recommended to conduct annual reviews to check that PPE and wildland equipment resources for Fire Department are complete, and that the crews are well versed in their set-up and use. Interface training could include completion of a mock wildfire simulation in coordination with BCWS, instruction on early detection and reporting of wildfires. Community members could educate BCWS on their water systems and suppression capabilities and equipment. It is recognized that BCWS crew resources are limited and their availability and is highly dependent upon the current fire season and other BCWS priorities. Coordination with adjacent communities and First Nations for cross-training opportunities would benefit the entire region.	$2,000 - $4,000 (annually)
17	High	• The SLRD to provide reflective house numbers and instructions about how and where best to affix them to facilitate emergency response. Research possible funding opportunities to offset costs.	$3,000
18	High	• Work with the fire departments to inventory equipment, identify gaps, and source replacements and/or new equipment, as needed. Ensure that wildland-specific equipment, water delivery, and equipment required to access natural water sources, are included in the assessment.	Within Current Operating Budget

Item	Priority	Recommendation	Estimated Cost to SLRD and possible funding opportunities ($)
19	Moderate	• Review UBCM-owned SPU request procedure. Complete training with SPU and assess sprinkler needs based on training outcomes.	Within Current Operating Budget
20	Moderate	• Working with community groups, consider the purchase of basic structural protection sprinkler system and trailer to provide interface protection. The system should be sufficient to provide protection to 15 – 20 rurally spaced houses/ structures. The trailer and system could be deployed to high fire danger areas or areas with impending wildfire. Local fire departments should be trained on their use.	Pre-assembled kits are approximately $3000 per 4 houses. Custom kits could be assembled for considerably less.
Emergency Response and Preparedness (Evacuation and Access) – Section 7.3.1			
Objective: To improve access and egress and enhance emergency preparedness and study area-specific evacuation plans.			
21	High	• The SLRD should consider development of study-area specific evacuation plans in coordination with the RCMP to: map and identify safe zones, marshaling points and alternative (aerial and water) evacuation locations; plan traffic control and accident management; identify volunteers that can assist during and/or after evacuation; and create an education/ communication strategy to deliver information. Communication plans may require alternative strategies for areas with limited or unavailable cellular service.	TBD
Emergency Response and Preparedness (Trail Management and Access) – Section 7.3.1.1			
Objective: To improve access to interface natural areas and reduce chance of ignition and potential fire behaviour along high-use recreational trails.			
22	Moderate	• Establish trail standards that will ensure that trails act as surface fuelbreaks and provide access for suppression crews. To act as a surface fuel break, provide access for equipment and crews, and serve as a control line, trails should be 1 m wide, pruned to a minimum of 2 m in height (slope dependent), and thinned within a minimum of 5 m of trail center. Trails can be prioritized for their potential as fuelbreaks, depending on location and current state (width, adjacent fuels, and accessibility).	Dependent upon trails prioritized
23	Moderate	• Develop standards for the abatement of residual activity fuels associated with trail building and trail maintenance. Trail crews should be educated on mitigation of fuels accumulations resulting from their regular maintenance activity. Standards should include fuel disposal or mitigation methods (scattering, chipping, burning, or removal, dependent upon location, amount of material, and access). Fuels from trail maintenance and trail building should not be allowed to accumulate trailside.	Within Current Operating Budget
24	Moderate	• Develop a Total Access Plan to map and inventory trail and road network for suppression planning, identification of areas with insufficient access and to aid in strategic planning. The plan should be updated every five years, or more regularly, as needed to incorporate additions or changes.	$5,000 - $10,000

Item	Priority	Recommendation	Estimated Cost to SLRD and possible funding opportunities ($)
Planning and Development – Section 7.4			
Objective: To reduce wildfire hazard on private land, increase number of homes in FireSmart compliance, and decrease risk of human-caused ignitions.			
25	High	• Review and amend Bylaw No. 1110, 2008 to explicitly include items regarding hazardous accumulations of combustible materials, forest fire prevention regulations, and fireworks restrictions.	TBD
26	High	• Ensure that Bylaw No. 1110, 2008 campfire and BBQ bans are applied and enforced consistent with campfire bans issued by the BCWS for the appropriate fire zone.	TBD
27	Moderate	• Consider amending OCP to include Wildfire Hazard Development Permit Areas within which building standards and fuel mitigation activities can be enforced (rated roofing requirements, minimum setbacks from forested edge and top of slope, rated exterior building materials, and fuel management activities such as thinning, brushing, or pruning).	Within Current Operating Budget – In Process
28	Low	• Develop a comprehensive list of native (and non-native), low-flammability, climatically suited (low maintenance) trees, shrubs, and herbs which are appropriate to plant within 10 m of structures. This list should be distributed to individual home builders, developers, and the general public as part of a FireSmart initiative.	$500
Planning and Development (Subdivision design) – Section 7.4.1.1			
Objective: To incorporate wildfire hazard reduction considerations in subdivision design.			
29	High (with approval of new subdivisions)	• New subdivisions should be developed with access points that are suitable for evacuation and the movement of emergency response equipment. The number of access points and their capacity should be determined during subdivision design and be based on threshold densities of houses and vehicles within the subdivision.	Within current operating budget
30	High (with approval of new subdivisions)	• Where forested lands border new subdivisions, consideration should be given to requiring roadways to be placed adjacent to those lands. If forested lands surround the subdivision, ring roads should be part of the subdivision design. These roads both improve access to the interface for emergency vehicles and provide a fuel break between the wildland and the subdivision.	Within current operating budget
31	High (with approval of new subdivisions)	• Proximity of hydrant locations to access points for forested parks should be a consideration during the design process for new subdivisions.	Within current operating budget
32	Moderate (with approval of new subdivisions)	• Consider establishing or enhancing existing water bodies that could serve as emergency water sources in areas of new development.	TBD

Item	Priority	Recommendation	Estimated Cost to SLRD and possible funding opportunities ($)
Fuel Management – Section 7.5			
Objective: Reduce wildfire threat on private and public lands through fuel management.			
33*	High	• Apply for UBCM/SWPI funding to implement operational fuel management projects for shovel ready projects identified in Section 7.5.1.2.	UBCM SWPI Funding / Municipal Funding (up to 90% of project cost)
34*	High	• Proceed with detailed assessment, prescription development and treatment of hazardous fuel units identified in this CWPP. Collaboration with BCTS, woodlot owners, and other licensees may facilitate larger projects.	UBCM SWPI Funding / Municipal Funding (up to 75% of prescription development cost)
Objective: Maintain previously treated areas under an acceptable level of wildfire fire threat (moderate).			
35*	N/A (7 – 10 years after treatment)	• Complete monitoring and maintenance, as necessary, on previously treated areas. Treated areas should be assessed by a Registered Professional Forester, specific to actions required in order to maintain treated areas in a moderate or lower hazard. **NB: This recommendation does not apply currently, but will likely be relevant within the potential shelf-life of this document (7 – 10 years post-treatment).**	UBCM SWPI Funding/ Municipal Funding
Objective: Reduce the wildfire threat to Area C and neighbouring jurisdictions with a cooperative regional approach.			
36	High	• Submit phase 1 application for FES funding for those landscape level fuelbreaks identified as high priority, particularly focusing on those areas which also help to maintain or improve safe evacuation routes for SLRD residents. Consultation with neighbouring local and First Nations governments, BCWS, and MFLRNO should be started prior to submitting application to ensure cooperative approach.	FESBC funding

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INTRODUCTION

The Community Wildfire Protection Plan (CWPP) process was created in British Columbia (BC) to aid communities in developing plans to assist in improving safety and reducing the risk of damage to property. The Program was developed in response to recommendations from the "Firestorm 2003 Provincial Review"[4].

The 2003, 2004, 2009, 2010, and 2015 BC wildfire seasons resulted in substantial economic, social and environmental losses. Devastating wildfires south of the border in the 2014 and 2015 wildfire seasons (Pateros and Wenatchee, WA) served additional notice of the risk and vulnerabilities of communities in the wildland urban interface (WUI). Within Canada, tragedies like those experienced in Slave Lake and Fort McMurray, Alberta are further evidence of the potential toll of wildfires on the community and economy of entire municipalities. These losses emphasized the need for greater consideration and due diligence with respect to fire risk in the WUI.

The 2015 wildfire season highlighted the impacts of wildfire on Electoral Area C (Area C): the Boulder Creek Fire burned over 6,500 ha and resulted in evacuation orders, the Elaho fire burned 67 km west of Pemberton and consumed over 12,500 ha[5]. The Pemberton valley was blanketed by smoke for several weeks from nearby fires. The smoke hindered aerial suppression efforts and air quality advisories were issued across the region; residents were advised to refrain from outdoor activity.[6]

In considering the wildfire risk in the WUI, it is important to understand the unique risk profile of a given community. While there are common themes that contribute to the risk profile of communities across BC, each community has unique aspects that require consideration during the CWPP process. Understanding these factors is important in developing a comprehensive plan to identify and reduce wildfire risk for that area. The consequences of a WUI fire can be very significant and proper consideration and pre-planning is vital to reducing the impacts of wildfire.

In 2016, B.A. Blackwell and Associates Ltd. were retained by the Squamish-Lillooet Regional District (SLRD) to complete an update of the CWPP. The original CWPP for Electoral Areas C and D (hereinafter referred to as the '2006 CWPP') was completed by Diamondhead Consulting Ltd, Valhalla Consulting Ltd, and Geographica Group in 2006. This update is specific to Area C, although there will be considerable overlap in content with the CWPP Update for Electoral Area D. A complete enumeration of the recommendations from the 2006 CWPP and status of implementation specific to Area C is found in APPENDIX A: STATUS OF 2006 CWPP RECOMMENDATIONS.

Since 2006, methods for assessing wildfire threat have been modernized; this update will make use of the methodology and baseline data that is the current provincially accepted standard for hazard and threat analysis.

[4] http://bcwildfire.ca/History/ReportsandReviews/2003/FirestormReport.pdf

[5] http://www2.gov.bc.ca/gov/content/safety/wildfire-status/wildfire-statistics/wildfire-season-summary

[6] Sieniuc, K. "Whistler, B.C. issues air-quality warning due to wildfire smoke." *The Globe and Mail*. July 7, 2015. Web http://www.theglobeandmail.com/news/national/whistler-bc-issues-air-quality-warning-due-to-wildfire-smoke/article25348519/.

This CWPP update provides a reassessment of the level of risk with respect to changes in the area that have occurred since 2006 and gives the SLRD a current and accurate description of the threat facing their constituent communities.

Specifically, the objectives of this update are to:

- Provide the SLRD with an updated threat assessment taking into account new development, changes in forest health and fuels, and mitigating actions taken by the Regional District; and
- Prioritize mitigating action recommendations to address communication and education, structure protection, emergency response, planning and development, and fuel management.

This CWPP update will provide the SLRD with a framework that can be used to identify methods and guide future actions to mitigate fire risk in the community. The scope of this project included three distinct phases:

I. Assessment of fire threat to the Area C to spatially identify those areas of the Electoral Area most vulnerable or at highest risk of wildfire;

II. Consultation with representatives from SLRD's Fire Departments, Ministry of Forests, Lands and Natural Resource Operations (MFLNRO), BC Wildfire Service (BCWS), and Union of British Columbia Municipalities (UBCM) to assist with defining the objectives for wildfire protection, and to develop the mitigation strategy alternatives that would best meet the SLRD's needs.

III. Development of the Plan which outlines measures to mitigate the identified risk through communication and education programs, structure protection, emergency response and management of forestlands adjacent to the community.

To assess Area C's threat, the 2015 Provincial Strategic Threat Analysis (PSTA) was used in addition to completion of Wildland Urban Interface (WUI) Wildfire Threat Assessment Worksheets (as required by the UBCM).

1.0 COMMUNITY WILDFIRE PROTECTION PLANNING PROCESS

This CWPP document will review the background information related to the study area, which includes those areas within Area C that meet the density threshold of 6 structures per square kilometer and a 2 km spotting buffer. The CWPP update consists of six general phases:

1. **Background research** - general community characteristics, such as demographic and economic profiles, critical infrastructure, environmental and cultural values, fire weather, fire history, relevant legislation and land jurisdiction.
2. **Field work** - site visits to the area to allow for 1) meetings with SLRD staff; 2) fuel type verification; 3) completing WUI hazard assessment forms, and 4) identification of site specific issues.
3. **Consultation** – meetings and consultation with the Sea to Sky Natural Resource District staff (land manager) and Fire Zone representatives.

4. **GIS analyses** – final fuel type updating and threat rating based upon field ground-truthing and the results of hazard assessment forms.
5. **Report and map development** - identification of Area C and SLRD challenges and successes, identification of measures to mitigate risks, and recommendations for action.
6. **Report review** - by SLRD staff and representatives from the Sea to Sky District, and the BCWS. The report was also sent to the following nations for an opportunity to review and input on the contents: St'at'imc Chiefs Council, Lillooet Tribal Council, N'Quatqua First Nation, Tsal'alh (Seton Lake Indian Band), Tit'q'et First Nation, Lil'wat Nation Mount Currie Band, Skatin Nation, Samahquam First Nation, In-SHUCK-ch Nation, and the Lower St'at'imc Tribal Council.

Reducing the level of wildfire risk to Area C is the main focus of the CWPP. The Action Plan (Section 7.0) specifically addresses the five elements of a CWPP that contribute to risk reduction. The five elements are: 1) communication and education; 2) structure protection and planning; 3) emergency response and preparedness; 4) planning and development; and 5) fuel management. This document makes specific recommendations (planning tools) on how risk can be reduced by making changes to these five elements.

2.0 ELECTORAL AREA C – PEMBERTON VALLEY/ MOUNT CURRIE-D'ARCY CORRIDOR

The SLRD's Area C, also known as the Pemberton Valley/Mount Currie – D'arcy Corridor is best characterized by numerous rivers and lakes, productive agricultural lands, and steep mountains rising from the valley bottoms. The population of the Electoral Area is approximately 1,800 (~3,500, including First Nations communities) and 761 private dwellings (2011 Census). The key industries in the area are agriculture, tourism, and forestry. Incorporated or independent jurisdictions within Area C include the Village of Pemberton, Mount Currie (Lil'Wat First Nation and reserves), and N'Quatqua Band reserves near the south shores of Anderson Lake.

There are many bodies of water associated with Area C. Lillooet, Gates, and Birkenhead Lakes are the main large freshwater lakes; the Lillooet, Green, and Birkenhead Rivers are the major rivers.

Area C is a total of 5,570 square kilometers, though much of this area is undeveloped. The study area for this report was refined to those areas within Area C that meet the minimum WUI threshold density (6 structures/ km^2) and a 2 km spotting buffer around those areas. Those areas which fall under other jurisdictions, or which are covered in another jurisdiction's CWPP, were removed from the study area (e.g. Village of Pemberton, Mount Currie/ Lil'Wat, D'Arcy/ N'Quatqua) and are not within the scope of this report, although the threat assessment and recommendations contained within those documents are relevant to the SLRD. The threat assessments and recommended fuel treatment areas for the omitted areas mentioned above are available in the publicly available CWPP documents through the respective governments/ jurisdictions. The process of refinement resulted in eight discrete study areas:

1. Birken/ Gramsons/ Gates
2. Birkenhead Lake EstateS
3. Birkenhead Lake North/ Blackwater

4. Lillooet Lake Estates
5. Lizzie Bay
6. Pemberton Meadows/ Pemberton surroundings
7. Ponderosa
8. Wedgewoods

An overview of the SLRD's Area C study areas are illustrated below (Figure 1).

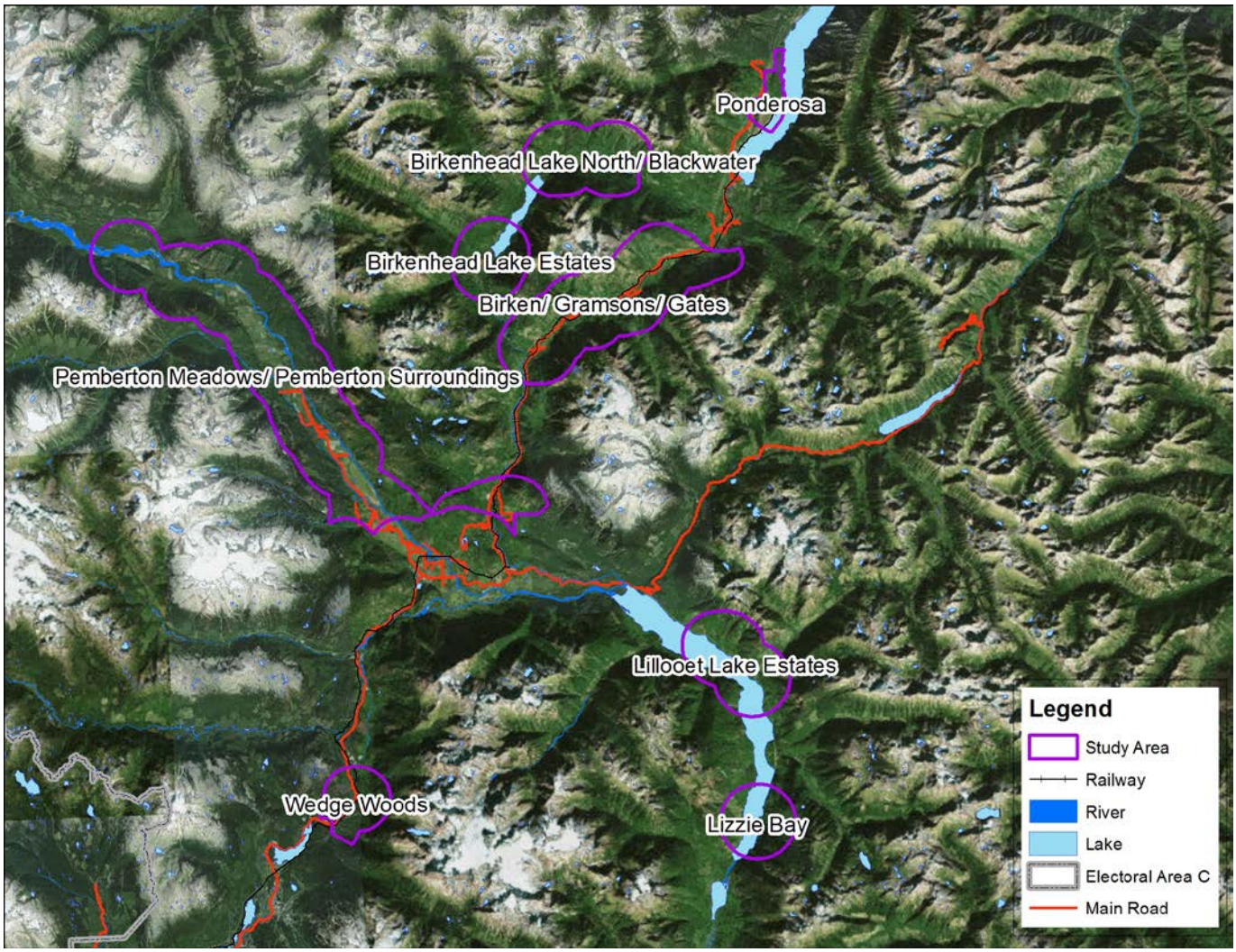


Figure 1. Overview of the CWPP Update study area for the SLRD's Area C.

2.1 CRITICAL INFRASTRUCTURE

Protection of infrastructure during a wildfire event is important to ensure that emergency response is as effective as possible, coordinated evacuation can occur if necessary, and essential services in the study area can be maintained or restored quickly. Critical infrastructure includes emergency and medical services, water, electrical service, transportation, and communications infrastructure. Critical infrastructure locations are illustrated below (Figure 2). Schools and government offices may serve as critical infrastructure, but were only included as critical infrastructure in those locations where local Fire Officials indicated their importance to the functioning of the community, particularly in times of emergency.

The main critical infrastructure in Area C is the Birken Fire Hall, the BC Hydro transmission lines and associated infrastructure, Forest Service Roads (FSRs) maintained by FLNRO as the sole access points to four communities (Birkenhead Lake Estates, Birkenhead Lake North/ Blackwater, Lillooet Lake Estates, and Lizzie Bay), and the railway.

Electrical service for most of the study areas population is received through a network of wood pole distribution lines. These lines are vulnerable to fire and could contribute to a service disruption in a wildfire event. Some portions of the study area are off the grid and are self-reliant through use of a combination of generators, batteries and/or solar panels.

The residents of Area C are largely dependent upon critical infrastructure in Pemberton in the event of emergencies. This infrastructure is outside the study areas of this document. Pemberton infrastructure that services the entire valley includes: Pemberton Health Centre, Pemberton RCMP detachment, Pemberton water infrastructure, and the BCWS Pemberton Zone Base and associated regional airport/ heliport. There are no ambulance or RCMP detachments within the study areas of this document.

Private water supplies and water infrastructure within the study areas, when noted during field visits have also been identified as critical infrastructure. Although the SLRD is not responsible for the maintenance or protection of this infrastructure, the water supply systems are critical to the function of the communities that they serve, and therefore are duly noted as critical infrastructure.

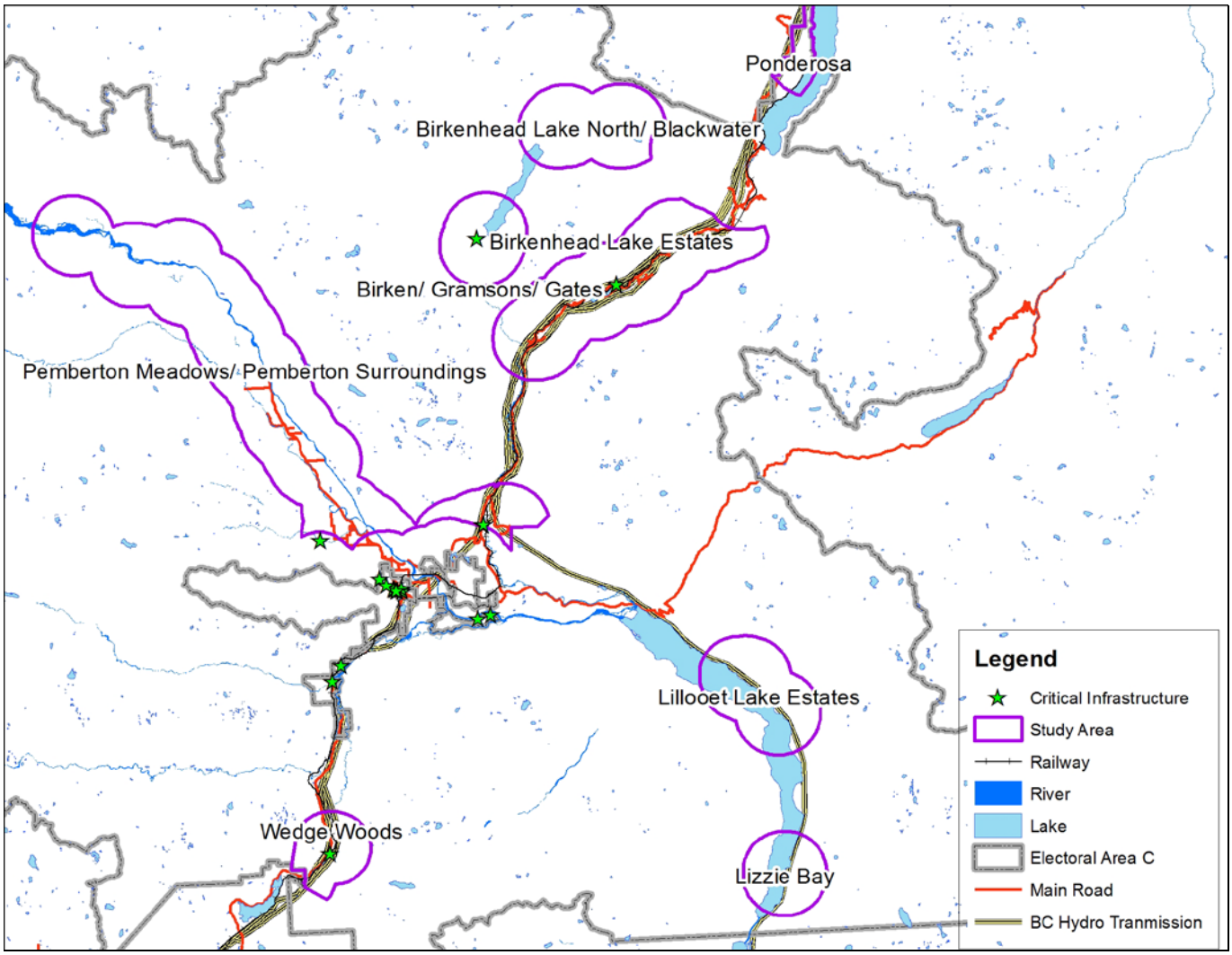


Figure 2. Map of critical infrastructure in and around the study areas of Area C.

2.2 WATER

Pemberton Meadows is supplied water through a bulk water purchasing agreement with the Village of Pemberton. This system is owned, operated and maintained by the Village of Pemberton. The SLRD retains one surface water license on Pemberton Creek, but there is no intake. Pemberton Meadows road is not hydranted, although natural and private water sources are plentiful.

Birkenhead Lake Estates owns and operates their water system. It is a propane generator-pumped, well-sourced system which gravity feeds to each lot. Birkenhead Lake Estates is off the grid and self-reliant for power. Birkenhead Lake Estates has standpipes and the water tower has 1 – 2 hours water supply when used for suppression.

The Lillooet Lake Estates are serviced through surface water systems, which the residents maintain, and a system of standpipes. Water pressure has not been a limiting factor during suppression efforts.

Ponderosa residents have three separate water systems to supply the three housing clusters. Additionally, the community has installed a separate system from their domestic water systems, which is used solely for irrigation and suppression. Small tanks of water are strategically placed throughout the community during the fire season (Figure 3).

Figure 3. Portable water tanks strategically placed around the Ponderosa community.

The remaining residents in Pemberton Surroundings, and the study areas of Birken/ Gramsons/ Gates, Birkenhead Lake North/ Blackwater, and Lizzie Bay have points of diversions and surface water intakes or private wells for their domestic water supply. Water for suppression would require drawing from a natural water source or shuttled water (portable tanks, water tenders, etc.).

Area C is comprised of many, small and geographically scattered rural areas operating on a variety of water systems, both domestic and for suppression. In many areas, fire suppression would rely upon, or be greatly enhanced, by the availability of natural water sources, as well as the capability to utilize natural sources. Alternative water sources for suppression activities, such as helicopter bucketing and pump sites, are of great importance, particularly in rural settings or where hydrant coverage is limited or unavailable. The SLRD should continue work on identifying and mapping alternative water sources within the study areas.

Furthermore, it is recommended that all SLRD Fire Departments are aware of the available water sources and are equipped to take advantage of alternate water sources. In areas where the Pemberton Fire Rescue provides first response, the SLRD should work cooperatively with Fire Rescue to provide them spatial water availability information for suppression needs. Shuttled water also aids in suppression efforts, though many values at risk are too far from hydrants or standpipes to rely upon shuttled water as the only water source. Detailed information regarding these recommendations is found in the Action Plan, Section 7.2.

2.3 ENVIRONMENTAL & CULTURAL VALUES

Environmental, cultural and recreational values are high throughout the study area. The area offers a range of outdoor activities for both tourists and residents, including motorized and non-motorized front and backcountry activities. Cultural values within or overlapping the study area include Lil'Wat, In-SHUCK-ch, and N'Quatqua First Nation traditional lands which comprise fish bearing habitat, hunting grounds, archaeological sites, and sites of cultural significance.

Other values within the study area include Crown and private forest lands, and land that is administered by the Provincial Agricultural Land Commission (ALC), where the ALC is responsible for the administration of the *Agricultural Land Commission Act*. This land is part of the Agricultural Land Reserve (ALR). Subdivision and land use within the ALR is regulated by the ALC and the priority use of this land is for agriculture.[7] The ALR lands, which include farmed, forested or vacant lands, are valuable to the community and the Province. A significant wildfire would result in an impact on various values at risk throughout the study area, including valuable forest and farmland.

2.3.1 ENVIRONMENTAL VALUES

The Conservation Data Centre (CDC), which is part of the Environmental Stewardship Division in the Ministry of Environment, is the repository for information related to plants, animals and ecosystems at risk in BC. To identify species and ecosystems at risk within the study area the CDC database was referenced. The CDC keeps two classes of data: non-sensitive occurrences for which all information is available (species or ecosystems at risk and location); or masked sensitive occurrences where only generalized location information is available.

Spatially explicit ministerial orders regarding the establishment and management of Old-Growth Management Areas (OGMAs) are based upon Landscape Unit within the Sea to Sky Resource District (see section 4.2.1 for more information). There are legally established wildlife reserve areas, such as designated Wildlife Habitat Areas (WHAs) within which special management practices may be specified (spotted owl, for example). Where proposed fuel treatment areas overlap these legally protected wildlife or old-growth areas, inquiries should be made to the Sea to Sky Natural Resource District to assess the suitability of the area for treatment and to ensure that if treatment does occur, potential impacts are recognized and mitigated.[8]

Within the study areas there are 3 occurrences of red-listed species and 3 occurrences of blue-listed species. Site level operational plans must determine, through consultation with the CDC and biologist or qualified professionals, if these occurrences (masked or publicly available) will be impacted by fuel management or other wildfire mitigation activities. All future fuel treatment activities or those associated with recommendations made in this plan should consider the presence of, and impact upon, potentially affected species. Additionally, all site level operational plans should consult the most recent data available to ensure that any new occurrences or relevant masked occurrences are known and considered in the operational plan to mitigate any potential impacts

[7] http://www.alc.gov.bc.ca/index.htm

[8] Personal communication, Frank DeGagne, January 31, 2017.

on species at risk. A detailed table of all publicly available occurrences within the study area is found in APPENDIX B: SPECIES AT RISK WITHIN STUDY AREA.

2.3.2 ARCHAEOLOGICAL VALUES

Archaeological sites in BC are protected by the *Heritage Conservation Act* (HCA), which applies on both private and public lands. Archaeological remains in the Province of British Columbia are protected from disturbance, intentional and inadvertent, by the HCA. Archaeological sites that pre-date 1846 are automatically protected under the HCA whether on public or private land. Sites that are of an unknown age that have a likely probability of dating prior to 1846 (e.g. lithic scatters) as well as Aboriginal pictographs, petroglyphs, and burials (which are likely not as old but are still considered to have historical or archaeological value) are also automatically protected. Under the HCA, protected sites may not be damaged, altered or moved in any way without a permit. It is a Best Practice that cultural heritage resources such as culturally modified tree (CMT) sites be inventoried and considered in both operational and strategic planning.

There are hundreds of identified archaeological sites within the study areas. Additionally, there are sites of spiritual or cultural significance within the First Nations traditional territory with which the SLRD Area C overlaps. Due to site sensitivity, the locations of archaeological sites may not be made publicly available. The SLRD should apply for direct access to Remote Access to Archaeological Data (RAAD) to look up or track any archeological sites in the area.[9]

A number of cultural sites have been legally established through negotiated land use planning agreements and are protected through ministerial order.[10] These sites have varying levels of legal protection measures which impact potential land and resource use. Fuel treatments may be acceptable in these areas, although prescribing foresters must be aware of their existence, as well as the importance of First Nations consultation prior to any activity.

Prior to stand modification for fire hazard reduction, and depending on treatment location, preliminary reconnaissance surveys may be undertaken to ensure that cultural heritage features are not inadvertently damaged or destroyed. Pile burning and the use of machinery have the potential to damage artifacts that may be buried in the upper soil horizons. Above ground archeological resources may include features such as CMTs, which could be damaged or accidentally harvested during fire hazard reduction activities.

This plan was shared with nine First Nations groups with interest and rights which overlap, in part or entirely, the study areas. After consultation with the St'at'imc Tribal Council and the Lil'wat Nation, the following input was provided which should be duly noted:

- There is high potential that those areas identified as potential treatment areas in this strategy (see Section 7.5) were utilized by St'at'imc and Lil'wat ancestors.
- All fuel management prescription and operational projects should include consultation at an early stage and in a proactive manner to allow for informed decision-making and opportunity for meaningful and

[9] https://www.for.gov.bc.ca/archaeology/accessing_archaeological_data/obtaining_access.htm

[10] https://www.for.gov.bc.ca/tasb/slrp/pdf/lrmp/199237-MO-signed.pdf and https://www.for.gov.bc.ca/tasb/slrp/pdf/lrmp/175990%20S2S%20LRMP-Schedule%201.pdf.

thorough review and input. Referrals of specific geographic areas at the site-level prescription development phase will also allow for First Nations to determine if archaeological work is required.

- Prescriptions and operational fuel treatments should manage for, and mitigate impacts to, First Nations interests (cultural, heritage, economic, and environmental).
- Prescriptions and operational fuel treatments should manage for wildlife habitat in order to enhance habitat or mitigate potential impacts.

2.4 COMMUNITY SUPPORT

Community awareness of wildfire risk and support for vegetation management is varied across Area C. Some community members and neighbourhoods are very aware of the risk of wildfire to their communities and are actively engaged in community initiatives, as well as private projects to mitigate the risk to their home and property. Communities taking notable action are: Ponderosa, Birkenhead Lake Estates, and Lillooet Lake Estates. Other areas show a range of interest in FireSmarting and reducing their wildfire risk. Reasons for lack of action may include a feeling that the SLRD or the province (BCWS) will provide adequate protection, a feeling of helplessness at the magnitude of the risk, lack of knowledge or awareness about the risk that exists, or the desire to live in an 'unaltered' forest state.

The SLRD has been active in some aspects of wildfire risk reduction, such as providing funding for volunteer fire departments to purchase wildland equipment, completing detailed assessments and fuel management prescriptions on hazardous land, and implementing FireSmart initiatives and programming. The SLRD is supportive of fuel treatments and is looking for opportunities to partner with neighbouring jurisdictions and governments to implement projects and gain access to a variety of funding opportunities.

2.5 KEY CONTACT, PARTNERSHIP AND FUNDING OPPORTUNITIES

A list is provided below to guide future activities regarding fire and fuels management. This should not be considered an exhaustive list, and investigations should be made at the time of project development to confirm contacts and programs.

- **Provincial Government**
    - Union of British Columbia Municipalities (UBCM) – funding opportunities through the Strategic Wildfire Prevention Initiative (SWPI) program. These funding opportunities are limited to areas within 2 km of communities meeting the threshold density.
    - Forest Enhancement Society of BC (FESBC) – funding opportunities for wildfire risk reduction and FireSmart activities that are not eligible under the UBCM funding structure may be available through the Forest Enhancement Program (FEP).
    - Sea to Sky Natural Resource District – Ministry of Forests, Lands, and Natural Resource Operations (MFLNRO)
        - BC Wildfire Service (BCWS) – support is already established with the zone. This relationship will be integral for any future prescribed burning and fuel management.

Additionally, the BCWS is an excellent resource for FireSmart education and cross training opportunities, as their time allows.

- Landscape level fire management planning at the District level (the Sea to Sky Fire Management Plan) has the potential to impact activities undertaken by the SLRD, adjacent jurisdictions, and funding opportunities, particularly for landscape level fuelbreaks which would benefit the region.
- Recreation Sites and Trails Branch – potential relationship for fuel treatments along registered trails and recreation sites.

o BC Parks – Provincial parks within the study area pose wildfire threat to neighbouring communities, such as Birkenhead Lake Estates and Blackwater.

- **BC Hydro** – right of way clearing and fuel hazard should be discussed in future contract work between the SLRD and BC Hydro. BC Hydro should be encouraged to maintain its rights of way in a low hazard state (frequent brushing, with brushed material removed prior to curing). When maintained in a low hazard state, the right of ways can act as a fuel break. There are multiple transmission right of ways crossing the study areas which could serve as fuelbreaks.

- **Licensees** – Aspen Planers, British Columbia Timber Sales (BCTS), Lil'wat Forestry Ventures, Pebble Creek Timber Limited, Creekside Resources, and others – there may exist an opportunity for partnerships in commercial harvest of hazardous areas that may not qualify under the SWPI program (i.e., too far from infrastructure, but which may still pose a spotting risk to the community or could be leveraged into a landscape level fuel break). Additionally, the SLRD can work with all licensees to ensure that operations within or near to study areas are complying with fire hazard abatement and assessment requirements.

- **Member and adjacent municipalities and governments** – Village of Pemberton, Resort Municipality of Whistler, Lil'wat Nation, N'Quatqua Band, In-SHUCK-ch First Nation – a regional approach to wildfire management has been successful in other areas. There may be an opportunity to create a regional steering committee to help guide and implement strategic wildfire initiatives.

- **Industrial Operators** – CN Rail and independent power producers (along with the aforementioned BC Hydro and licensees) may have infrastructure and right of ways which should be maintained in a low hazard state (free of cured fine-fuel accumulations). Communication with industrial operators may help to maintain right-of-ways and other infrastructure in a low hazard state, as well as minimizing potential ignitions.

2.6 FOREST FUEL AND PAST WILDFIRE INFORMATION

2.6.1 BIOGEOCLIMATIC UNITS

The Biogeoclimatic Ecosystem Classification (BEC) system describes zones by vegetation, soils, and climate. Regional subzones are derived from relative precipitation and temperature. The following section is synthesized from information found on MFLRNO's Research Branch BECWeb.[11]

The study areas are scattered across the coast/ interior transition zone, as they are located on the leeward side of the Coast Mountains. This is demonstrated by the majority of the areas being either within the Coastal Western Hemlock Dry Submaritime zone (CWHds 1), Coastal Western Hemlock Moist Submaritime (CWHms1), or the Interior Douglas Fir Wet Warm (IDFww) (Figure 4).

The majority of the Study Area is characterized by three main subzones:
The IDFww is distributed in low elevation drainages in the easternmost portions of the Vancouver Forest Region. The climate in this zone is continental that is transitional to maritime due to the proximity to the Pacific Ocean. It is common to have pronounced growing season water deficits.

The CWHds1 occurs at elevations above the IDFww: from the valley bottom to an approximate elevation of 650 m. Similarly, this zone is transitional from coast to interior, and also has significant growing season water deficits

The CWH ms1 occurs at elevations above the CWHds to an elevation of 1,200 m. This zone has a transitional climate between that of the coast and the interior, and has cool and dry summers.[12] This subzone is mostly limited to the upper-most elevations of the study areas in the Pemberton and Lillooet River Valleys and the majority of the Wedgewoods study area.

Other subzones which cover smaller proportions of the study area at higher elevations include the Engelmann Spruce Subalpine Fir Moist Warm (ESSFmw) and the Mountain Hemlock Leeward Moist Maritime zone (MHmm2).

It should be noted that there are new terrestrial ecosystem mapping (TEM)-based BEC available for the study area which may have relevance for the site-level planning and in support of more detailed field work completed at the fuel management prescription development phase. This data can be sourced from the Sea to Sky Natural Resource District.

[11] https://www.for.gov.bc.ca/HRE/becweb/resources/classificationreports/subzones/index.html

[12] Green, R. N. & Klinka, K., 1994. *A Field Guide to Site Identification and Interpretation for the Vancouver Forest Region*, Victoria: Province of British Columbia - Research Branch.

Table 2. BEC zones of the study areas in Area C.

BEC Zones	Area (rounded to ha)	% of Study area[13]
CWHds1	17,538	45%
IDFww and IDFww1	11,958	31%
CWHms1	6,340	16%
ESSFmw	2,735	7%
MHmm2	254	1%

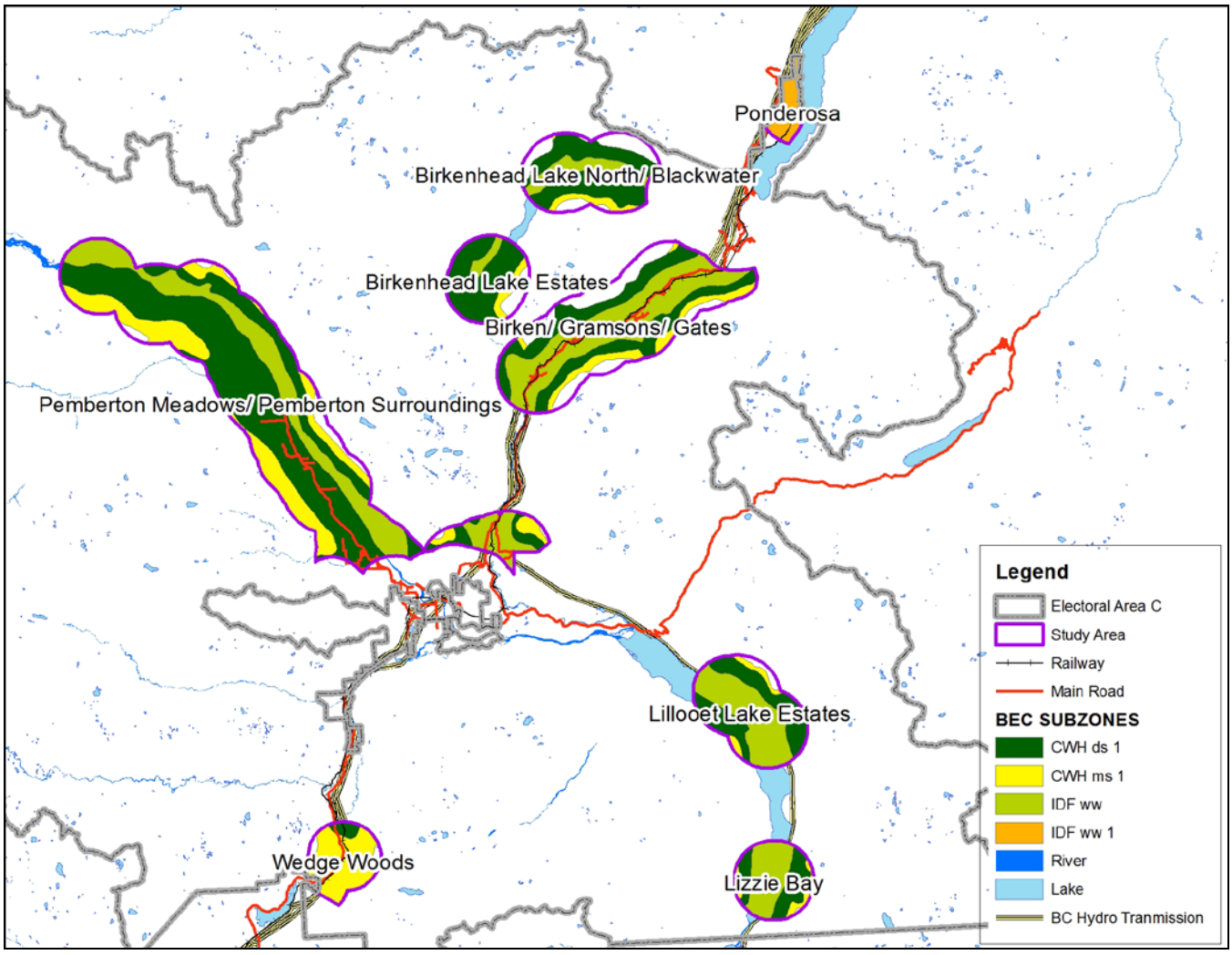


Figure 4. Main BEC subzones found within the study areas of Area C.

[13] Includes terrestrial portion of study area only.

2.6.2 NATURAL DISTURBANCE TYPES

Biogeoclimatic subzones are categorized into natural disturbance types (NDTs) based on the size and frequency of natural disturbances (largely fire) that historically occur within the subzone. BEC zones have been used to classify the Province into five NDTs. NDTs have influenced the vegetation dynamics and ecological functions and pathways that determine many of the characteristics of our natural systems. The physical and temporal patterns, structural complexity, vegetation communities, and other resultant attributes should be used to help design fuel treatments, and where possible, to help ensure that treatments are ecologically and socially acceptable (Province of British Columbia, 1995).

The IDFww is categorized as NDT4 – ecosystems with frequent stand-maintaining fires. The forested portions of these ecosystems would normally experience frequent, low-intensity fires that remove understory vegetation and maintain larger, fire resistant trees. Variable intensity and frequency of these types of fires across the landscape create mosaics of uneven-aged forests and grassy or shrubby openings.

Exclusion of fire, combined with other variables such as forest health factors and logging, has altered the fuel composition and ecosystems within this natural disturbance type within parts of the study areas. Forests within this natural disturbance type have, generally, become denser and more uniform with a greater abundance of younger trees in the understory and a build-up of ladder and surface fuels. This increases the fire behaviour potential.

The CWHds1 and CWHms1 are categorized as NDT2 – ecosystems with infrequent stand-initiating events. Major stand initiating events are rare, resulting in large tracts of old seral stage forests with complex stand structure. The mean disturbance return interval for these ecosystems is approximately 200 years. Although the fire frequency is not high and fires are not large, pre-planning and preparation are essential to reduce the negative impacts of a wildfire.

2.6.3 TIMBER HARVESTING LANDBASE

The majority of Area C and the study areas are surrounded by the Soo Timber Supply Area (TSA) which covers approximately 900,000 hectares of the region. Approximately 28% of the TSA is considered productive forest land managed by the Crown (administered by the Sea to Sky Natural Resource District) and 11% of the TSA, or 98,000 hectares, is within the current timber harvesting land base. This equates to 61% of the productive forested area not available for timber harvesting.[14] The major commercial tree species are Douglas-fir, amabilis fir, western hemlock, western redcedar, and Englemann spruce. The most recent data package compiling information on forest resources inventory was completed in 2011.[15] The allowable annual cut (AAC) has been increased twice and reduced four times since 1980. The current AAC is 480,000 m^3 which will remain in effect until a new AAC determination which will occur on or before 2021.[14]

[14] Ministry of Forests, Lands, and Natural Resource Operations Forest Analysis and Inventory Branch. 2010. *Soo TSA Timber Supply Analysis Public Discussion Paper*.

[15] Soo Timber Supply Area Rationale for Allowable Annual Cut (AAC) Determination. 2011.

The Ponderosa study area is within the Lillooet TSA, which is administered by the Cascades Natural Resource District in Merritt. The current AAC is 570,000 m3, which will remain in effect until the next determination, which will occur in, or by, the year 2019.

2.7 FOREST HEALTH

A major forest health factor for the Study Area has been the mountain pine beetle. The beetle was first recorded in the area on mostly white pine in the 1940's, continuing into the 1970's. In the mid-80's the pine beetle population surged, with general increases until the population peaked in 2007, when a yearly total of nearly 17,000 ha were infested (Zeglen & Heppner, 2015). The pine beetle epidemic has resulted in the accumulation of dangerous forest fuels in some portions of the study areas, most notably from Whistler north to D'Arcy, in the form of dead and downed pine trees (crown and surface fuels). Additionally, these dead fuels will also contribute to higher levels of spotting.

Another leading forest health agent is Western Spruce Budworm, an insect that defoliates Douglas-fir, particularly understory regeneration. It has been recorded in the Soo TSA since the 1940's, with five major outbreaks. A peak in defoliation occurred in 1992, when almost 21,000ha of forest were defoliated, after which the budworm population collapsed (Zeglen & Heppner, 2015). This type of infestation results in dead or suppressed understory trees, resulting in increased ladder fuels. Dead needles are a short-term fine surface fuel.

Other forest health agents in the Study Area are western balsam bark beetle, spruce beetle, root diseases, Douglas-fir beetle and balsam woolly adelgid. Currently, there are no major forest health issues within the Sea to Sky Natural Resource District; pest damage has generally been at endemic levels.[16] Root rots are usually limited to single tree or small patch distribution.

All forest health outbreaks should be noted, as the CWPP may need updating to reflect changing fuel types if outbreaks are extensive.

3.0 WILDFIRE BEHAVIOUR AND WUI THREAT ASSESSMENT

3.1 FUEL TYPE SUMMARY

The Canadian Forest Fire Behaviour Prediction (FBP) System outlines five major fuel groups and 16 fuel types based on characteristic fire behaviour under defined conditions.[17]

The initial starting point for study area fuel typing is the 2015 Provincial Strategic Threat Analysis (PSTA), which is based on the FBP fuel typing system. PSTA data is limited by the accuracy and availability of information within the Vegetation Resource Inventory (VRI) provincial data; confidence in fuel type provincial fuel type data is low on

[16] Sea to Sky Natural Resource District/ Pemberton Zone Fire Management Plan. 2016

[17] Forestry Canada Fire Danger Group. 1992. Development and Structure of the Canadian Forest Fire Behavior Prediction System: Information Report ST-X-3.

private land. For the above reasons, fuel types from the PSTA data have been updated using imagery of the study area with fuel type calls based upon field fuel type verification.

It should be noted that fuel typing is intended to represent a fire behaviour pattern. A locally observed fuel type may have no exact analog within the Canadian Forest Fire Behaviour Prediction System. In these cases, the most appropriate fuel type to predict fire behaviour was assigned; the FBP system was almost entirely developed for boreal and sub-boreal forest types, which do not occur within the study areas. Furthermore, fuel types depend heavily on Vegetation Resource Inventory (VRI) data, which is gathered and maintained in order to inform timber management objectives, not fire behaviour prediction. This has resulted in fuel typing being recognized as a blend of art and science. Although a subjective process, the most appropriate fuel type was assigned based on research, experience, and practical knowledge; this system has been successfully used within BC, with continual improvement and refinement, for 20 years.[18] In addition, fuel type polygons may not adequately describe the variation in the fuels present within a given polygon, due to errors within the PSTA and VRI data and adjustments required in the data. In some areas, aerial imagery is of low spatial resolution, making fuel type assessment difficult. Where fuel types could not be updated from imagery with a high level of confidence, the original PSTA fuel type call was retained. It is believed that this practice results in a slight overestimation of C5 fuel types, and a slight underestimation of C3 fuel types.

Table 3 summarizes the fuel types by general fire behaviour and total area for the study areas. In general, the fuel types considered hazardous in terms of dangerous fire behaviour and spotting potential are C2, C3, and C4. An M2 fuel type can sometimes be considered hazardous, depending on the proportion of conifers within the forest stand. An O1-b fuel type often can support a rapidly spreading grass or surface fire capable of damaging or destroying property and jeopardizing human life. C-5 fuel types have a moderate potential for active crown fire, when wind-driven. Under drought conditions, fire intensity can be higher than expected due commonly occurring dead and downed woody fuel accumulations.[18] Table 3 lists the fuel types that were used to guide the threat assessment.

Forested ecosystems are dynamic and change over time: fuels accumulate, stands fill in with regeneration, and forest health outbreaks occur. It is recommended that periodic updating of fuel types and threat assessments occur every 5 – 10 years.

[18] Perrakis, D. and G. Eade. 2015. BC Wildfire Service. Ministry of Forests, Lands, and Natural Resource Operations. *British Columbia Wildfire Fuel Typing and Fuel Type Layer Description* 2015 Version. For more details, please visit: http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/wildfire-management/fire-fuel-management/bcws_bc_provincial_fuel_type_layer_overview_2015_report.pdf

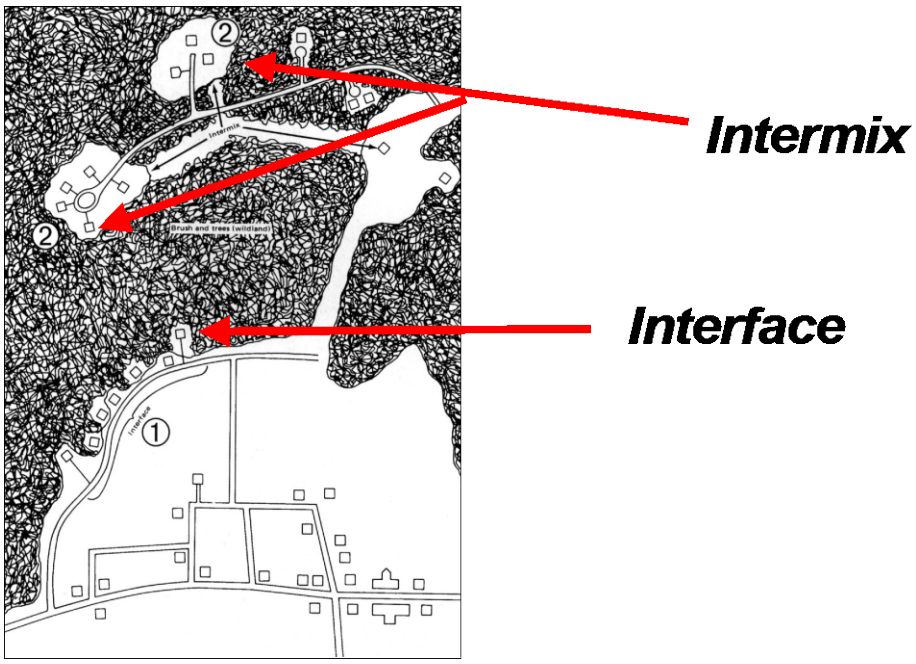
Table 3. A summary of fuel types, associated hazard and areas within the study areas.

Fuel Type	Description	Wildfire Behaviour Under High Wildfire Danger Level	Rounded Area (ha)	Percent (%)
C-2	As identified by PSTA data	Almost always crown fire, high to very high fire intensity and rate of spread	198	1%
C-3	Fully stocked, late young forest, crowns separated from the ground	Surface and crown fire, low to very high fire intensity and rate of spread	4,979	13%
C-4	Dense pole-sapling forest and young plantations, heavy standing dead and down, dead woody fuel accumulations, continuous vertical crown fuel continuity	Almost always crown fire, high to very high fire intensity and rate of spread	63	0%
C-5	Well-stocked mature forest, crowns separated from ground. Moderate understory herbs and shrubs. Often accompanied by dead woody fuel accumulations.	Moderate potential for active crown fire in wind-driven conditions. Under drought conditions, fuel consumption and fire intensity can be higher due to dead and downed woody fuel accumulations.	12,315	32%
C-7	Open, uneven-aged forest, crowns separated from the ground except in conifer thickets, understory of discontinuous grasses, herbs	Surface fire spread, torching of individual trees, rarely crowning (usually limited to slopes > 30%), moderate to high intensity and rate of spread	4,791	12%
O-1a/b	Matted and standing grass communities. Continuous standing grass with sparse or scattered shrubs and down woody debris. Vegetated, non-treed areas dominated by shrubs or herbs in dry ecosystems. Areas of very scattered trees.	Rapidly spreading, high- intensity surface fire when cured	2,644	7%
M-2	Moderately well-stocked mixed stand of conifers and deciduous species, low to moderate dead, down woody fuels.	Surface fire spread, torching of individual trees and intermittent crowning, (depending on slope and percent conifer)	2,860	7%
D-1/2	Deciduous stands.	Always a surface fire, low to moderate rate of spread and fire intensity	4,999	13%
S-1	Jack or lodgepole pine slash	Moderate to high rate of spread and high to very high intensity surface fire	6	0%
S-3	Coastal cedar/hemlock/Douglas-fir slash	Moderate to high rate of spread and high to very high intensity surface fire	103	0%
W	Water	N/A	2,649	7%
NF	Non-fuel: irrigated agricultural fields, golf courses, urban or developed areas void or nearly void of forested vegetation.	N/A	3,301	8%

3.2 THE WILDLAND URBAN INTERFACE

The WUI is generally defined as the place where the forest meets the community. There are different WUI conditions, which are variations on 'perimeter interface' and 'intermix'. A perimeter interface condition is generally where there is a clean transition from urban development to forest lands. Smaller, more isolated developments that are embedded within the forest are referred to as intermixed areas. An example of interface and intermixed areas is illustrated in Figure 5.

Figure 5. Illustration of intermix and interface areas.



In interface and intermixed communities, fire has the ability to spread from the forest into the community or from the community out into the forest. Although these two scenarios are quite different, they are of equal importance when considering interface fire risk. Regardless of which scenario occurs, there will be consequences for the community and this will have an impact on the way in which the community plans and prepares for interface fires.

3.2.1 VULNERABILITY OF THE WILDLAND URBAN INTERFACE TO FIRE

Fires spreading into the WUI from the forest can impact homes in two distinct ways:

1. From sparks or burning embers carried by the wind, or convection that starts new fires beyond the zone of direct ignition (main advancing fire front), and alight on vulnerable construction materials or adjacent flammable landscaping (*i.e.* roofing, siding, decks, juniper, etc.) (Figure 6).

2. From direct flame contact, convective heating, conductive heating or radiant heating along the edge of a burning fire front (burning forest), or through structure-to-structure contact. Fire can ignite a vulnerable structure when the structure is in close proximity (within 10 meters of the flame) to either the forest edge or a burning house (Figure 7).

Figure 6. Firebrand caused ignitions: burning embers are carried ahead of the fire front and alight on vulnerable building surfaces.

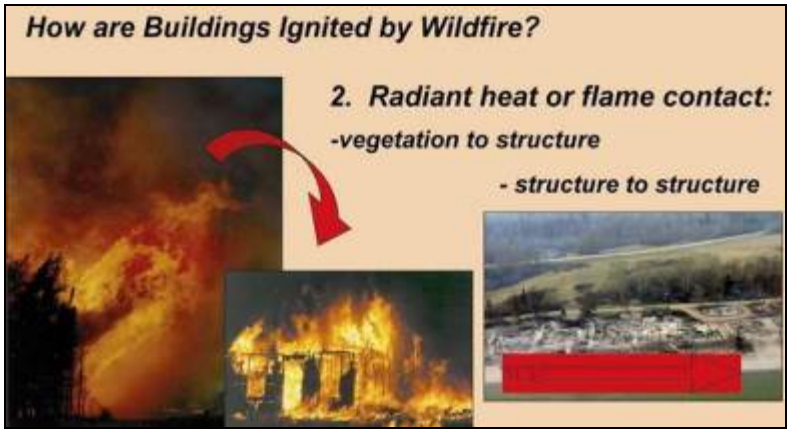


Figure 7. Radiant heat and flame contact allows fire to spread from vegetation to structure or from structure to structure.

3.2.2 WUI THREAT ASSESSMENTS

WUI Threat assessments were completed on July 18 – 22 and September 7 - 9, 2016, in conjunction with verification of fuel types. WUI Threat Assessments were completed in the interface areas of the study area, in order to support decision making regarding priority treatment areas, and in order to ground truth remotely classified polygons and to establish baseline scores for sites which have similar fuel, topographic, and proximity to structure characteristics.

A total of 33 WUI threat plots were completed and more than 120 other field stops (qualitative notes and/or photograph documentation) were made across the study areas over the 8 field days. The data collected and field observations recorded from the plots and field stops inform much of this document. A table detailing WUI plot locations and threat ratings by worksheet component can be found in APPENDIX C: WUI THREAT PLOT DETAILS.

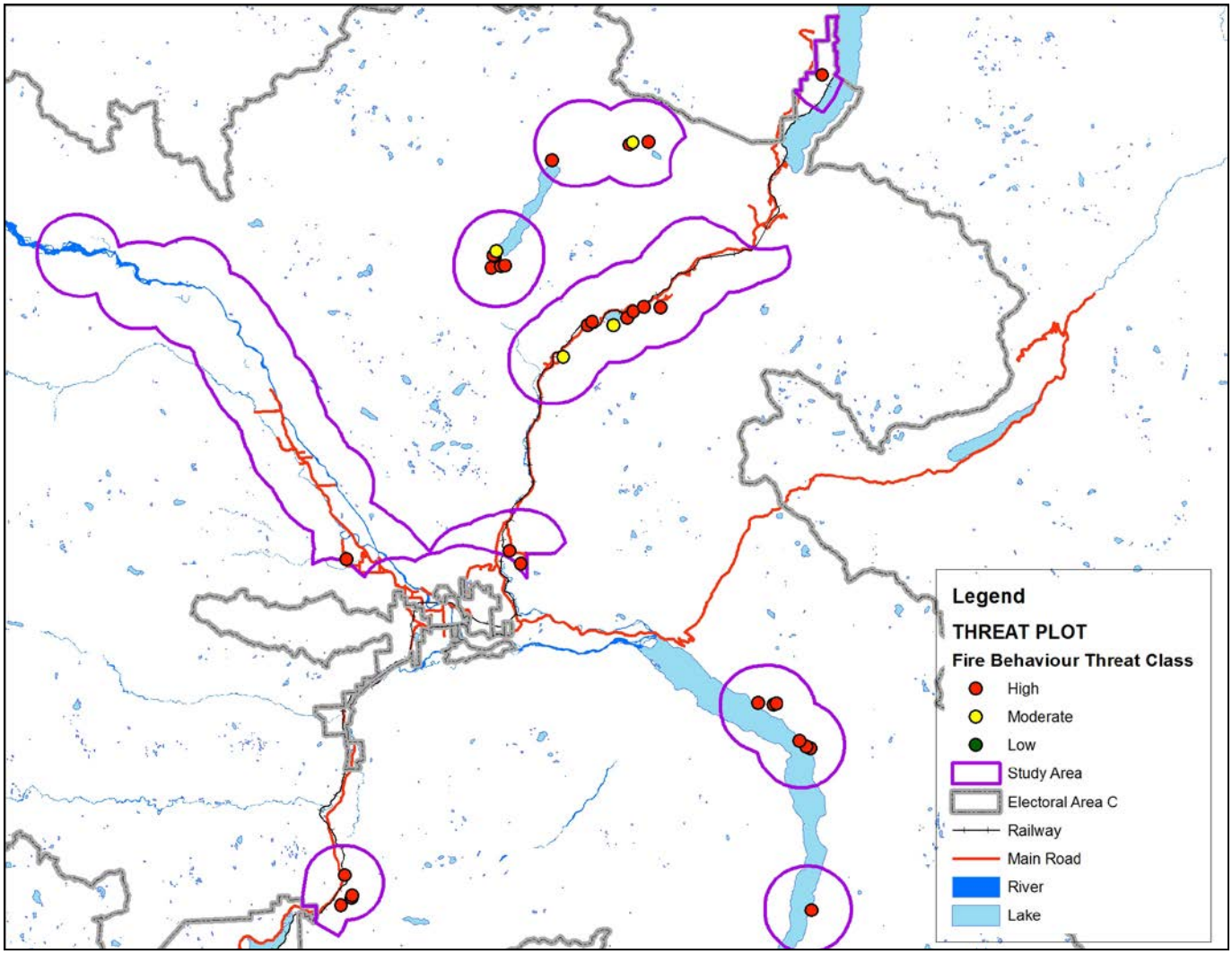


Figure 8. WUI threat plot locations by Fire Behaviour Threat Class.

3.2.2.1 STUDY AREA THREAT RATING

There are two main components of the threat rating system: the wildfire behaviour threat class (fuels, weather and topography sub-components) and the WUI threat class (structural sub-component), all of which is guided by WUI threat plots and a resulting numerical rating for each sub-component. The cumulative points of the sub-components, and thus for the two main components, are used to assign classes: Wildfire Fire Behaviour Threat Rating and the WUI Threat Rating. Figure 9 and Figure 10 display the fire behaviour threat ratings and WUI threat class ratings within the study area. Maps displaying the threat assessment for each study area polygon are found in APPENDIX D: THREAT RATING MAPS BY STUDY AREA.

The areas which represent the highest wildfire behaviour threat are:

- along the D'arcy – Pemberton Corridor in the Birken/ Gramsons/ Gates study area;
- surrounding Birkenhead Lake Estates at the south end of Birkenhead Lake;

- the south aspect slopes above Blackwater and Birkenhead Lake Provincial Park in the Birkenhead Lake North / Blackwater study area;
- the south and west aspect slopes along Pemberton Meadows in the Pemberton Meadows/ Pemberton Surroundings study area;
- the area around Owl Ridge in the Pemberton Meadows/ Pemberton Surroundings study area;
- surrounding Lillooet Lake Estates;
- the lower, west aspect slopes of Lizzie Bay;
- the entirety of Ponderosa; and,
- the west aspect slopes and steeper slopes in Wedgewoods.

The majority of the hazardous areas mentioned above are on Crown land, although some portions are on private land or within a provincial park, and are therefore ineligible for UBCM/SWPI funding for treatment. Collaborative efforts with multiple agencies, private landowners, and organizations will be required in order to reduce the overall risk profile of Area C.

Beyond the study areas, but within the boundary of Area C, continuous forested areas represent a threat that is outside the scope of this document. Although these areas were not included in the threat assessment, field observations and orthophotos show that they are similar fuel types to those with moderate, high and extreme fire behaviour threat ratings within the study area, and thus likely would exhibit similar fire behaviour threat. The newly established Forest Enhancement Society fund may be a funding opportunity to explore for areas such as these which were previously ineligible for any provincial funding, due to their location outside the 2 km WUI area. These areas may be desirable locations for landscape level fuelbreaks or larger and more complex projects. See section 7.5.2 for more details.

The threat class ratings are based initially upon GIS analysis that best represents the WUI wildfire threat assessment worksheet and are updated with ground-truthing WUI threat plots. WUI threat plots were completed in a variety of fuel types, slopes, and aspects in order to be able to confidently refine the GIS analysis. It should be noted that there are subcomponents in the worksheet that are not able to be analyzed using spatial analysis; these are layers that do not exist in the GIS environment. Furthermore, threat worksheets completed in the field are an estimate of the threat class of relatively small polygons, whereas the spatial analysis is a coarser scale.

The threat assessment is based largely on fuel typing, therefore the limitations with fuel typing accuracy (as detailed in Section 3.1) impacts the threat assessment, as well.

Additionally, the WUI threat plot methodology uses fire zone as a representative of fire weather. In the case of Area C, the study areas, with the exception of Ponderosa, are in the Pemberton Fire Zone and Coastal Fire Centre and therefore receive the lowest number of points for fire weather, based upon the assumption that the fire weather is closer to Coastal climatic conditions. In reality, the study areas are generally in the transitional zone between Coastal and Interior ecosystems (with the exception of Wedgewoods); this may result in an

underestimation of the Wildfire Behaviour Threat in some areas. The difference is particularly visible when comparing the Wildfire Behaviour Threat in the Ponderosa study area, to the threat in the other study areas when looking at similar fuel types (C3, for example). In many cases, the 9 point difference between the two fire zones would be sufficient to increase Wildfire Behaviour Threat Rating from moderate to high. The SLRD's threat class rating should be viewed keeping all the above-mentioned limitations in mind.

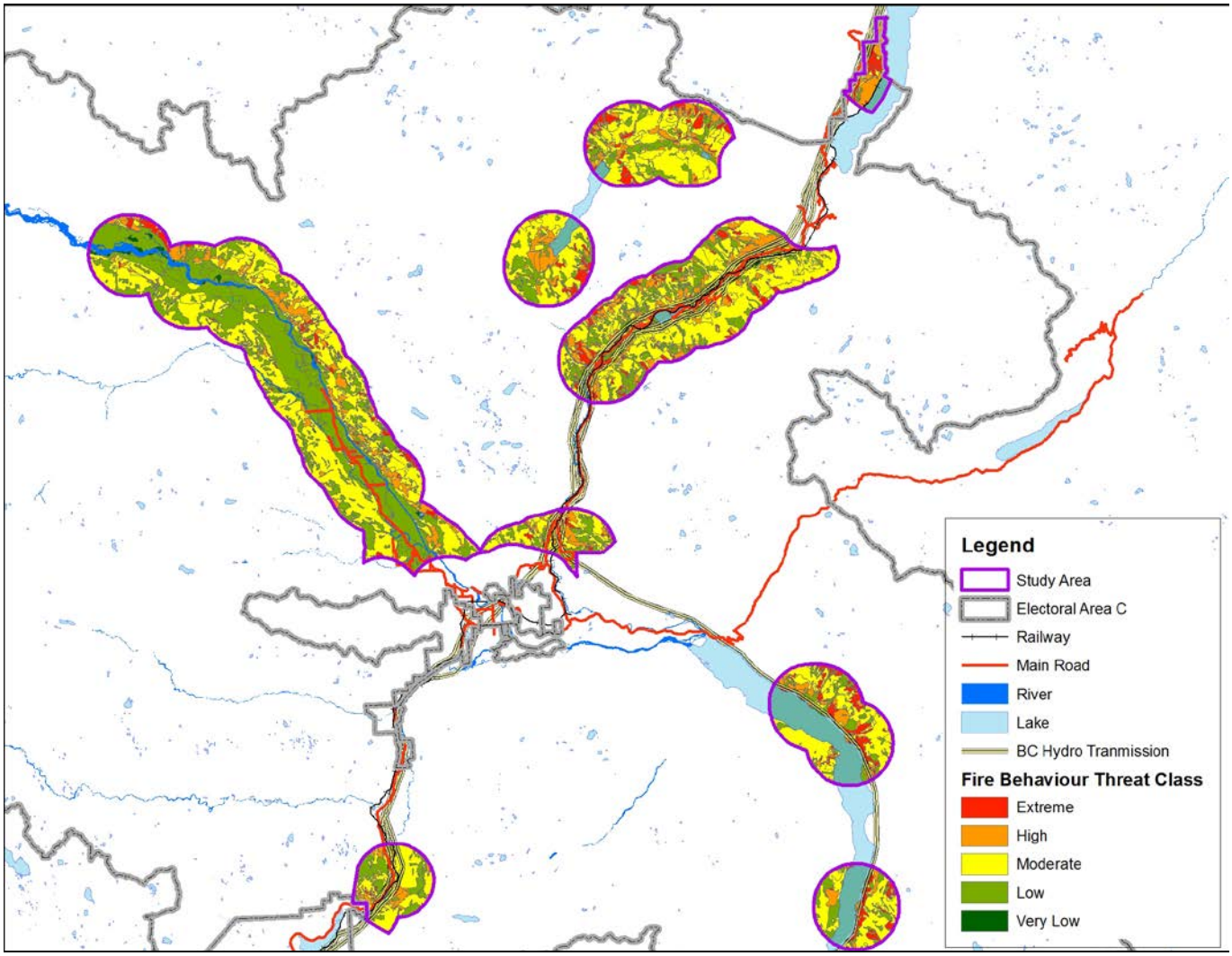


Figure 9. Fire behaviour threat class rating for the study area.

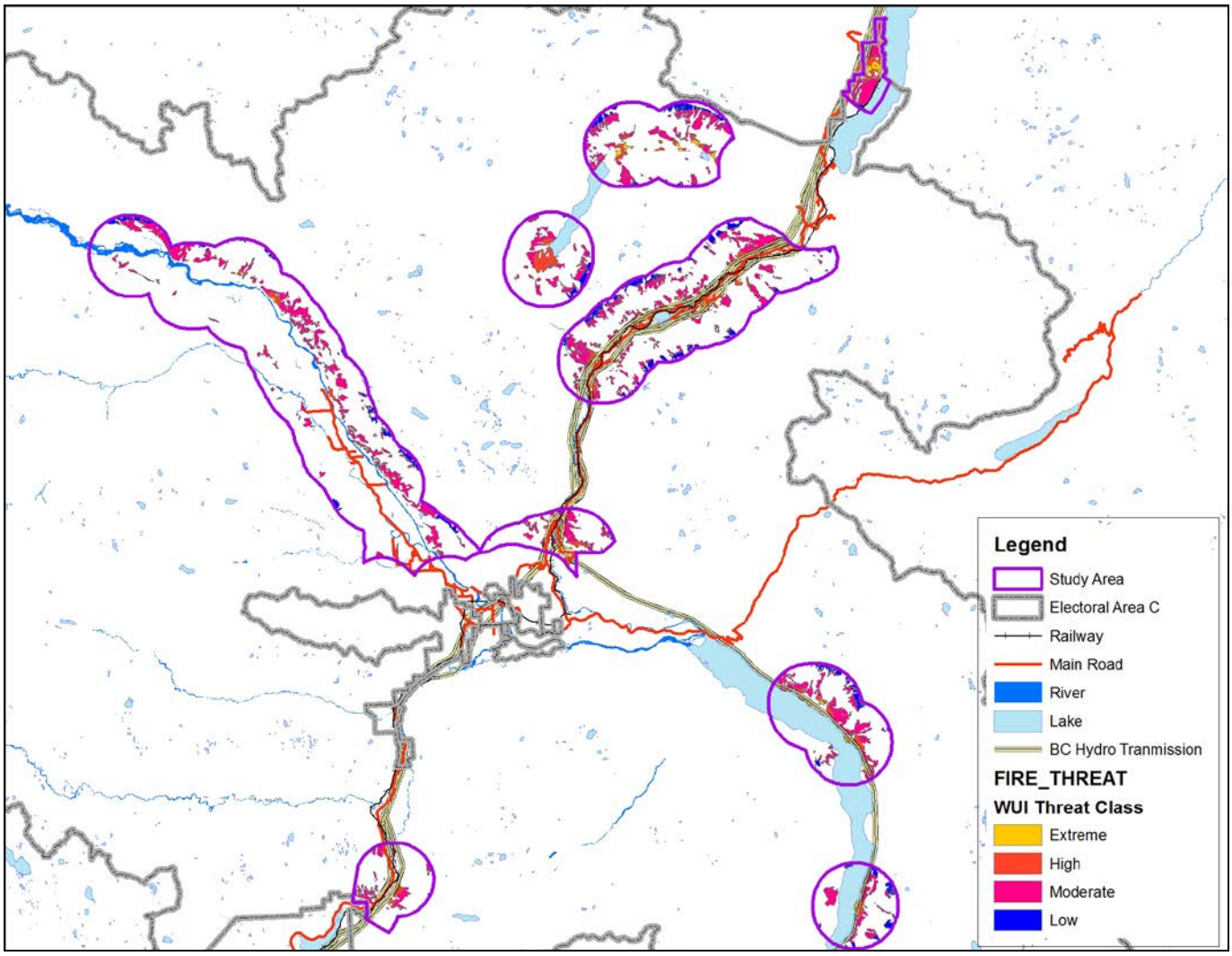


Figure 10. WUI threat class rating within the study area. WUI Threat Class is only applicable to those polygons that rank high or extreme in Wildfire Behaviour Threat Class, as per the WUI threat assessment form methodology.

3.2.2.2 WUI THREAT ASSESSMENT METHODOLOGY

Threat assessment for the study area was completed using the WUI threat plots and methodology outlined in the Wildland Urban Interface Wildfire Threat Assessments in BC handbook.[19] Detailed methodology can be found in APPENDIX E: WUI THREAT ASSESSMENT METHODOLOGY.

3.3 LOCAL WILDFIRE HISTORY

The MFLNRO fire reporting system was used to compile a database of fires that occurred within the study area. This database provides an indication of fire history for the area, but should not be considered comprehensive. The

[19] Morrow, B., K. Johnston, and J. Davies. 2013. Wildland Urban Interface Wildfire Threat Assessments in BC.

historical fire ignitions across all eight study areas were analyzed together. There was no notable difference in ignition statistics between the eight study areas.

Within the study areas, most of the historical ignition points are attributed to human causes (80%); approximately 20% of the ignitions were attributed to lightning. Approximately one-third of total ignitions (30%) can be attributed to what could be best described as "the general public"; causes include campfire use, juvenile fire setter, incendiary (arson), and smoker. The remaining human-caused ignitions are from industrial activities (equipment use, fire use, railroads) or are uncategorized (miscellaneous). Considering the high number of human ignitions compared to lightning caused ignitions, the importance of fire education and regulation must be emphasized. The railroads must be recognized as a significant ignition risk: approximately 11% of the fires within in the study areas have been from railroad use, although it should be noted that railroad ignitions have declined in the last three decades. In the 2015 fire season, there were two ignitions in the study areas, though neither is considered notable: one was a nuisance campfire call and one considered a "smoke-chase", a report of smoke or fire which is inaccurate: the fire does not exist.

Fire perimeters were also compiled for the study area for the years 1919 - 2015. There have been a number of significant fires within the study area, the distribution and frequency of which demonstrates the natural role of wildfire in the ecosystem. The largest fire on record was human-caused, occurred in 1926 and burned over 4,000 ha between Whistler and Pemberton. More recently, in 2009, a lightning-ignited fire burned more than 650 ha on the western side of Pemberton Meadows and a powerline short circuit burned more than 10 ha on the western shores of Anderson Lake. In 2015, a significant, lightning-caused wildfire occurred outside the study areas (in the wildland up Pemberton Meadows Road). Within the SLRD Area C, the Boulder fire burned more than 6,500 ha and thick smoke from this fire and the Elaho fire filled the mountain valleys, hindering wildfire response and causing air quality and public health concerns. Smoke spread along Howe Sound and into the Vancouver area, which raised significant air quality concerns outside Area C.[20]

[20] Sea to Sky Natural Resource District/ Pemberton Fire Zone Fire Management Plan. 2016.

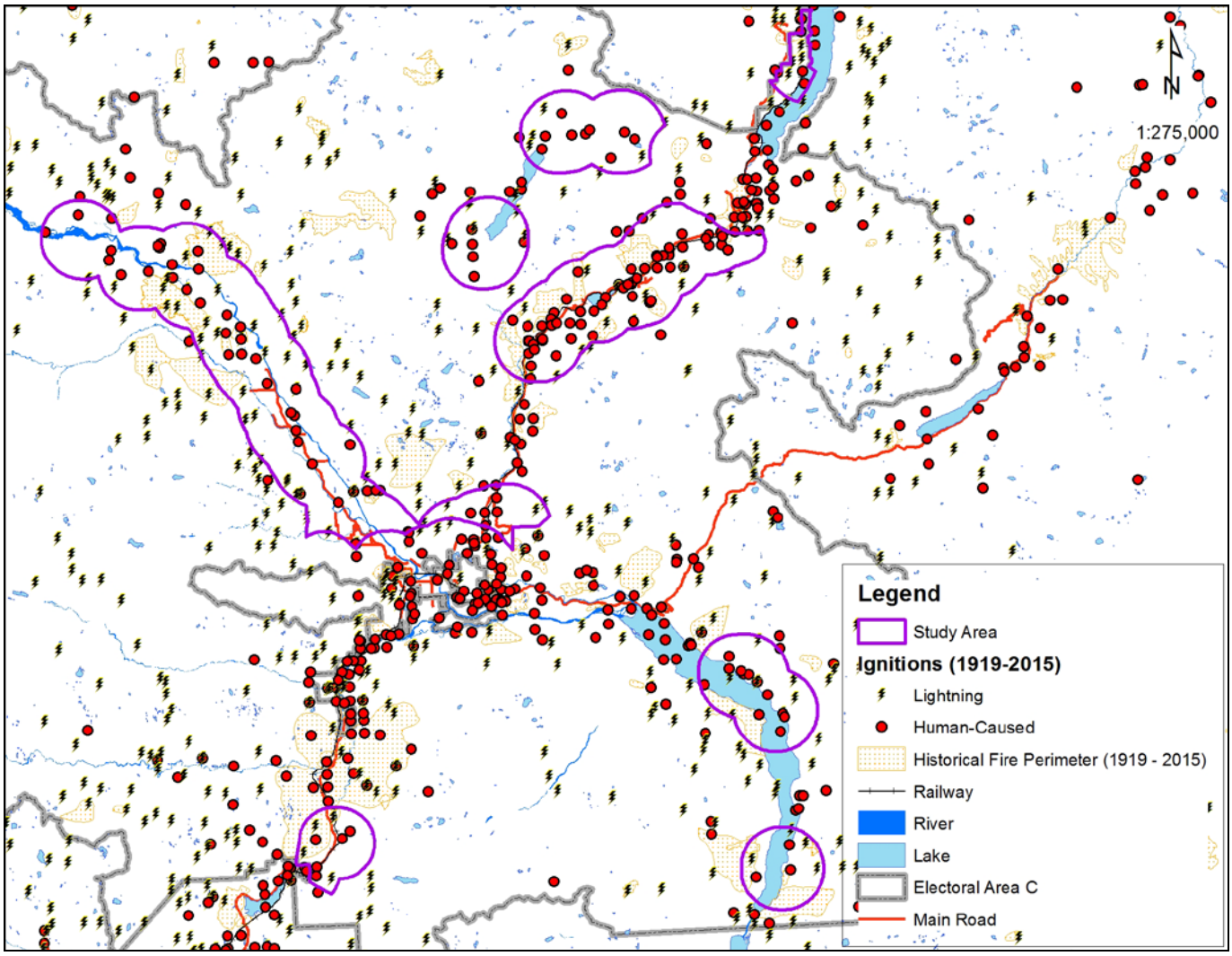


Figure 11. All BCWS-data for ignitions and fire perimeters from 1919 – 2015 displays how fire has helped to shape the landscape.

3.3.1 FIRE WEATHER DATA

The Canadian Forestry Service developed the Canadian Forest Fire Danger Rating System (CFFDRS) to assess fire danger and potential fire behaviour. A network of fire weather stations during the fire season are maintained by MFLNRO and are used to determine fire danger, represented by Fire Danger Classes, on forestlands within a community. The information can be obtained from the BCWS and is most commonly utilized by municipalities and regional districts to monitor fire weather, and determine the fire hazard ratings associated with bans and closures.

Fire Danger Classes provide a relative index of how easy it is to ignite a fire and how difficult control is likely to be. The BC *Wildfire Act* [BC 2004] and *Wildfire Regulation* [BC Reg. 38/2005], which specify responsibilities and obligations with respect to fire use, prevention, control and rehabilitation, uses Danger Classes to restrict high risk activities. Fire Danger Classes are defined as follows:

- **Class 1 (Very Low)**: Fires are likely to be self-extinguishing and new ignitions are unlikely. Any existing fires are limited to smoldering in deep, drier layers.
- **Class 2 (Low)**: Creeping or gentle surface fires. Fires are easily contained by ground crews with pumps and hand tools.
- **Class 3 (Moderate)**: Moderate to vigorous surface fires with intermittent crown involvement. They are challenging for ground crews to handle; heavy equipment (bulldozers, tanker trucks, and aircraft) are often required to contain these fires.
- **Class 4 (High)**: High-intensity fires with partial to full crown involvement. Head fire conditions are beyond the ability of ground crews; air attack with retardant is required to effectively attack the fire's head.
- **Class 5 (Extreme)**: Fires with fast-spreading, high-intensity crown fire. These fires are very difficult to control. Suppression actions are limited to flanks, with only indirect actions possible against the fire's head.

The period of high fire danger (when danger class is 4 or 5) varies year to year. It is important for the development of appropriate prevention programs that the average yearly period of High Fire Danger is calculated. Danger class days are summarized below to provide an indication of the fire weather in the study area, and are presented in Figure 12.

Data was provided from the BCWS and comes from the four weather stations closest to, and most representative of the weather conditions of, the study area: D'Arcy, Pemberton, Callaghan, and Whistler. The Whistler and Callaghan fire weather data is only applicable to the Wedgewoods study area; these weather stations are in the same BEC zone as the majority of Wedgewoods (CWHms1). D'Arcy (IDFww) and Pemberton (CWHds1) weather data is representative of average fire weather for the other seven study areas. Details regarding weather station data are found in Table 4.

Table 4. Fire weather station data details for those stations used in the fire weather analysis.

Weather Station	BEC Zone	Years of Data	Most Applicable to Study Area(s)	Appx. Distance From Study Area(s) (km)
D'Arcy	IDFww	**38** (1978 – 2015)	Devine/ Birken/ Gramsons Birkenhead Lake Estates Blackwater Lillooet Lake Estates Ponderosa Lizzy Bay	0 13 7 27 10 38
Pemberton	CWHds1	**15** (2001 – 2015)	Pemberton Meadows/ Surroundings	7
Whistler	CWHms1	**35** (1970 – 1975, 1977 – 2005)	Wedgewoods	14
Callaghan	CWHms1	**11** (2005 – 2015)	Wedgewoods	15

3.3.1.1 D'ARCY AND PEMBERTON

Generally, in May, fire danger classes are moderate or higher less than half of the time. In June, fire danger classes are moderate or higher approximately half of the time. On average, the greatest numbers of high and extreme danger class (DC IV and V) days occurs during July and August. Although in September the probability of high or extreme ratings declines, there are still more than 4 days per month that are high or extreme fire danger class rating. For about four months of the year in the summer, there is a high risk of a significant wildfire event (June, July, August, September), peaking in August.

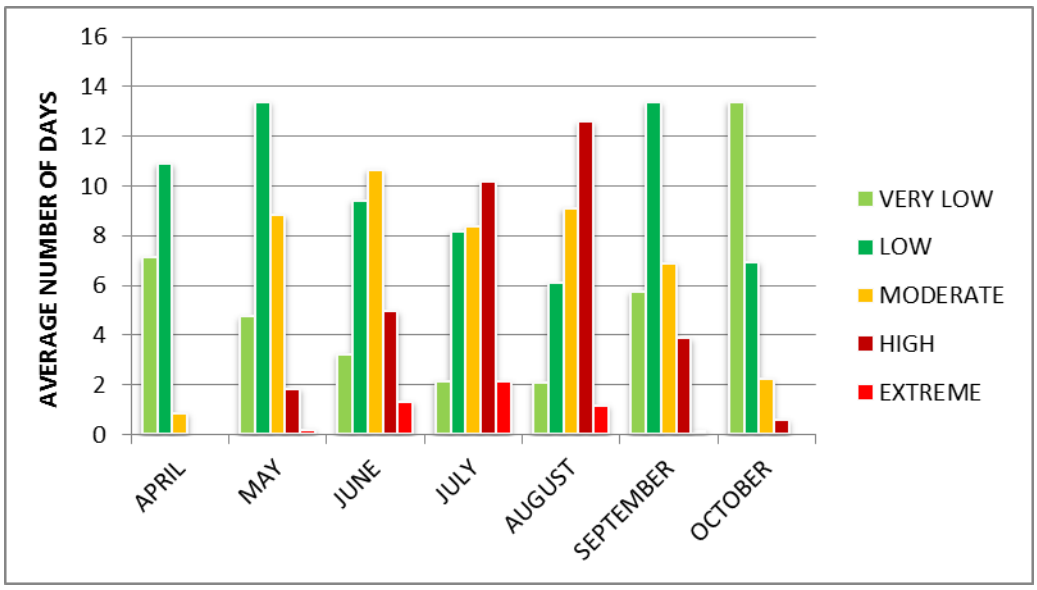


Figure 12. Average frequency of Fire Danger Class ratings by month over a 38-year period (1978 – 2015) from the D'Arcy weather station.

The predominant fire season wind direction in D'Arcy and surrounding areas is from the south and southeast (Figure 13), with gusts up to 18 kilometers per hour.

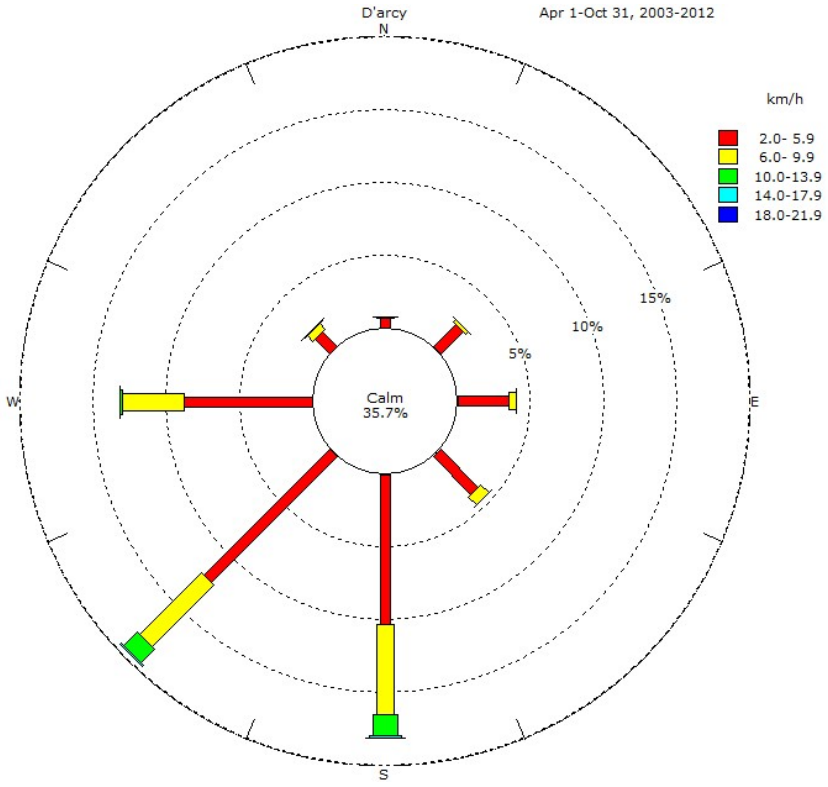


Figure 13. Windrose showing hourly wind readings during the fire seasons (2003 – 2012) for the D'Arcy weather station.

Pemberton weather data is collected at a weather station along the Lillooet River and at the base of Mount Currie; this data should be interpreted with caution. After consultation with the BCWS provincial weather analyst, it was determined that the Pemberton weather station is located in a moister microclimate than the surrounding area and therefore underestimates the fire danger of the surrounding valley. It is likely that the D'Arcy station, or a mixture of D'Arcy and Pemberton stations, weather data is more representative of conditions of the Pemberton to D'Arcy corridor and Lillooet Lake.

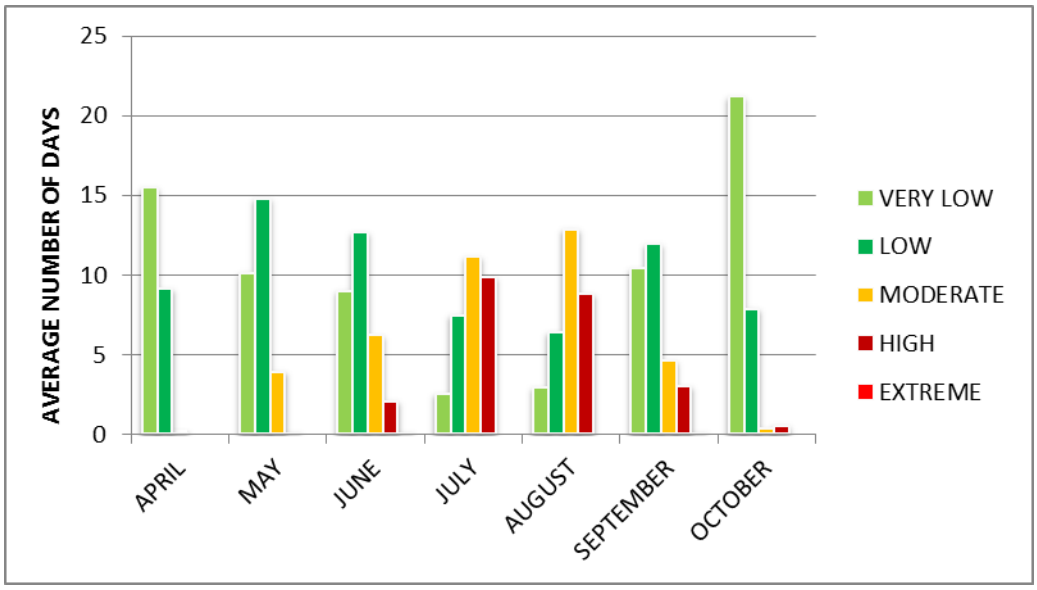


Figure 14. Average frequency of Fire Danger Class ratings by month over a 15-year period (2001 - 2015) from the Pemberton weather station.

Winds in the Pemberton Valley are varied in their direction, though it is uncommon during the fire season to have a northerly wind. The predominant wind directions are from the east and south. The winds in the area are highly terrain driven; winds are funneled up through the Harrison Valley, which is directly applicable to study areas on the shore of Lillooet Lake, as well as up through the Sea to Sky corridor.

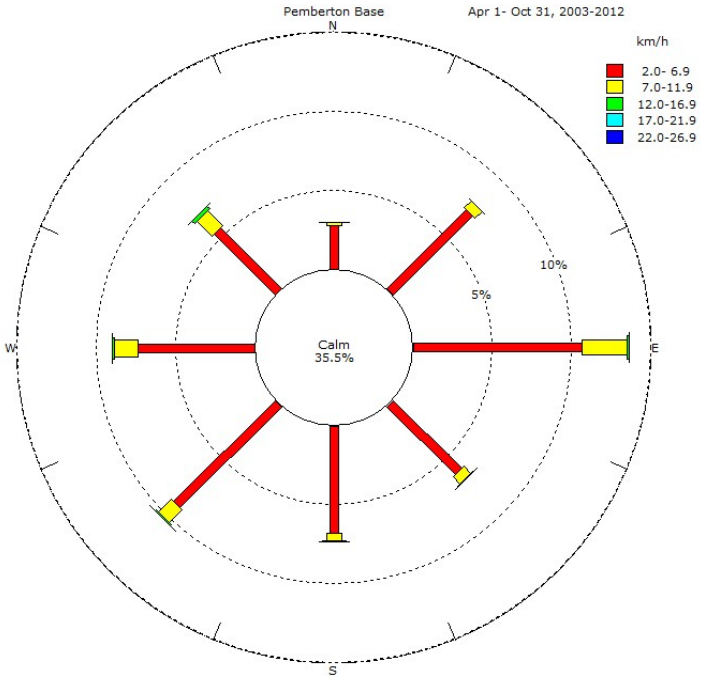


Figure 15. Windrose showing hourly wind readings during the fire seasons (2003 – 2012) for the Pemberton weather station.

3.3.1.2 WHISTLER/ CALLAGHAN

In the Whistler/ Callaghan area, both July and August average more than half the month in moderate or higher danger class. Although June and September average 8 and 12 days in danger class moderate or higher, both months average 3 or more days of high or extreme danger class. It should be noted that there is no danger class data for the month of May for the Callaghan weather station, but both weather stations show similarities in the remaining fire season. It can be cautiously assumed that weather data for May in the Callaghan would display similar fire danger ratings as in Whistler. It should also be noted that the fire weather data for these two stations are not from overlapping time periods; Whistler provides data to 2005 and Callaghan from 2005 – 2015.

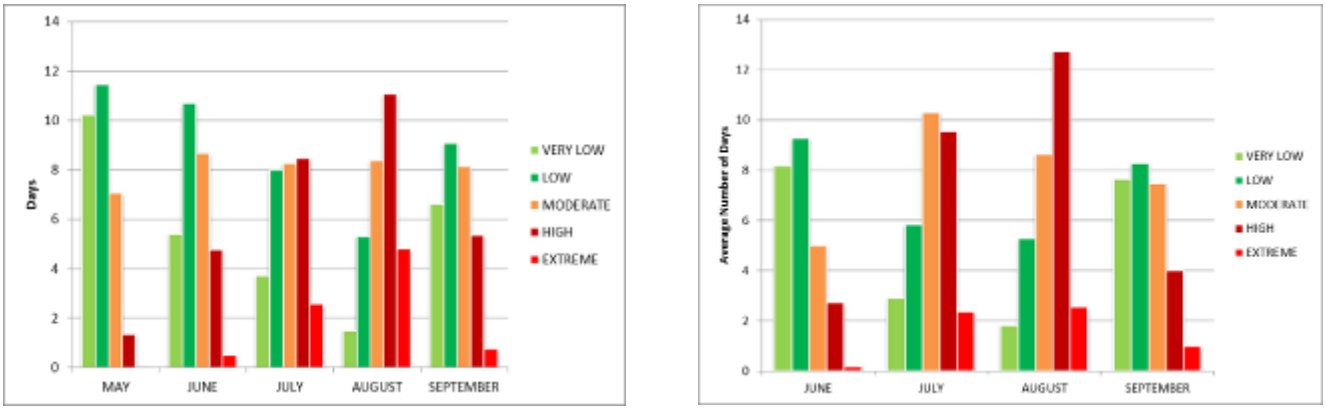


Figure 16. Left: Average frequency of Fire Danger Class ratings by month over a 35-year period from the Whistler weather station. Right: Average frequency of Fire Danger Class ratings by month over a 11-year period from the Callaghan weather station. NB: there was insufficient data to chart April or October for both the Whistler and Callaghan weather stations.

Although there is no wind data available for the Callaghan or Whistler weather stations, local knowledge is that the predominant winds for the Wedgewoods study area are southerly through the Sea to Sky corridor.

4.0 EXISTING POLICIES AND GUIDELINES

The following is a summary of Regional District and provincial policies and guidelines that relate to strategic wildfire management, wildfire threat reduction, and operational fuel treatments.

4.1 REGIONAL DISTRICT

The following municipal bylaws are relevant to wildfire planning in the SLRD.

Bylaw No. 1110, 2008: A Bylaw to Regulation Fire Protection Services Throughout the Squamish Lillooet Regional District

The Fire Protection Bylaw sets forth open air burning restrictions, limits size and location of campfires, and gives fire officials the power to temporarily ban outdoor fires, including barbeques and campfires

Electoral Area C Official Community Plan (OCP)

The OCP provides direction for land use and development within Area C. The OCP recognizes wildfire as a natural hazard within the Electoral Area and provides recommendations on land use planning and development in order to protect life and property and ensure appropriate emergency response. The OCP places the onus for CWPP implementation on Crown agencies and private property owners and recognizes the role of the BCWS as the lead agency for wildfire suppression.

There is no wildfire development permit area identified for Area C identified within the OCP, with the exception of Wedgewoods/ Green River Estates. Development within Wedgewoods (building, construction, and landscaping) must comply with FireSmart standards, installation of fire suppression sprinklers is mandatory, and the purchaser of each lot must be provided a comprehensive owner's manual, a component of which is dedicated to information on decreasing fire hazard on homeowner property.

Within the OCP, the Regional District encourages the following actors to contribute to wildfire hazard reduction:

- Ministry of Transportation to designate and maintain emergency access routes and a unified road signing and street addressing system;
- MFLNRO and Ministry of Environment (MOE) to implement and maintain wildfire hazard reduction treatments on Crown land;
- Private homeowners to complete wildfire hazard assessments and implement FireSmart measures; and,
- The SLRD Emergency Planning Coordinator to complete strategic planning including mitigation measures, identify low fire risk muster points in case of emergency evacuation, annually review fire protection infrastructure with BCWS and local fire departments, create a public education program based on fire safety and emergency evacuation, engage the MFLNRO to address risk and complete fuel management on Crown lands, and to engage BC Hydro to mitigate slash hazard on transmission corridors.

4.2 PROVINCIAL

4.2.1 SEA TO SKY LAND AND RESOURCE MANAGEMENT PLAN

The Sea to Sky Land and Resource Management Plan (S2S LRMP) has two levels of management direction for the region. These are 'General Management Direction' which applies to a range of land and resource values, and 'Land Use Zones', which are area-specific directions for particular values. There are 16 values identified under the General Management Direction including: access, cultural heritage values, forest health, recreation, riparian and aquatic habitats, water, wildfire management, wildlife and biodiversity, bald eagle, deer, moose, mountain goat, grizzly bear, marbled murrelet, spotted owl, and visual quality. There are several specific management zones for wildlife and biodiversity including legal old growth management areas (OGMAs), and spatially explicit ministerial orders pertaining to ungulate winter range (UWR), visual quality objectives (VQO), and wildlife habitat areas (WHA) for a variety of wildlife. There are spatially explicit areas designated within the LRMP, designed to protect cultural and spiritual high-value areas, and in which land use or potential practices may be impacted.

The majority of the study areas are designated as 'Front Country Area', under the Land Use Zoning. Small areas are within 'Cultural Management Areas', 'All Resource Uses Permitted', and 'Parks and Protected Areas'. The study areas cross many Landscape Units (LUs), areas which are designated mainly for the purpose of old-growth forest planning (Table 5).

Within the General Management Direction for Wildfire Management, the S2S LRMP acknowledges that wildfires pose a risk to public safety, resource values and infrastructure, and that historic practices of fire suppression are contributing to increased risk (Ministry of Agriculture and Lands, 2008). The stated goals of the S2S LRMP in this regard are to 1) enhance the ability to manage or suppress wildfire, and 2) maintain and/or restore ecosystem health through reintroduction of health-sustaining disturbance processes. The development of a Fire Management Plan is a key measure for obtaining these objectives.

Although most of these plans and orders should not impact the ability of the SLRD to prescribe and complete fire hazard mitigation activities, these plans and spatially explicit ministerial orders must be reviewed, considered, and addressed during the site level planning phase. Fuel management within these areas should aim to enhance these values, whenever possible and the land manager must be consulted regarding any overlapping values at risk, spatially explicit ministerial orders, or other notable values on the land base, during prescription development.

Table 5. Applicable Landscape Units for each study area within SLRD Area C.

Study Area	Landscape Unit(s)
Pemberton Meadows/ Pemberton Surroundings	Ryan, Meager, Railroad, Birkenhead
Devine/ Birken/ Gramsons	Gates, Birkenhead
Birkenhead Lake Estates	Birkenhead
Birkenhead Lake North/ Blackwater	Gates, Birkenhead
Lillooet Lake Estates	Lizzie
East Anderson Lake/ Ponderosa	Connel Creek
Lizzy Bay	Lizzie
Wedgewoods	Whistler, Soo

Landscape level fuelbreaks and other fire hazard reduction activities on Crown land would be most successful and supported when planned for areas that can be dovetailed geographically with other landscape level fuel management opportunities, such as ones funded through the SWPI program or as part of a commercial licensee harvest. Landscape level fuelbreaks should also look to manage for or enhance more than one value on the land base. Landscape level fuelbreaks can also be applied to enhance or improve access/ egress routes, particularly in locations in the Regional District with very limited access (one way in and out).

4.2.2 SEA TO SKY/ PEMBERTON ZONE FIRE MANAGEMENT PLAN

The Sea to Sky Fire Management Plan (S2S FMP) is in the development phase, and currently only Part 1 is available for public review. Tactical planning is currently under development and will be publicly available at a later date. The current plan identifies values at risk and prioritizes broad categories of values as 'themes' for categorizing response through the Resource Strategic Wildfire Allocation Protocol (RSWAP). The themes are categorized by priority:

1. Human Life and Safety;

2. Property and Critical Infrastructure;

3. High Environmental and Cultural Values; and

4. Resource Values.

Part 1 of the Plan identifies those areas where natural or managed wildfires are permitted. These areas are where fires serve an ecological benefit (such as NDT4 and portions of NDT3 ecosystems), where the type and intensity of fire is determined ecologically beneficial, identified values are not at risk, and the area is amenable to suppression efforts if required. The Wildland Urban Interface does not meet these criteria, and as such are identified as full suppression zones.

The areas that fall within the IDFww BEC zone are considered to be a product of a high frequency, low severity fire regime (NDT4) and have a high potential for ecosystem restoration to ameliorate the high fuel loads caused by forest in-growth and a history of fire suppression.

The Plan recognizes the importance of CWPP and fuel management recommendations within communities which can augment other treatments on a landscape scale. The strategic direction presented in the District-wide planning processes must be considered for future fuel treatments, as these plans are developed and made publicly available and through consultations with the resource district.

A tactical planning section (part 2) was not completed in 2016 and is targeted for finalization in 2017. Although not yet released to the public, drafts of Part 2 of the FMP recommend landscape level fuelbreaks across the region, many of which are partially within the study areas and/ or are complementary to areas where smaller-scale fuel mitigation activities are appropriate. Combinations of funding from various programs (SWPI and FES, for example) and coordination with a variety of agencies and governments may allow for larger-scale projects to be completed effectively and to the benefit of the Area C and their member municipalities.

4.3 ADJACENT JURISDICTIONS/ GOVERNMENTS

CWPPs have been developed for much of the adjacent areas to the study areas defined for this document. The N'Quatqua Nation and Village of Pemberton are in the process of updating their CWPPs (2016). The Lil'Wat Nation Mount Currie Indian Band completed a CWPP for IR #6 and #10 in 2010 and the Resort Municipality of Whistler last updated their CWPP in 2012. All four documents have been reviewed for synergistic project opportunities, as well as to confirm that there are no conflicting recommendations. CWPPs are public documents and, in many instances, the study area for these CWPPs overlap with the SLRD's jurisdiction. The SLRD may wish to initiate or cooperate on projects recommended within other CWPPs. Should this be the case, the appropriate CWPP and government should be consulted for implementation recommendations and funding opportunities.

4.4 OTHER

BCTS operates over most of the study areas. In addition, licensees within the study areas have Forest Stewardship Plans (FSP) that apply to the study areas. Within these FSPs, there are identified results and strategies for values

identified under the Forest and Range Practices Act (FRPA), which have specific directives under the Forest Planning and Practices Regulation (FPPR). These values typically have results and strategies identified by Forest Development Unit (FDU). These results and strategies are legally binding to those licensees to which the FSP applies; SLRD fuel management activities must follow applicable legislation and any requirements of specific licences for forestry activities on Crown land, but not necessarily these specific FSP documents. That being said, direct consultation with the holders of these FSPs will ensure that on the landscape level (for the applicable Landscape Unit), the FRPA values are being addressed through sound forest management. Some examples of objectives are spotted owl management areas (short and long term habitat), old growth management areas, and ungulate winter ranges. Other factors that will need consideration during prescription development include, but are not limited to, grizzly bear connectivity corridors for threatened populations, community watersheds, visual quality objectives, archaeological sites, and species at risk.

Forest licensees operating in the WUI have a responsibility to achieve appropriate fire management stocking standards to achieve stocking and wildfire management objectives. Furthermore, forest professionals are expected to sign-off on a post-harvest commitment to appropriately abate any hazard created as result of harvesting or land clearing (plans may include pile burning or mulching wood waste).

5.0 PAST WILDFIRE RELATED PROJECTS

The SLRD has been working to improve their community wildfire planning. In 2006, the SLRD completed a Fuel Management Strategy.[21] The strategy outlined areas of high risk and recommended polygons for fuel treatment. The SLRD has not completed any fuel management activities based on the recommendations of this document. It was noted that many of the recommended polygons were completely or partially located on private land, thus rendering them ineligible for provincial funding through the SWPI program. The implication is not that polygons identified in the 2006 Fuel Management Strategy are low or moderate hazard, but instead are not under the control of the SLRD and will require alternative methods to mitigate hazard.

The SLRD has completed a UBCM-funded detailed assessment and fuel management prescription for hazardous fuels around Gates Lake. This project was completed with cooperation from the BCWS. Operational fuel treatment has not yet occurred.

The SLRD has undertaken FireSmart initiatives to increase public education and awareness of the practices and principles of FireSmart, an example of which is providing FireSmart handouts at pubic engagements. The SLRD provides funding to the Fire Departments for wildfire equipment. They have also been supportive in community-initiated FireSmart and wildfire training programs, such as S-100 training delivery to residents in Ponderosa.

In 2013, the SLRD completed a Fire Services Review.[22] Although this document is not directly wildfire related, the recommendations to improve the SLRD's Fire Services are relevant to emergency services and volunteer Fire Departments' ability to provide first response in WUI areas, both for structural and wildland/ interface calls.

[21] Davies, J. and M. Coulthard. 2006. Squamish-Lillooet Regional District Fuel Management Strategy.

[22] MJ (Jack) Blair Consulting Services. 2013. Squamish-Lillooet Regional District Fire Services Review.

Future successes in wildfire threat reduction activities will benefit from intra-department communication and cooperation to move them forward (individual Fire Departments, Planning, Emergency Program, Parks and Trails, and Public Works).

6.0 FIRESMART

One of the most important areas with respect to forest fire ignition and the damages associated with a wildfire is the zone adjacent to buildings and homes. *FireSmart, Protecting Your Community from Wildfire*[23] is a guide developed by Partners in Protection that provides practical tools and information on how to reduce the risk of loss from interface fires. The FireSmart website can be visited at: www.firesmartcanada.ca.

We often consider wildfire an external threat to our residences; however, in many cases fire can originate as a house fire and spread into the interface. Regardless of the origin of the fire, home owners and businesses can take steps to reduce the probability of this occurring. There are two main avenues to FireSmart a home: 1) change the vegetation type, density, and setback from the building (fuel treatments and landscaping) and 2) change the structure to reduce vulnerability to fire and the potential for fire to spread to or from a building.[23]

FireSmart is a program that helps homeowners and the community prepare for the threat of wildfire in the WUI and aims to decrease the probability of ignition of a home (increase ignition resistance) by direct flame contact, embers igniting a structure, or by spot-ignited surface fires. It is based on creating defensible space around homes and structures, which can reduce the structures' or properties' fire hazard and allow for more effective and safer suppression efforts. The Wildfire Hazard Assessment System is based on two components:

1. The Structure and Site Hazard Assessment Form, which evaluates building and adjacent site (yard) hazard, and,
2. The Area Hazard Assessment, which assesses the hazard of the site greater than 30 m from the home.

Though completing both assessments gives a more complete understanding of the interface fire hazard of a property, it is noted that in many developed areas in the interface, the areas more than 30 m from the home are often not in the control of the homeowner. Therefore, the overall fire hazard of each home and structure is, in part, dependent upon the FireSmart conditions of adjacent properties and the property owners' ability and motivation to complete hazard reduction activities. This is the basis of the FireSmart Canada Community Recognition Program, a Program geared to motivate entire neighbourhoods or communities to cooperatively undertake fire hazard reduction activities and to recognize these efforts.

In more rural interface and intermix areas, homeowners often have ownership or control over larger areas of land. Although this provides the homeowner with opportunity to mitigate their risk with less dependence on their neighbour, it represents a much larger amount of work and cost for a single family or individual.

During extreme wildfire events, most homes are destroyed as a result of low-intensity flame exposures. For example, during the 2010 Fourmile Canyon fire outside Boulder, Colorado, 17% of the 162 homes destroyed were

[23] For further information regarding the FireSmart program see www.pep.bc.ca/hazard_preparedness/FireSmart-BC4.pdf

attributed to crown fire.[24, 25] Instead of high intensity flames, the majority of homes ignited as a result of firebrands (or embers), which ignited lower-intensity surface fires adjacent to structures or the home directly.[24] The likelihood of home ignition is mostly determined by the area within 30 m of the structure: the building materials, design, landscaping, and maintenance (accumulation or presence of flammable debris on or near the structure). Additionally, areas of denser suburban development have additional risk associated with direct house-to-house transmission and the accompanying risk that such transmission will overwhelm the available firefighting capacity. In the more rural study areas that this document covers, fire response is provided by volunteer fire departments with limited resourcing and equipment and long response times from neighbouring fire protection services. More than one structural fire at the same time would likely overwhelm their efforts. Effective fire protection depends on ignition resistant homes and properties during extreme wildfire events.[24]

Incorporating FireSmart at the neighbourhood level is a process dependent upon incremental build-out: one structure or property at a time. The success of a FireSmart program therefore rests upon the commitment of communities, elected officials, policies and bylaws over long time scales.

6.1 FIRESMART STRUCTURE PROTECTION

An important consideration in protecting the WUI zone from fire is ensuring that homes can withstand an interface fire event. Often, it is a burning ember traveling aloft and landing on vulnerable housing materials (spotting), rather than direct flame contact (vegetation to house) or radiative heat that ignites a structure. Alternatively, the convective or radiant heat produced by one structure may ignite an adjacent structure if it is in close proximity. Structure protection is focused on ensuring that building materials and construction standards are appropriate to protect individual homes from interface fire. Materials and construction standards used in roofing, exterior siding, window and door glazing, eaves, vents, openings, balconies, decks, and porches are primary considerations in developing FireSmart neighbourhoods. Housing built using appropriate construction techniques and materials are less likely to be impacted by interface fires.[23]

While many BC communities established to date were built without significant consideration with regard to interface fire, there are still ways to reduce home vulnerability. Changes to roofing materials, siding, and decking can be achieved over the long-term through voluntary upgrades, as well as changes in bylaws and building codes. The FireSmart approach has been adopted by a wide range of governments and is a recognized process for reducing and managing fire risk in the wildland urban interface. The most important components of the FireSmart approach are the adoption of the hazard assessment systems for wildfire, site and structure hazard assessment, and the proposed solutions outlined for fuel management, structure protection, and infrastructure.

[24] Calkin, D., J. Cohen, M. Finney, M. Thompson. 2014. Proc Natl Acad Sci U.S.A. Jan 14; 111(2): 746-751. Accessed online 1 June, 2016 at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3896199/.

[25] Graham, Russell; Finney, Mark; McHugh, Chuck; Cohen, Jack; Calkin, Dave; Stratton, Rick; Bradshaw, Larry; Ned Nikolov. 2012. Fourmile Canyon Fire Findings. Gen. Tech. Rep. RMRS-GTR-289. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 110 p.

The following link accesses an excellent four minute video demonstrating the importance of FireSmart building practices during a simulated ember shower: http://www.youtube.com/watch?v=_Vh4cQdH26g.

6.1.1 FIRESMART COMPLIANCE WITHIN THE STUDY AREAS

Individual interface homes in the study areas are in various states of FireSmart conditions. The majority of homes have rated roofing, though shake roofing was noted in a few locations. Cladding (siding), soffits, and eaves throughout the study areas are constructed of a range of materials, from unrated vinyl and wood siding to non-combustible or fire resistant materials, such as hardie-board, heavy timber and stone. Decking in the study area is largely not FireSmart compliant: wood and open (underside joists are exposed). Underneath the deck is a common storage place for combustible materials in all study areas.

Figure 17. Left: firewood and other combustibles piled adjacent and underneath a residence with cedar shake siding. Right: a preferred alternative, with firewood piled more than 10 m away from the home.

Figure 18. All homes are in a range of FireSmart compliance. Left: residence with unrated shake roofing with accumulations on roof and in gutters. Right: residence with unrated vinyl siding, rated roofing, and FireSmart landscaping, including pruned conifers visible in the far right foreground.

Landscaping in the study areas is not common; much of the private property is maintained in a close to natural state (*i.e.* there are far less plantings than in more urban areas). During field visits, homeowners undertaking FireSmart compliant property and home improvements were found in every study area, including fire wood piled away from homes, pruning, cleaning out underbrush, and thinning. On the other hand, there are many homes and properties in a very high state of hazard due to fuel accumulations and proximity of flammable fuels to structures. Thick, dense coniferous regeneration within 10 m of a home and coniferous overstory accumulations in roof corners and gutters were not uncommon. Firewood stacked adjacent to, or directly under structures increased the hazard of many homes.

Generally speaking, second, or vacation, homes and cabins were more likely to have hazardous fuels near to their homes (firewood, conifer trees with low branches, etc.). The difference between primary residents and second homeowners was particularly notable in the most rural study areas with a high proportion of second homeowners to primary residents (Birkenhead Lake Estates, Lillooet Lake Estates, and Ponderosa).

Figure 19. Two homes in the same study area. Left: home is completely surrounded by a very dense, juvenile pine forest. Right: homeowner has undertaken thinning and clearing around the home.

Homes that were landscaped were generally FireSmart compliant. The most common landscaping material around homes was well-maintained grass.

Detailed FireSmart compliant construction and FireSmart landscaping information is found in APPENDIX F: FIRESMART CONSTRUCTION AND LANDSCAPING.

It is recommended that a multi-prong plan be put in place that addresses reducing the fire hazard on private land. Due to the long emergency response time for many of the study areas (either by BCWS or local fire departments), it is recommended that a multi-prong plan be put in place to increase FireSmart compliance on private land. This plan should incorporate public awareness around hazard on their property and within their neighbourhood, recruitment of communities into the FireSmart Canada Community Recognition Program, and providing support and resources to help them overcome small hurdles which may be hindering action in their community.

6.2 FIRESMART FUEL TREATMENTS

FireSmart fuel treatments are an effective method of reducing the ease with which fire can move to and from a home. Treatments are completed by altering the vegetation around the home; the type of alteration required is determined by the distance from the home, or value at risk (Figure 20).

The following information regarding fuel treatments is based on the FireSmart Manual (Partners in Protection 2002).

Priority Zone 1 is a 10 m fuel free zone around structures. This ensures that direct flame contact with the building cannot occur and reduces the potential for radiative or conductive heat to ignite the building. While creating this zone is not always possible, landscaping choices should reflect the use of less flammable vegetation such as deciduous shrubs, herbs and other species with low flammability. Coniferous vegetation such as juniper or cedar shrubs and hedges should be avoided, as these are highly flammable. Any vegetation in this zone should be widely spaced and well setback from the house.

Priority Zone 2 extends from 10 to 30 m from the structure. In this zone, trees should be widely spaced 5 to 10 m apart, depending on size and species. Tree crowns should not touch or overlap. Deciduous trees have much lower volatility than coniferous trees, so where possible deciduous trees should be preferred for retention or planting. Trees in this area should be pruned as high as possible (without compromising tree health), especially where long limbs extend towards buildings. This helps to prevent a fire on the ground from moving up into the crown of the tree or spreading to a structure. Any downed wood or other flammable material should also be cleaned up in this zone to reduce fire moving along the ground.

Priority Zone 3 extends from 30 to 100 m from the home. The main threat posed by trees in this zone is spotting, the transmission of fire through embers carried aloft and deposited on the building or adjacent flammable vegetation. To reduce this threat, cleanup of surface fuels as well as pruning and spacing of trees should be completed in this zone (Partners in Protection 2002).

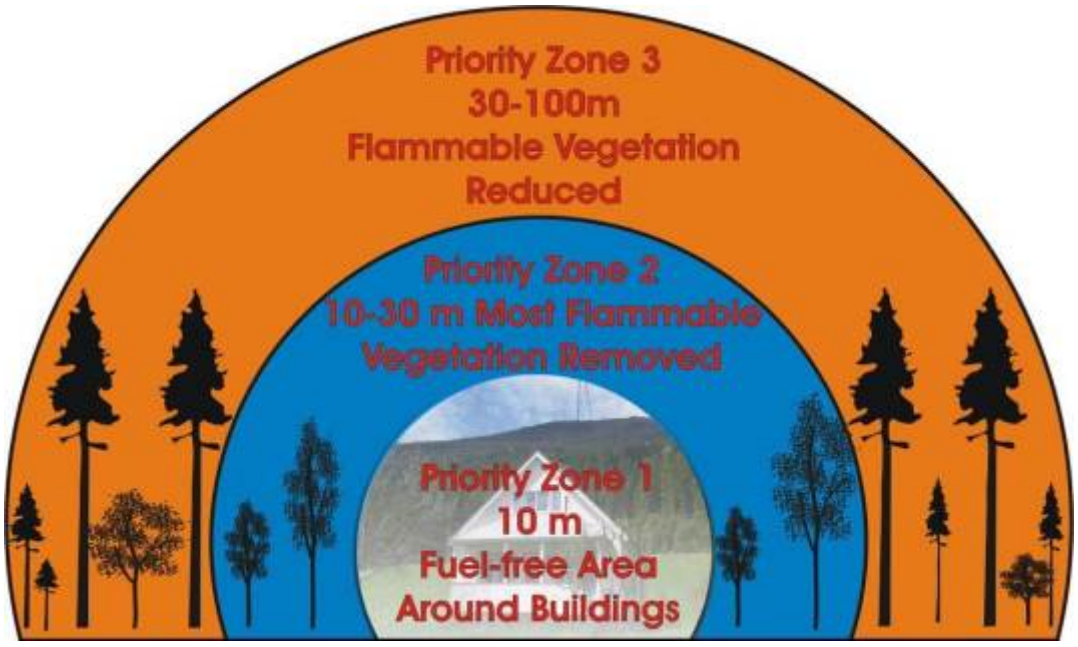


Figure 20. Illustration of FireSmart zones. (Figure adapted from FireSmart)

7.0 ACTION PLAN

The following material consists of the key elements of the CWPP and provides recommendations to address each element. The elements discussed in this section include: Communication and Education; Structure Protection and Planning; Emergency Response and Preparedness; Planning and Development; and Fuel Management.

7.1 COMMUNICATION AND EDUCATION

The establishment of tools to reduce fire risk is one of the keystones to building a FireSmart community. Without the support of the community, the efforts of public officials, fire departments, and others to reduce wildfire will be hindered. In many communities there is a general lack of understanding about interface fire and the simple steps that can be taken to minimize risk. Additionally, public perception of fire is often underdeveloped due to public confidence and reliance on local and provincial fire rescue services. In communities where the dangers of wildfire are understood, there is increased support and interest in reducing fire risk and tools to reduce fire risk are more likely to be adopted.

Based on the consultation completed during development of this Plan, it is evident that the SLRD and local fire departments generally have a good level of awareness of fire risk in the interface; however, field observations highlighted the need to further educate the community on what private landowners can do to build a FireSmart community. The Communication and Education objectives for the study area are:

- To improve public understanding of fire risk and personal responsibility by increasing resident awareness of the wildfire threat in their community and to establish a sense of homeowner responsibility;
- To enhance the awareness of elected officials and stakeholders regarding the fire preparedness of their community and of the actions necessary to improve this state of preparedness; and,
- To inform private landowners of programs, initiatives, and opportunities available to them to aid in wildfire risk and fuels reduction on their properties.

The two principal goals for the SLRD to enhance wildfire related Communication and Education should be to:

- Reduce human-caused fire ignitions; and
- Reduce fire risk on private property.

Communicating effectively is the key aspect of education. Communication materials must be audience specific, and delivered in a format and through a medium that will reach the target audience. Audiences should include home and landowners, school students, local businesses, council and staff, regional directors and staff, local utility providers, and forest tenure holders. Education and communication messages should be simple yet comprehensive. A basic level of background information is required to enable a solid understanding of fire risk issues and the level of complexity and detail of the message should be specific to the target audience.

The SLRD should consider implementing a multi-media education program that maximizes education efforts during the wildfire season. The website could be upgraded to display fire/burning bans when they are in effect. Websites and social media are some of the most cost-effective methods of communication available. The local fire

departments could utilize websites and social media to communicate fire bans, wildfire prevention initiatives and other real time information.

The SLRD has been proactive at distributing FireSmart information at community public events; this can be expanded upon and/or adapted to further enhance wildfire preparedness and education. The SLRD should consider developing or recruiting elementary school curriculum, which could include both fire and safety program and also include wildfire preparedness. This curriculum could be presented annually in elementary schools around the Regional District. Programming could include volunteer/ advocacy work from professional foresters, wildland firefighters, local fire departments, and Regional District staff. Costs for program development and resourcing required for administration and implementation could be shared by multiple jurisdictions/ governments (across many electoral areas and the member municipalities, as well as First Nations governments).

Provincial funding for fuel management is only provided for public lands. It is important for homeowners to understand what they can do to reduce the risk of wildfire damage to their property or adjacent residences. In particular, WUI property owners need to be made aware of their responsibility to implement FireSmart mitigation measures on their properties and also understand how their contributions benefit community wildfire safety.

FireSmart information material is readily available and simple for municipalities to disseminate. It provides concise and easy-to-use guidance that allows homeowners to evaluate their homes and take measures to reduce fire risk. However, the information needs to be supported by locally relevant information that illustrates the vulnerability of individual houses to wildfire.

Bringing organizations together to address wildfire issues that overlap physical, jurisdictional or organizational boundaries is a good way to help develop interagency structures and mechanisms to reduce wildfire risk. Engagement of various stakeholders can help with identifying valuable information about the landscape and also help provide unique and local solutions to reducing wildfire risk. The SLRD should consider leading the establishment of a regional interface committee to coordinate wildfire risk reduction efforts and aim to integrate forest licensees that are operating within the TSA. MFLNRO has expressed support of this idea and would like to increase communication between the SLRD and the District Forest Management Leadership Team (FMLT), which includes both licensees and consultants within the TSA.[26] Coordination of fuel management activities with forest licensees could significantly aid in the establishment of large, landscape-level fuelbreaks or compliment current or proposed fuel treatment areas.

[26] Personal communication, Frank DeGagne. January 31, 2017.

Table 6. Summary of Communication and Education recommendations. Recommendations which are potentially eligible for UBCM/ SWPI funding are identified with an asterisk.

Communication and Education			
Item	**Priority**	**Recommendation**	**Estimated Cost to SLRD and possible funding opportunities ($)**
Objective: To improve public understanding of fire risk and personal responsibility by increasing resident awareness of the wildfire threat in their community and to establish a sense of homeowner responsibility.			
1	High	• Leverage and expand social media presence (e.g., Facebook, Twitter, etc.) to communicate fire bans, high fire danger days, wildfire prevention initiatives, easily implementable FireSmart activities, and updates on current fires and associated air quality, road closures, and other real time information. Facilitate social media expansion for local Fire Departments to ensure that issues specific to their area are available to their community.	Within current operating budget
2	High	• This report and associated maps to be made publicly available through webpage, social media, and public FireSmart meetings.	Within current operating budget
3*	High	• Regular updates of the CWPP to gauge progress and update the threat assessment for changes in fuels, forest health, land planning, stand structure or changes to infrastructure in the interface. Updates should be completed every 5 - 7 years.	UBCM/ SWPI funding/ Municipal funding (SWPI funds up to 75% of update cost)
4	Moderate	• Upgrade the SLRD website to display or link real time information on fire bans and high fire danger. FireSmart information and wildfire preparedness links and information are currently readily available.	$500
5	Moderate	• Establish a school education program to engage youth in wildfire management. Consult the Association of BC Forest Professionals (ABCFP) and BCWS (the zone) to facilitate and recruit volunteer teachers and experts to help with curriculum development and to be delivered in elementary and/or secondary schools. Educational programming can be done in conjunction with programs on fire extinguisher training and should include local fire departments in curriculum development and presentation. Costs to be shared regionally (multiple Electoral Areas, member municipalities, and First Nations).	$2,000
6	Low	• The SLRD should continue to install fire danger rating signs in strategic locations across the study areas. Recreation sites and high-use recreational areas that are not already signed should be targeted first.	$500 - $1,000 per sign

Communication and Education			
Item	**Priority**	**Recommendation**	**Estimated Cost to SLRD and possible funding opportunities ($)**
Objective: To enhance the awareness of elected officials and stakeholders regarding the resources required to mitigate fire risk.			
7	High	• Establish a Wildfire Suppression Group (N'Quatqua Band, SLRD, MFLNRO, BCWS, Lil'Wat, and forest licensees) to identify wildfire related issues in the area, resource deficiencies, and to allow for a coordinated and cost-sharing approach to wildfire mitigation.	Within current operating budget
8	High	• Create and maintain a spatial database that includes CWPP spatial data for all CWPPs that have been developed on, or include threat assessments and recommendations over, SLRD jurisdiction land. This includes amalgamating spatial data from SWPI/UBCM, RMOW, Lil'Wat Nation, N'Quatqua Band, and SLRD. This database can be used in the regional wildfire mitigation planning for the Wildfire Suppression Group.	$1,500 + maintenance costs (annual or biennial updates)

7.1.1 COMMUNICATION WITH INDUSTRY

Risk of human-caused ignition within the study areas is not limited to private property owners and individual residents. Railways, power lines, and forest industry activity all pose a risk of ignition, particularly in areas where cured fuels or fuel accumulations exist. Train cars can cause sparks that ignite cured fuels along the railway tracks and tree failures adjacent to power lines (transmission and distribution) are common occurrences and represent significant risks of ignition within the study areas. Industrial operators have further responsibility, in terms of road maintenance, to ensure that fine fuels are not allowed to accumulate along right of ways, for example. Independent power producers (such as run-of-the-river hydro projects) may be potential partners in wildfire hazard mitigation, as their infrastructure includes power generation sites, roads, penstocks, and power lines.

Table 7. Summary of Communication with Industry recommendations.

Communication with Industry			
Item	**Priority**	**Recommendation**	**Estimated Cost to SLRD and possible funding opportunities ($)**
Objective: To reduce the risk of ignition from industrial sources.			
9	High	• Work with industrial operators to ensure that right-of-ways do not contain fine fuel accumulations (easily cured) prior to the fire season and further are maintained in a low hazard state. Work with industrial operators to ensure that high risk activities, such as right of way mowing, do not occur during high or extreme fire danger times to reduce chance of ignitions. Industrial operators include CN Rail, BC Hydro, licensees, and independent power producers.	Within current operating budget
10	High	• Work with BC Hydro to ensure that hazard trees along distribution lines are assessed regularly. Work with BC Hydro to ensure that transmission line right-of-ways are maintained in a moderate hazard state and dead, fine fuel accumulations do not occur.	Within current operating budget

7.2 STRUCTURE PROTECTION AND PLANNING

Establishing a FireSmart community will reduce losses and impacts related to wildfire. For this Plan two classes of structures were considered: critical infrastructure and residential or commercial infrastructure. Critical infrastructure is distinct as it provides important services that may be required during a wildfire event or may require additional consideration or protection. As outlined above, FireSmart principles are important when reducing wildfire risk to both classes of structure and are reflected in the outlined recommendations. The structure protection objectives for the SLRD are to:

- Enhance protection of critical infrastructure from wildfire; and
- Encourage private homeowners to voluntarily adopt FireSmart principles on their properties.

The two main avenues for implementing FireSmart include:

- Change the vegetation type, density and setback from the structure; and
- Change the structure (where feasible) to reduce vulnerability to fire and reduce the potential for fire to spread to or from a structure.

Critical infrastructure is important to consider when planning for a wildfire event. The use of construction materials, building design and landscaping must be considered for all structures when completing upgrades or establishing new infrastructure. Additionally, vegetation setbacks around critical infrastructure should be compliant with FireSmart recommendations.

Detailed FireSmart assessments were not completed for critical infrastructure, but general observations were made. In general, infrastructure was constructed of fire resistant material. Critical infrastructure seemed to be generally FireSmart compliant, although regular vegetation monitoring and removal/maintenance is recommended.

Figure 21. Annually monitor vegetation and remove vegetation encroaching upon critical infrastructure (within 10 m) as needed. Mow all grass and weeds. Remove conifer regeneration (left) and ensure that hydrants and standpipes are easily accessible (right).

Water is the single most important suppression resource. Local fire departments depend on stand pipes/ hydrants, but are often limited to water carried aboard emergency vehicles and natural water sources for suppression. It is recommended that the SLRD improve or ensure the accessibility to water for suppression by: identifying and mapping all available water sources and providing that mapping to local fire departments, identifying areas of particularly poor water availability, ensuring that fire departments have the equipment and knowledge required to access natural water sources, and ensuring that fire departments have emergency vehicles that are able to hold and transport water, working with communities on pumped well systems to ensure they have secondary power sources in case of power outage or electrical failure, and determine locations for man-made water bodies (or underground cisterns)[27] in new wildland developments and areas of poor water availability.

[27] Davies, J. and M. Coulthard. 2006. Squamish-Lillooet Regional District Community Wildfire Protection Plan.

Table 8. Summary of Structure Protection and Planning recommendations. Recommendations which are potentially eligible for UBCM/ SWPI funding are identified with an asterisk.

Structure Protection and Planning			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: Improve the FireSmart conditions of Area C by increasing FireSmart compliance for critical infrastructure, improving suppression abilities for interface areas, and increasing FireSmart compliance on private property.			
11*	High	• For each study area, facilitate their recognition as a FireSmart community. Recruit champions within each study area/ community to implement local projects. Champions should be trained in FireSmart, have educational materials available to them, and be supported by the Regional District and local fire departments to complete fire hazard mitigation projects.	$2,500 UBCM/SWPI FireSmart funding available
12	High	• Review and monitor critical infrastructure, including stand pipes, for FireSmart compliance regularly. Remove vegetation which may be impeding access or impacting fire hazard.	~$1,000
13	Moderate	• Identify and map available water sources (must have adequate supply for suppression purposes during the fire season and be accessible to suppression crews). Identify areas of poor water availability. Enhance the currently existing waterways geospatial database with water availability and accessibility attributes, specific for suppression use.	$1,000

7.2.1 WUI SITE AND STRUCTURE ASSESSMENTS

There are a number of mechanisms that can be employed to motivate/ compel homeowners to reduce the threat to their home, and in turn, to the neighbourhood/ and greater community. One mechanism is to compel change through bylaws or covenants. Another way to motivate change is through education and increased awareness of fire hazard on private property. The reduction of wildfire hazards on private lands generally depends on the homeowner. This includes choices in exterior building materials, setbacks from forest edges and landscaping. In other jurisdictions (notably Colorado Springs, CO and Whistler, BC), programs to increase awareness of fire hazard and spur homeowner action have been implemented successfully. In these jurisdictions, fire hazard assessments were completed for homes in the Wildland Urban Interface. The results of the assessments were shared with the homeowner/ property owner at the time of assessment. The results of the hazard assessments were compiled into a geo-spatial database and made available to the public. Each home and property owner could look up to see the hazard of their property, as well as their neighbours' and how both may contribute to, or lessen, the overall fire hazard and risk of their neighbourhood (Figure 22). This database may be useful for the SLRD or local fire departments as triage assessments and to aid in suppression planning.

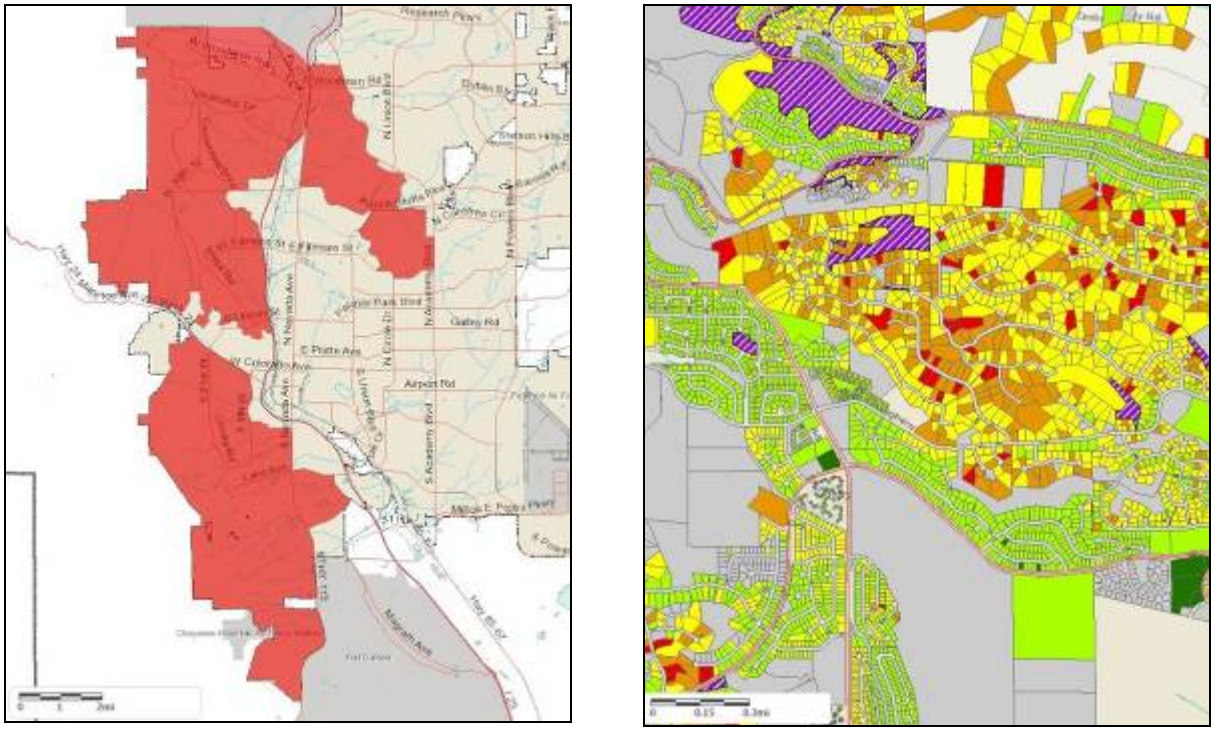


Figure 22. Screen captures of Colorado Springs, Colorado public internet mapping service. The left figure displays the WUI area in red in which fire hazard assessments were completed. The right figure displays a neighbourhood within the WUI area and the fire hazard for each individual property (red is extreme, orange is very high, yellow is high, bright green is moderate and dark green is low).[28]

It is recommended that the SLRD develop a similar fire hazard assessment program. Individual properties in the interface and intermix should be assessed using a FireSmart site and structure assessment form and to provide the results and opportunities for hazard mitigation to the property owner/ resident. Results may be made available spatially on the SLRD's Web Map. Property owners could request a re-assessment upon completion of various mitigative actions and updates posted periodically on the mapping site.

This program could be combined with other initiatives, such as a chipping program, free yard waste drop-off, a scheduled garden debris burning weekend, or include distribution of additional FireSmart educational materials. The program will be most effective if it evaluates hazard, as well as provides property owners the information they need to effectively reduce the hazard and methods to dispose of materials removed.

It is recognized that this program could come at considerable cost to the Regional District. Opportunities for savings may include options such as utilizing a student or work experience program participant to complete the assessments, retaining a consultant to complete the work, recruiting local fire departments to complete the assessments, or targeting the program to the highest priority (highest threat) areas, and then expanding the program in phases, as resources allow. Training one or more community members to complete the assessments

[28] http://gis.coloradosprings.gov/Html5Viewer/?viewer=wildfiremitigation. Colorado Springs, CO.

would have the bonus of capacity building and increasing local knowledge of wildfire risk and mitigative options. The program could be reduced in scope and completed without the spatial data component at considerably less cost, although this would likely reduce effectiveness, as well as the ability to track program results and progress through time.

The recently launched 2015 SWPI FireSmart Grant Program provided funding of up to $10,000 to undertake FireSmart planning activities for private lands. The 2017 intake deadline is January 27th.[29] It is recommended that the SLRD stay up to date on all UBCM/SWPI funding initiatives, in order to leverage FireSmart funding for this and other FireSmart programs, if funding again becomes available.

Table 9. Summary of Structure Protection and Planning recommendations, specific to WUI Site and Structure Assessments. Recommendations which are potentially eligible for UBCM/ SWPI funding are identified with an asterisk.

Structure Protection and Planning			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: Encourage private homeowners to voluntarily adopt FireSmart principles on their properties.			
14*	High	• Complete WUI Site and Structure Hazard Assessments for interface homes, make hazard mapping for assessed homes publicly available, and provide informational material to homeowners on specific steps that they can take to reduce fire hazard on their property.	$10 -$12/ home UBCM/SWPI FireSmart funding available
15*	Moderate	• Remove barriers for landowners by providing methods for them to cheaply and easily dispose of the wood and green waste removed from their property. Programs may include scheduled community chipping opportunities, free green/ wood waste drop-off, or scheduled burning weekends. Information on how to obtain burning permits could be made available.	Cost dependent upon program UBCM/SWPI FireSmart funding may be available (depending on program)

7.3 EMERGENCY RESPONSE AND PREPAREDNESS

Fire protection within the study areas, when available, comes from a variety of emergency service departments. Fire protection for neighbourhoods surrounding Pemberton is provided by the Village of Pemberton Fire Department. The Birken Fire Service Area serves the Pemberton Portage Road corridor from Gramsons in the west to Gates in the east. The fire chief related that the Birken Fire Department routinely attends calls outside their Fire Service Area, and they receive mutual aid from N'Quatqua Fire Department, although they are not aware of any existing official mutual aid agreements between neighbouring departments (Village of Pemberton or N'Quatqua). Wedgewoods is within the Resort Municipality of Whistler Fire Service Area.

The remaining study areas do not have fire protection services and are dependent upon self-sufficiency for smaller incidents and initial attack, with support from BCWS crews. Ponderosa, Lillooet Lakes, and Birkenhead

[29] http://www.ubcm.ca/EN/main/funding/lgps/strategic-wildfire-prevention/2017-swpi-program.html

Lake Estates all have fairly reliable water systems and some wildland firefighting equipment. Lillooet Lakes has an informal group who respond to fires and other emergencies. The community of Ponderosa recently certified 25 community members through S-100 training (2016). Additionally, Ponderosa has created access routes and fuelbreaks across their property and strategically placed portable water tanks for initial attack on their property. Birkenhead Lake Estates pays an on-site property manager to undertake daily management of the property. A portion of the job responsibility includes early fire detection and initial attack, though it is not known if these are formal or informally assumed responsibilities. For the most part, those communities that do not have fire response available are aware of the fire risk in their area, and have the equipment, water, and experience to provide initial attack on very small wildfires until the BCWS crews arrive. These communities also have demonstrated considerable commitment to early detection, awareness of specific local high-risk areas, and commitment to helping the entire community in times of emergency.

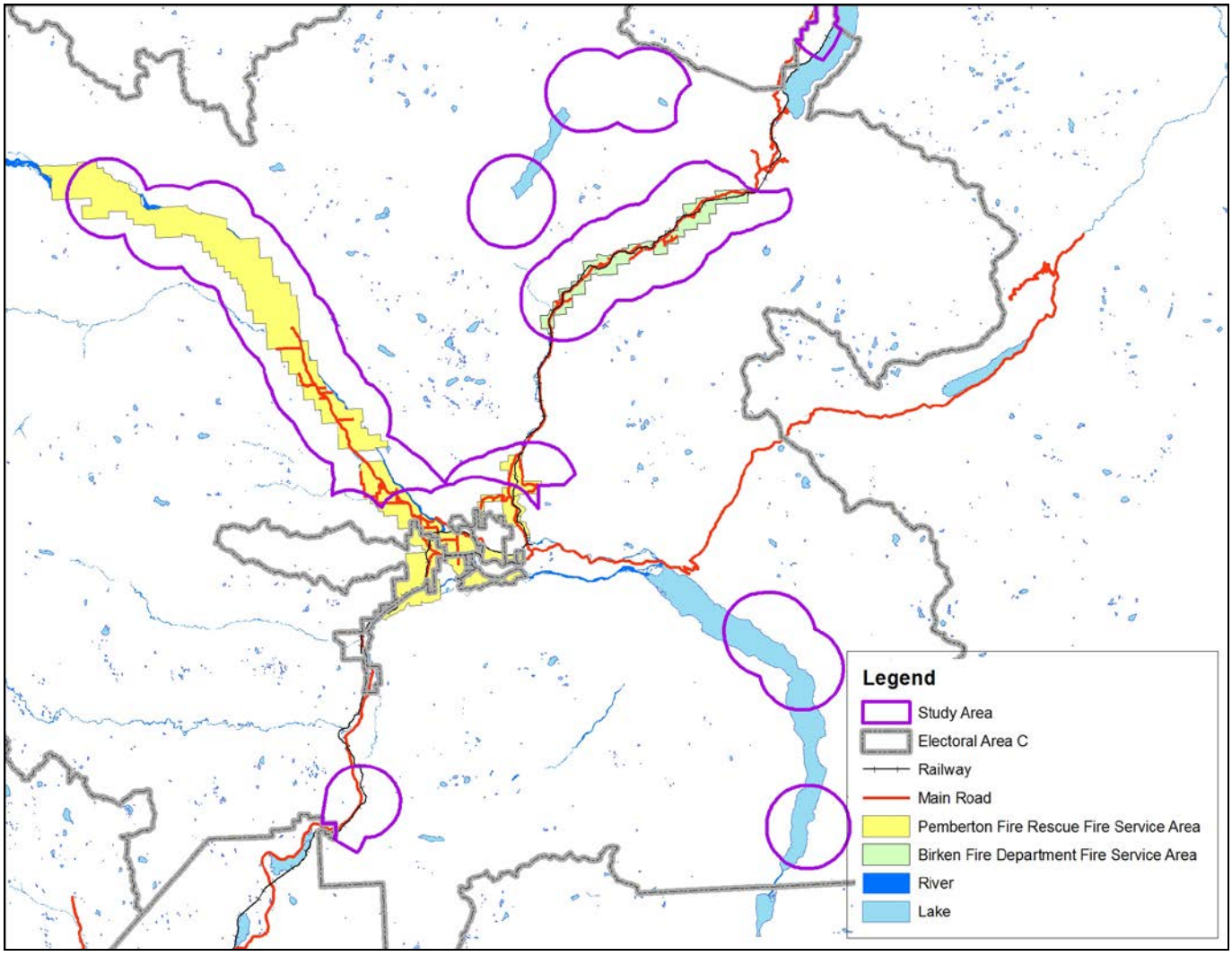


Figure 23. Display of Fire Service Areas within Area C. Please note: spatial data for the Resort Municipality of Whistler and N'Quatqua Fire Service Areas was not available. RMOW Fire Service covers the Wedgewoods study area (southwestern polygon).

The SLRD commissioned a 2013 Fire Services Review in 2013. The purpose of the review was to provide an assessment of the SLRD's fire services, specifically operational effectiveness, risk management, administration and governance structures.[30] The review identified several issues with, and challenges being faced by, the local fire services within the SLRD. The SLRD is currently working towards resolving the challenges identified in the 2013 Fire Review, many of which are related to, but much further reaching than, the scope of this report, as they address the daily function of fire services for structural and interface wildfire response. The fire services model, governance, and daily operations is outside the expertise of a professional forester. Additionally, these challenges were comprehensively outlined in the 2013 Fire Services Review. Because the outcome of the report recommendations are not finalized at the time of document development, this report will focus on what the current fire services model can do to prepare for wildfire and mitigate wildfire risk.

After consultation with the Birken Fire Chief, it was determined that there has been little change in inventory or operations since the development of the above-mentioned review. One notable exception was additional member training completed in 2016: two members became certified to teach Structure Protection Program (SPP) Wildland Firefighter Level 1 and two members completed the Justice Institute's Fire I and Fire II courses. BCWS historically has done some training with the Birken Fire Department, but has not been continued in recent years. Consultation with the Birken Fire Department Chief identified the following challenges:

- Long response times due to geographically spread out fire service areas.
- Member attrition.
- Many homes in the study areas lack visible addresses or addresses are not visible in the dark. This can hinder emergency response or increase response time.
- Lack of understanding or knowing when and from where resources would be available or provided (training, funding, equipment, etc.).

The Birken Fire Department has wildland fire suppression equipment including: 2,000' forestry hose and associated jewelry, Wajax pump, and a Ford F350 to attend interface fires. The Fire Department has expressed a need for a new fire truck, but at this time, there are no concrete plans for purchase. Truck purchase will depend, in part, upon the outcome of the Fire Services Review, as well as type of truck needed to satisfy the Fire Underwriters Survey requirements to allow for fire insurance for area homeowners.

The SLRD does not own a sprinkler protection unit (SPU). The UBCM owns four complete SPUs, each equipped to protect 30 – 35 structures. The kits are deployed by the MFLNRO/ BCWS incident command structure and are placed strategically across the province during the fire season based on fire weather conditions and fire potential. When the kits are not in use, they may be utilized by fire departments for training exercises. SPUs can be useful tools in the protection of rural/ interface homes in the event of a wildfire. It is recommended that the SLRD stays up to date on the location of, and request process for, the UBCM-owned SPUs.[31] It is also recommended that the SLRD consider an SPU training session with the local Fire Services to gain experience with the SPUs available, as well as to assess whether an SPU may be a good investment for the Regional District.

[30] http://www.slrd.bc.ca/inside-slrd/news-events/slrd-completes-fire-services-review

[31] http://www.ubcm.ca/EN/main/funding/lgps/structural-protection-units.html for more information.

Table 10. Summary of Emergency Response recommendations.

Emergency Response and Preparedness			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: To improve structural and wildfire equipment and training available to SLRD local Fire Departments.			
16	High	• The SLRD to organize and facilitate annual cross training opportunities with MFLNRO BCWS, the Birken Fire Department, and key members of each study area. As part of the training, it is recommended to conduct annual reviews to check that PPE and wildland equipment resources for Fire Department are complete, and that the crews are well versed in their set-up and use. Interface training could include completion of a mock wildfire simulation in coordination with BCWS, instruction on early detection and reporting of wildfires. Community members could educate BCWS on their water systems and suppression capabilities and equipment. It is recognized that BCWS crew resources are limited and their availability and is highly dependent upon the current fire season and other BCWS priorities. Coordination with adjacent communities and First Nations for cross-training opportunities would benefit the entire region.	$2,000 - $4,000 (annually)
17	High	• The SLRD to provide reflective house numbers and instructions about how and where best to affix them to facilitate emergency response. Research possible funding opportunities to offset costs.	$3,000
18	High	• Work with the fire departments to inventory equipment, identify gaps, and source replacements and/or new equipment, as needed. Ensure that wildland-specific equipment, water delivery, and equipment required to access natural water sources, are included in the assessment.	Within Current Operating Budget
19	Moderate	• Review UBCM-owned SPU request procedure. Complete training with SPU and assess sprinkler needs based on training outcomes.	Within Current Operating Budget
20	Moderate	• Working with community groups, consider the purchase of basic structural protection sprinkler system and trailer to provide interface protection. The system should be sufficient to provide protection to 15 – 20 rurally spaced houses/ structures. The trailer and system could be deployed to high fire danger areas or areas with impending wildfire. Local fire departments should be trained on their use.	Pre-assembled kits are approximately $3000 per 4 houses. Custom kits could be assembled for considerably less.

7.3.1 EVACUATION AND ACCESS

Evacuation and access is a major limitation in many of the study areas across Area C. Both study areas on Lillooet Lake are accessed by In-SHUCK-ch Forest Service Road. If travel to the north on this road is cut-off, access to Fraser Valley is approximately four hours on unpaved logging roads.

Area C is accessed largely by Hwy 99, the Sea-to-Sky Highway, which runs through Pemberton and continues out of the Electoral Area north to Lillooet. The communities of Ponderosa, Birken, Gramsons, Devine, and Birkenhead Lake have one dependable, paved, four season access route: Pemberton Portage Road. There is a maintained gravel access road (Highline Road or Douglas Trail Road) to the north which leads to Seton Portage. This road

traverses the steep slopes to the west of Anderson Lake and is not recommended for regular vehicular use (*i.e.* high clearance 4WD is necessary). This restricts emergency access/ egress to the Pemberton Portage Road, which could be limited depending on location of fires or other emergencies[32]. Pemberton Portage Road is situated in the same direction as funneled Pacific in/ outflows, increasing the possibility of wildfire being channeled down the same valley that residents would use for emergency evacuation. The communities along Lillooet Lake are accessed by In-SHUCK-ch Forest Service Road (FSR). Wedgewoods and Pemberton are both accessed from Hwy 99 and egress is available to the north and south, although the highway is narrow and winding.

Road networks in a community serve several purposes including providing access for emergency vehicles, providing escape/ evacuation routes for residents, and creating fuelbreaks. Access and evacuation during a wildfire emergency often must happen simultaneously and road networks should have the capacity to handle both. Access throughout the study area is limited, as such if wildfire were to block roads, particularly Pemberton Portage Road, evacuation of several communities would be severely limited. Smoke and poor visibility can further complicate evacuations and hinder safe passage.

In addition to the safe evacuation of residents, safety of firefighting personnel is a major consideration. Under extreme fire conditions, it may be difficult for Fire Departments or BCWS to access areas due to potential for resources to be entrapped by fire. Defense of property is secondary to safety.

The SLRD Emergency Management Program (EMP) is responsible for coordinating the regional response and recovery programs in the event of a major emergencies or natural disaster. The EMP identifies local hazards and issues local hazard warnings, shelter in place orders, and evacuation orders. This system includes the SLRD Alert, which is an emergency notification system for residents of the Regional District. The EMP provides residents with important information on emergency preparedness and maintains partnerships with member municipalities and provincial emergency management Evacuation plans for specific study areas are not in place. No study-area specific emergency evacuation planning is in place.

Emergency access and evacuation planning is of particular importance in the event of a wildfire event, but is also important during large public events. An evacuation plan could:

- Map and identify safe zones, marshalling points and aerial evacuation locations;
- Plan traffic control and accident management;
- Identify volunteers that can assist during and/or after evacuation;
- Create an education/communication strategy to deliver emergency evacuation procedures to residents.

The SLRD should lead the development of emergency evacuation plan specific to the study areas/ communities, prioritizing those communities with the most vulnerable access routes (Birken/ Gramsons/ Gates, Birkenhead Lake Estates, Birkenhead Lake North/ Blackwater, Lillooet Lake Estates, Lizzie Bay, and Ponderosa). The SLRD should coordinate with key community members, MFLRNO, and licensees, where relevant. The evacuation plan

[32] A mudslide in September 2015 closed the Pemberton Portage Road and the Highline Road and left residents between Birken and D'Arcy isolated and without power for two days. A previous slide in 2013 resulted in similar circumstances. This highlights the vulnerability of these communities in regards to access and egress.

should contain a strategy to ensure that emergency services announcements are communicated to the entirety of the communities, focusing strategies to reach those communities with unreliable or unavailable cellular service.

Table 11. Summary of Evacuation and Access recommendations.

Emergency Response (Evacuation and Access)			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: To improve access and egress and enhance emergency preparedness and study area-specific evacuation plans.			
21	High	• The SLRD should consider development of study-area specific evacuation plans in coordination with the RCMP to: map and identify safe zones, marshaling points and alternative (aerial and water) evacuation locations; plan traffic control and accident management; identify volunteers that can assist during and/or after evacuation; and create an education/ communication strategy to deliver information. Communication plans may require alternative strategies for areas with limited or unavailable cellular service.	TBD

7.3.1.1 TRAILS MANAGEMENT

The 2006 CWPP contains 3 recommendations specific to the use of trails as fuelbreaks (Rec # 16 – 18 in APPENDIX A: STATUS OF 2006 CWPP RECOMMENDATIONS. The objective of this section is to provide additional clarity and direction around trails management and trail building and to build upon the recommendations from the 2006 CWPP. Trails can act as effective fuelbreaks for surface fires and, depending on width, clearance, and surface, can provide access for equipment and control lines for suppression efforts.[33] This should be considered when planning new trails and maintaining or improving currently existing trails.

In order to reduce the chance of fire spread upon ignition and to act as a fuel break for surface fires, trail side conifers should be pruned to a minimum of 2 m in height and higher on slopes. Thinning activities (flammable understorey and intermediate conifer ladder fuels) should be undertaken on 5 m of either side of the trail centreline. Trails should be down to mineral soil (or of non-combustible surfacing material) and a width of 1 m to allow for ATV travel. A trail 4.5 m wide can be used for pick-up truck access.

Prior to implementation of fuel management projects along registered trails and recreation sites, it is recommended that the SLRD engage MFLRNO District Recreation Sites and Trails Branch staff to explore for potential review of treatment plans and possible aid in public and community engagement and communication, particularly with local groups with which the MFLNRO may have an established relationship.

It is important that trail building and maintenance does not result in residual fuels which increase the fire hazard. Minor work (pruning or individual tree falling) can usually be mitigated by scattering fuels in a discontinuous manner at a distance more than 5 m from the trail. Larger volumes of biomass resulting from larger thinning, pruning, or trail building operations should be burned, chipped and spread, or removed off-site. Fuels

[33] Davies, J. and M. Coulthard. 2006. Squamish-Lillooet Regional District Community Wildfire Protection Plan.

accumulations from trail work can significantly increase the chance of ignition and increase potential fire behaviour should an ignition occur, such as from an errant cigarette butt or other human-caused ignition.

Mapping or spatial data of the trail network, or a total access plan, can be used by Local Fire Departments and the BCWS to aid in suppression efforts of interface natural areas. Total access plans should, at a minimum, include maps and spatial data of the existing trail network, identify the type of access available for each access route (foot, ATV, pick-up, etc.), identify those trails which are gated and/or have barriers, and provide information as to how to unlock/ remove barriers (key location, etc.). The plan could also identify those natural areas where access is insufficient and prioritize areas of trail building to improve access. Access assessment should consider land ownership, proximity of values at risk, wildfire threat, opportunities for use as fuel break/ control lines, and opportunities to use trails for future fuel treatment activities (operational access for fuel treatments and other hazard reduction activities).

Table 12. Summary of trails management and access recommendations.

Emergency Response (Trail Management and Access)			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: To improve access to interface natural areas and reduce chance of ignition and potential fire behaviour along high-use recreational trails.			
22	Moderate	• Establish trail standards that will ensure that trails act as surface fuelbreaks and provide access for suppression crews. To act as a surface fuel break, provide access for equipment and crews, and serve as a control line, trails should be 1 m wide, pruned to a minimum of 2 m in height (slope dependent), and thinned within a minimum of 5 m of trail center. Trails can be prioritized for their potential as fuelbreaks, depending on location and current state (width, adjacent fuels, and accessibility).	Dependent upon trails prioritized
23	Moderate	• Develop standards for the abatement of residual activity fuels associated with trail building and trail maintenance. Trail crews should be educated on mitigation of fuels accumulations resulting from their regular maintenance activity. Standards should include fuel disposal or mitigation methods (scattering, chipping, burning, or removal, dependent upon location, amount of material, and access). Fuels from trail maintenance and trail building should not be allowed to accumulate trailside.	Within Current Operating Budget
24	Moderate	• Develop a Total Access Plan to map and inventory trail and road network for suppression planning, identification of areas with insufficient access and to aid in strategic planning. The plan should be updated every five years, or more regularly, as needed to incorporate additions or changes.	$5,000 - $10,000

7.4 PLANNING AND DEVELOPMENT

Municipal policy and bylaws are tools available to mitigate wildfire risk to the Regional District. It is recognized that, in order to be successful, all levels of government (municipal, provincial, and federal) and individual landowners need to work together to successfully reduce their risk. To a large extent, private landowners and industry can determine whether a local government policy can be successfully implemented. On the other hand, it is important for local and regional governments to educate the public on the associated risks, and to show

leadership to help reduce that risk to the Regional District and the individual community members, their homes and properties, and other values at risk.

Policy tools can be developed and implemented to help incrementally adopt FireSmart building standards over the mid-term (5 – 20 years) and reduce the chance of structure loss from wildfire. Minimum setbacks, fire vulnerability standards for roofing materials, and sub-division design standards are examples of tools available to the Regional District to ensure that new builds or major renovations (such as roof replacements) are adopting FireSmart principles.

At the time of plan development, the SLRD does not identify a wildfire hazard development permit area within the OCP, although Area C is in the process of updating zoning to include a Wildfire Hazard Development Permit Area and requirements. A wildfire hazard designated permit (DP) area would grant the Regional District the ability to impose building restrictions more stringent than the building code and require additional actions by developers and home builders.

A review of other jurisdictions' successfully implemented DP processes suggests that DPs can be used effectively to gradually phase in FireSmart practices on private land, both in the sub-division and individual lot re-development phase. The District of North Vancouver has a robust Wildfire Hazard Development Permit process, which could serve as a model for the Regional District from which aspects or components can be adapted. Within the Wildfire Hazard DP area in the District of North Vancouver, DPs are triggered at the building permit phase. Wildfire hazard assessments include review and approval of building materials, building design, setbacks, and landscaping (natural and planted). Bonds collected by the District are not returned to the homeowner or developer until a Qualified Professional has provided a post-development inspection sign off and photographs to ensure that recommendations regarding landscaping, setbacks, and exterior building materials were met. Through this process, the new lots and existing housing stock within the District of North Vancouver is rapidly converting to meeting FireSmart standards in both building materials and landscaping.

Alternatively, the building requirements for Wedgewoods can be viewed as an example and adapted for other sub-division developments. It is recognized that a DP process as in depth or stringent in the requirements as in North Vancouver or in Wedgewoods may not be appropriate across the entirety of the Regional District. However; creation of a DP area would allow the District to impose rules to mitigate fire hazard for interface development, such as requirement of rated roofing during new builds or for roof replacements, minimum setbacks from a forested edge and top of slope, and fuel mitigation activities on private land for new builds.

Section 5 of the Building Act provides local governments the authority to set local building bylaws for unrestricted and temporarily unrestricted matters, such as exterior design and finish of buildings in relation to wildfire hazard and within a development permit area. Until revisions of the Building Code to include requirements specific to prevention of wildfire spread are completed, local governments have the ability to set exterior requirements within the development permit area.[34] It is recommended that the Regional District consider amending the OCP, identifying a wildfire hazard DP area, and developing a terms of reference for DP requirements.

[34] Building and Safety Standards Branch. 2016. Bulletin No. BA 16-01 Building Act Information Bulletin: Update for Local Governments.

In the 2006 CWPP, it was recommended to require that builders submit detailed landscaping plans that follow the FireSmart guidelines. Should the SLRD choose to amend the OCP, FireSmart landscaping plans can be required as part of the DP process. At a minimum, it is recommended the Regional District provide landscaping information to those completing new builds. The landscaping information can be a list of native and non-native low-flammability plants that are suited to the climate. This list can serve to guide those that wish to plant within 10 m of their home. Detailed FireSmart Landscaping information can be found in APPENDIX F: FIRESMART CONSTRUCTION AND LANDSCAPING.

Fire protection or services bylaws are another tool available to the Regional District to compel homeowners to mitigate the fire risk on their property, as well as reduce the risk of human-caused ignitions. To that end, the SLRD's Regulation of Fire Protection Services Bylaw (Bylaw No. 1110, 2008) should be reviewed and strengthened. Additions to the bylaw could include: more explicitly stated regulation of conditions on private property (not allowing accumulations of combustible materials), forest fire hazard prevention regulations (granting power to temporarily close facilities, trails, etc., through or near forested areas), fireworks restrictions, as well as controlling open burning and campfires. It is recognized that enforcement is difficult, although strengthening the bylaw would provide a lever for the SLRD to compel desirable actions and behaviours from major offenders or in times determined to be very hazardous (several days of sustained high or extreme danger class, for example). The District of Squamish Fire Service Bylaw No. 2314, 2014 and Village of Pemberton Fire Prevention Bylaw No. 744, 2013 are good examples of robust Fire Service Bylaws. Campfire and BBQ bans, as noted in the current bylaw, should be consistent with campfire bans as issued by the BCWS for the appropriate fire zone (Pemberton or Lillooet).

Table 13. Summary of Planning and Development recommendations.

Planning and Development			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: To reduce wildfire hazard on private land, increase number of homes in FireSmart compliance, and decrease risk of human-caused ignitions.			
25	High	• Review and amend Bylaw No. 1110, 2008 to explicitly include items regarding hazardous accumulations of combustible materials, forest fire prevention regulations, and fireworks restrictions.	TBD
26	High	• Ensure that Bylaw No. 1110, 2008 campfire and BBQ bans are applied and enforced consistent with campfire bans issued by the BCWS for the appropriate fire zone.	TBD
27	Moderate	• Consider amending OCP to include Wildfire Hazard Development Permit Areas within which building standards and fuel mitigation activities can be enforced (rated roofing requirements, minimum setbacks from forested edge and top of slope, rated exterior building materials, and fuel management activities such as thinning, brushing, or pruning).	Within Current Operating Budget – In Process
28	Low	• Develop a comprehensive list of native (and non-native), low-flammability, climatically suited (low maintenance) trees, shrubs, and herbs which are appropriate to plant within 10 m of structures. This list should be distributed to individual home builders, developers, and the general public as part of a FireSmart initiative.	$500

7.4.1.1 SUBDIVISION DESIGN

Subdivision design should include consideration to decrease the overall threat of wildfire. The major aspects of subdivision design that influence wildfire risk are access, water pressure and hydrant locations. The number of access points and the width of streets and cul-de-sacs determine the safety and efficiency of evacuation and emergency response. Changing access in existing subdivisions is also costly if the road is not being built for other purposes. However, in terms of life safety during evacuation, the costs of road building are likely to be justified where access is particularly bad. In interface communities, roads are often narrow and densely vegetated in order to protect the privacy of homes and the character of the neighbourhood. On-street parking can also contribute to the hazard on these roads, which are already unlikely to have a high capacity under heavy smoke conditions (Cova 2005). When the time for evacuation is limited, poor access has contributed to deaths associated with entrapments and vehicle collisions during wildfires (DeRonde, 2002). Methodologies for access design at the subdivision level can provide tools that help manage the volume of cars that need to egress an area within a given period of time (Cova 2005). New subdivisions should be developed with access points that are suitable for evacuation and movement of emergency response equipment.

Where forested lands border new subdivisions, consideration should be given to requiring roadways to be placed adjacent to the forested lands (ring roads). Ring roads improve access to the interface for emergency vehicles and provide a fuel break between the forested wildland and the subdivision. Ring roads are generally not desirable for developers, as they increase road and infrastructure costs. Additionally, the market price for houses directly adjacent to forested land, as opposed to those on ring roads, is generally higher. The higher costs of subdivision design which incorporate wildfire hazard reduction considerations should be weighed against the cost of subdivision replacement, in the case of a devastating wildfire, as well as potentially lower insurance premiums.

The width of water mains can impact the water pressure available to fire fighters. The spacing of fire hydrants influences how effectively fire fighters can protect structures. Water mains and hydrant spacing can be improved in new subdivisions with a marginal increase in cost. However, the cost of changing these factors in existing subdivisions is extremely high and is not generally practical. If a subdivision is to be serviced by the SLRD (water mains and/or hydrants), their quantity and locations should be considered and approved in subdivision design review by a Fire Professional.

Table 14. Summary of subdivision design recommendations.

Planning and Development (Subdivision design)			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: To incorporate wildfire hazard reduction considerations in subdivision design.			
29	High (with approval of new subdivisions)	• New subdivisions should be developed with access points that are suitable for evacuation and the movement of emergency response equipment. The number of access points and their capacity should be determined during subdivision design and be based on threshold densities of houses and vehicles within the subdivision.	Within current operating budget

Planning and Development (Subdivision design)			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
30	High (with approval of new subdivisions)	• Where forested lands border new subdivisions, consideration should be given to requiring roadways to be placed adjacent to those lands. If forested lands surround the subdivision, ring roads should be part of the subdivision design. These roads both improve access to the interface for emergency vehicles and provide a fuel break between the wildland and the subdivision.	Within current operating budget
31	High (with approval of new subdivisions)	• Proximity of hydrant locations to access points for forested parks should be a consideration during the design process for new subdivisions.	Within current operating budget
32	Moderate (with approval of new subdivisions)	• Consider establishing or enhancing existing water bodies that could serve as emergency water sources in areas of new development.	TBD

7.5 FUEL MANAGEMENT

Fuel management (also referred to as vegetation management or fuel treatment) is generally considered a key element of a FireSmart approach. The principles of fuel management are outlined in detail in APPENDIX G: PRINCIPLES OF FUEL MANAGEMENT.

The SLRD has developed a Wildfire Fuel Management Projects Policy to guide in their identification, assessment, and implementation of fuel management projects in areas with hazardous fuels.

Area C has not completed any fuel management activities to date, though there are fuel management prescriptions signed and ready to implement; two fuel management projects are considered 'shovel-ready'. To complement the work completed to-date and to further reduce the wildfire risk in the study area, the objectives for fuel management are to:

- Reduce wildfire threat on private and public lands near to values at risk through shovel-ready fuel management projects;
- Reduce fire hazard, improve access/ egress, and mitigate the impact of wildfires within access corridors within and around the study areas; and,
- Establish landscape-level fuelbreaks to enhance community protection.

These objectives will enhance protection to homes and critical infrastructure by proactively reducing fire behaviour.

As discussed above, fuel treatments are designed to reduce the possibility of uncontrollable crown fire through the reduction of surface fuels, ladder fuels and crown fuels. This threshold of reduction varies by ecosystem type, current fuel type, fire weather, slope and other variables. Additionally, fuel management can be an effective method of reducing fire behaviour; however, it is important to note that it does not stop wildfire. The purpose of

altering vegetation for fire protection must be evaluated against the other key CWPP elements (outlined above) to determine its necessity.

Fuel management can be undertaken with minimal negative or even positive impact on the aesthetic or ecological quality of the surrounding forest and does not necessarily mean removing most or all of the trees. The focus for fuel management in the interface is not necessarily to stop fire but to ensure that fire intensity is low enough that fire damage is limited. For example, treating around a home may prevent structure ignition due to direct flame contact; at that point, the ability of the home to survive the fire would come down to whether construction materials can withstand or survive an ember shower. The intent of fuel management is not to stop the fire but to reduce fire intensity.

One of the constraints with fuel management is private land: funds from public sources, such as UBCM, are only eligible to be used on Crown lands and cannot be used to treat private land or Provincial Parks. The best approach to mitigate fuels on private lands is to promote FireSmart (as described under Structure Protection and Planning). A FireSmart approach to fuel management within 100 m of structures is considered beneficial in order to improve defensible space around structures and to reduce the likelihood that a house fire could spread to adjacent forests. In general, when considering fuel management to reduce fire risk, the following steps should be followed:

- A qualified professional forester must develop the prescriptions;
- Public consultation should be conducted during the process to ensure community support;
- Treatment implementation must weigh the most financially and ecologically beneficial methods of fulfilling the prescriptions goals;
- Pre- and post-treatment plots should be established to monitor treatment effectiveness; and
- A long-term maintenance program should be in place or developed to ensure that the fuel treatment is maintained in a functional state.

To assess risk, the *Provincial WUI Wildfire Threat Rating Worksheets* (worksheet) were used, as required by UBCM[35], in addition to professional judgment (WUI summaries are provided as a separate document). The worksheet provides point ratings for four components that contribute to wildfire risk. These components include fuels, weather, topography and structural values at risk. Proposed projects to reduce the wildfire hazard to the study area through fuel modification are summarized in the sections below. Detailed maps of recommended project locations are found in APPENDIX H: RECOMMENDED FUEL TREATMENT MAPS BY STUDY AREA.

7.5.1 LIST OF PRIORITY TREATMENT AREAS

As noted above, funding opportunities are currently limited to Crown Provincial, Regional District, or Municipal land. As such, priority treatment areas were, likewise, limited to land that is eligible for current funding opportunities (Crown land).

The following table summarizes the proposed treatment areas. Prioritized treatment areas can be separated into three categories:

[35] http://www.ubcm.ca/assets/Funding~Programs/LGPS/Current~LGPS~Programs/SWPI/Resources/swpi-WUI-WTA-Guide-(2012-Update).pdf

- Shovel-ready projects (detailed assessment completed and prescription developed);
- Synergistic projects between other governments/ jurisdictions and multiple available funding sources (FES and UBCM/ SWPI); and,
- New treatment areas requiring a detailed assessment and prescription development prior to implementation.

The shovel-ready and synergistic opportunities are generally rated as high priority, although it should be noted that synergies and recommended treatments identified in this document which are not within the study area, are at a landscape scale and identified in the Sea to Sky Draft FMP, or are otherwise not feasible to be implemented by SLRD alone are not prioritized. The shovel-ready projects are quick and easy to implement. Furthermore, investment into these projects has been made and the projects should be seen through to completion. The synergistic opportunities are also considered high priority. Although combining multiple agencies may introduce administrative complexity, these projects also represent great opportunities for efficiency (cost and benefit sharing) and therefore should be prioritized for investigation into cooperation and feasibility.

The new treatment areas represent high or extreme fire hazard areas which are close to values at risk. These treatment areas have been prioritized based on the fire hazard, operational feasibility, estimated project cost and expected efficacy of treatment.

Within the study areas, woodlots represent the potential to prioritize commercial harvesting for fuels management.

7.5.1.1 RECOMMENDED TREATMENTS

As a general rule, prescriptions should target crown closure of 40% or less, remove all coniferous regeneration ladder fuels with the exception of isolated patches, reduce surface fuel loading and continuity, and work to achieve natural variation in density and crown openings across the treatment area, as opposed to a uniform implementation. Grass surface fuels should target 40 – 60% cover. Fine (<7 cm diameter) and coarse (>7 cm diameter) woody surface fuels should be scattered: less than 0.5 kg/m^2 and <10% cover, respectively. Larger diameter logs should be favoured for coarse woody fuel retention in order to meet biodiversity objectives (wildlife habitat) and function as coarse woody debris (CWD). It should be noted that prescription details and post-treatment stand targets are highly variable and dependent upon the ecosystem, objectives, and management for other values.

The 2006 CWPP outlines Future (or Target) Stand Conditions for common fuel types in the study area. These conditions may be used as a starting point, or guide, for fuel treatment prescription development. All detailed assessments and fuel management prescriptions should be completed by a Registered Professional Forester with expertise in fire and fuel management and with a sound understanding of fire behaviour. All prescriptions should identify and consider the various overlapping values on the land. A detailed site assessment to consider archaeological and culturally or spiritually significant values (both legislated and identified through First Nations consultation), environmental values (including legislated spatially explicit orders and non-legislated values), and

social values (recreational and other) must take place as part of the prescription development process. Detailed site assessments should have field and office components to ensure that all values are identified and considered.

Site-specific operational challenges exist in almost all treatment areas. Steep ground, limited access, and terrain stability issues are among the constraints that must be further investigated during the detailed assessment and prior to prescription development and implementation. Many polygons are located on steep slopes, which may not be accessible by machinery and limit operations to manual labour. Housing developments, or other structures, often surround treatment areas, or are adjacent on one or more sides, which can further limit debris removal. Additionally, proximity to structures will impact the possibility of pile burning as a method of debris disposal; pile burning must comply with the Open Burning Smoke Control Regulations, which set minimum distances for burning from institutions and residences. Oftentimes, the most cost effective debris disposal method is pile burning of woody waste materials.

In the future, maintenance burns using prescribed broadcast burning or maintenance thinning are recommended every five to fifteen years, depending on polygon ecosystem and productivity and should be scheduled by a forester with experience in fuel management. Regular maintenance will help to avoid the high costs of initial treatment that will be required, if fuel is allowed to accumulate to hazardous conditions post-treatment.

7.5.1.2 SHOVEL-READY PROJECTS

Two polygons have been identified as shovel-ready projects: one adjacent to Birkenhead Lake Estates and one near Gates Lake. The Birkenhead Lake Estates prescription was developed by BCWS and has been partially implemented over the last few years by BCWS crews, as time and resources allow. The polygon is large and flat, with good access, which makes it operationally suitable for a machine treatment. The Pemberton Fire Zone has been using this area as a training opportunity for their crews, but is willing to defer project responsibility at this time due to the polygon size and their limited time and resources during the fire season. The Pemberton fire crews have completed approximately 2.5 ha of the 36 ha project.

The Gates Lake prescription was developed for the SLRD in cooperation with the BCWS. Project implementation has not yet begun. Table 15 details the two projects.

Table 15. List of high priority, shovel-ready projects within Area C.

Treatment Polygon	WUI Threat Plot No./ Fire Behaviour Score	Priority	Approximate Area (ha)	Recommended Treatment Type	Comments/ Rationale
Birkenhead Lake Estates (T.U.s 1, 2, 3)	N/A	High	36.2	Fall and burn understory and suppressed conifers, low and woody shrubs and flammable brush.	Prescription completed (signed June 2014). Prescription objectives are to reduce fire intensity, slow rate of spread, minimize spotting potential and to maintain evacuation route for residents. Approximately 1 ha has been treated by BCWS crews.
Gates Lake (T.U.s 1A, 1B, 2, 3, 4)	1A-PSP07/ 96 1B-PSP14 / 98 2-PSP2/ 74 3-PSP2/ 109 4-PSP2 / 68	High	27.0	Dependent upon treatment unit, a combination of thinning from below, pruning, piling and burning, and/or chipping.	Prescription completed (signed Dec 2015). Treatment area was targeted as a priority area by the BCWS. Prescription objectives are to enhance public safety; secondary objective is ecosystem and habitat restoration. Threat plots completed as part of UBCM-funded fuel management prescription.

7.5.1.3 SYNERGISTIC OPPORTUNITIES

One objective of this document is to identify opportunities to combine multiple funding streams and cost-share between jurisdictions where available. There are two main streams of provincial funding available for fuel management projects: Strategic Wildfire Prevention Initiative funding, administered by the Union of BC Municipalities (UBCM/ SWPI) and the Forest Enhancement Program administered by the Forest Enhancement Society of BC)(FESBC). Generally speaking, UBCM/SWPI funding is available for fuel management projects on Crown or local-government owned land within the WUI (communities and a 2 km spotting buffer surrounding). FESBC funding is available for fuel management opportunities that exist outside the UBCM/SWPI funding structure.

In the case of the opportunities identified in this section, projects over a larger geographical area and with a variety of specific risk reduction and hazard mitigation objectives could be combined to meet the funding criteria for both programs. Furthermore, risk reduction benefits of these projects may be shared regionally across multiple communities; therefore, they are ideal projects to implement cooperatively between multiple local governments.

Areas identified below which are within the study areas are considered to be within the 2 km spotting buffer for wildland urban interface and therefore may be eligible for UBCM/ SWPI funding. In areas where the wildfire behaviour threat class is moderate, UBCM/SWPI funding would only be available for projects supported by the fuels management specialist. In this case, FES funding may be available, depending on the project type and objectives.

Projects detailed below would require funding from both programs to be completed. Furthermore, they may require cooperation and additional funds from more than one local government and/or First Nation.

Pemberton Meadows/ Pemberton surroundings

The S2S FMP draft identifies two landscape level fuelbreaks that cross through the Pemberton surroundings study area, one of which overlaps with area identified as an area of high hazard around the Owl Ridge community, the OWL-1 polygon.

Table 16. List of synergistic opportunities within Pemberton Meadows/ Pemberton Surroundings study area, Area C.

Treatment Polygon	WUI Threat Plot No./ Fire Behaviour Score	Priority	Approximate Area (ha)	Funding Recommendation	Comments/ Rationale
PSLANDSCAPE-1	N/A		453	Seek FESBC funding	Identified in S2S FMP draft as landscape level fuelbreak location. Would require cooperation from Village of Pemberton, SLRD Area C, Lil'Wat First Nation, and BC Hydro. Expands protection provided by the transmission line (1) and forestry road (2). Provide risk reduction to BC Hydro critical infrastructure.
PSLANDSCAPE-2	N/A		307	Seek FESBC funding	

Treatment Polygon	WUI Threat Plot No./ Fire Behaviour Score	Priority	Approximate Area (ha)	Funding Recommendation	Comments/ Rationale
OR-1	OC-1 / 109 OC-2 / 102	High	44.6 (31.9 within SLRD Area C CWPP 2016 update area; 12.7 within Pemberton CWPP study area)	Seek UBCM/SWPI funding for detailed assessment, prescription development, and operational fuel treatment	Polygon partially within the study area; shared with the Village of Pemberton (VOP) CWPP study area. Would provide significant hazard reduction to the Owl Ridge development. Residences and properties in this community are generally FireSmart. Treatment should be completed cooperatively with the VOP. Treatment of this unit independently of the portion within the VOP CWPP will not provide effective fire hazard reduction.

Birkenhead Lake Estates and Birken/ Gramsons / Gates

The S2S FMP draft identifies the Birkenhead Lake Road as an opportunity for a landscape level fuel break. The polygon identified also overlaps partially with the area under prescription adjacent to Birkenhead Lake Estates (see section 7.5.1.2 for details). The proposed landscape level fuel break extends the entire length of Birkenhead Lake Road from Pemberton Portage Road in Gramsons past the entrance for Birkenhead Lake Estates. MFLNRO has identified this polygon as a priority for landscape level treatment and have secured funding to complete fuel treatment prescriptions on the Crown land portions within 100 m of the roadside. Prescriptions are to be completed in 2017; the operational portion of work is planned for 2017/ 2018 pending additional funding.

Table 17. Synergistic opportunities within Birkenhead Lakes Estates and Birken/ Gramsons/ Gates study areas, Area C.

Treatment Polygon	WUI Threat Plot No./ Fire Behaviour Score	Priority	Approximate Area (ha)	Funding Recommendation	Comments/ Rationale

Treatment Polygon	WUI Threat Plot No./ Fire Behaviour Score	Priority	Approximate Area (ha)	Funding Recommendation	Comments/ Rationale
BLELANDSCAPE-1	N/A		287	UBCM/SWPI funding or FESBC funding for prescription development and operational fuel treatment may be sought individually, or in combination. Details regarding funding would require further investigation.	Identified in S2S FMP draft as landscape level fuelbreak location. Hazardous fuels exist along access/ evacuation corridor. Overlaps with area under BCWS prescription, as detailed in section 7.5.1.2.

Birkenhead Lake North/ Blackwater

The N'Quatqua CWPP update (2016) recommends treating the high hazard fuels along Blackwater Road for landscape level strategies (polygons J1 and J2). The S2S FMP draft identifies the Blackwater Road corridor (including both BW-10 and BW-11 polygons) as a location for landscape level fuel break. There are two recommended polygons along the Blackwater Road: BW-10 which is a FireSmart fuel management project adjacent to the Blackwater community, and BW-11 which is to create a safe evacuation corridor for residents and Provincial Park guests and recreationalists.

MFLNRO has identified this access road as a priority for landscape level treatment and have secured funding to complete fuel treatment prescriptions on the Crown land portions within 100 m of the roadside. Prescriptions are to be completed in 2017; the operational portion of work is planned for 2017/ 2018 pending additional funding.

Table 18. Synergistic opportunities in Birkenhead Lake North/ Blackwater study area.

Treatment Polygon	WUI Threat Plot No./ Fire Behaviour Score	Priority	Approximate Area (ha)	Funding Recommendation	Comments/ Rationale
J1	N'Quatqua CWPP/ 96		98.4	Seek FESBC funding	Identified as moderate priority in the N'Quatqua

Treatment Polygon	WUI Threat Plot No./ Fire Behaviour Score	Priority	Approximate Area (ha)	Funding Recommendation	Comments/ Rationale
J2	N'Quatqua CWPP/ 116		19.5	Investigate alternative funding strategies	CWPP due to limited interface benefit, but as a priority for landscape level strategies. High hazard fuels exist along evacuation corridor. May be a commercial thin opportunity. J1 is eligible for FES funding. J2 is on N'Quatqua Reserve and would require investigation into alternative funding strategies.
BW-10	BCD-1/ 86 BCD-2/ 99 BCD-3/ 103	High	21.9	Seek UBCM/SWPI funding for detailed assessment, prescription development, and operational fuel treatment	Continuous with J1 and J2. Treatment would improve access and evacuation corridor for residents. Within 100 m of values at risk would be FireSmart fuel management. This polygon is eligible for UBCM/ SWPI funding.
BWLANDSCAPE-11	N/A		158.2	Seek FESBC funding	Landscape level fuelbreak and safe evacuation corridor for residents and Provincial Park guests. Portions of polygon overlap with private land. Cooperative approach would be required. Polygon identified in the S2S FMP as potential fuelbreak location.

Wedgewoods

The Sea to Sky Highway (Hwy 99) in the Wedgewoods study area is part of a proposed fuel break location in the S2S FMP draft. A portion of the identified polygon overlaps with recommended fuel treatment areas in the Wedgewoods study area. The SLRD could work cooperatively with the Resort Municipality of Whistler to apply for FESBC funding for the landscape level fuel break and implement the UBCM/SWPI-funded FireSmart fuel treatments to reduce the risk to the current Wedgewoods structures and future developments.

Table 19. Synergistic opportunities for the Wedgewoods study area.

Treatment Polygon	WUI Threat Plot No./ Fire Behaviour Score	Priority	Approximate Area (ha)	Funding Recommendation	Comments/ Rationale
WW-10	WW-2 / 109 WW-3 / 117 WW-4 / 96	Moderate	51.8	Seek UBCM/ SWPI funding for detailed assessment, prescription development and operational fuel treatment.	Hazardous fuels directly adjacent to planned development.
WW-11	WW-1 / 107	Moderate	8.5	Communicate with licensee regarding planned harvesting: timing and location. Seek UBCM/ SWPI funding dependent on licensee consultation.	Hazardous fuels directly adjacent to planned development and along Garibaldi Park/ Wedge Mount trailhead access.

Treatment Polygon	WUI Threat Plot No./ Fire Behaviour Score	Priority	Approximate Area (ha)	Funding Recommendation	Comments/ Rationale
WHISTLERLANDSCAPE-1	N/A		2,858	Seek FESBC funding. Prescription development and implementation would likely occur in phases.	Hazardous fuels along access/ evacuation corridor. Polygon extends from Black Tusk to north of the Wedgewoods study area; SLRD Area C would act in support capacity for a project of this magnitude. Minimally, cooperation from Electoral Area D, RMOW, MoT, MFLRNO, BCWS, is required.

7.5.1.4 NEW TREATMENT AREAS

Table 20. Details new treatment areas within the study areas of Area C. Each polygon is a rough identification of hazardous fuels and requires a detailed site assessment in order to determine treatment area boundaries and identify all the overlapping values within the polygon.

Treatment Polygon	WUI Threat Plot No./ Fire Behaviour Score	Priority	Approximate Area (ha)	Study Area	Comments/ Rationale
POND-10	P-1 / 110	High	23.4	Ponderosa	C4 fuel type adjacent to community. Community has been very proactive at mitigating hazardous fuels on adjacent private property through thinning and burning treatments. Treatment area helps to lower fire intensity and slow spread of fires on the south flank of the community.
BW-10	BCD-1/ 86 BCD-2/ 99 BCD-3/ 103	High	55.6	Birkenhead Lake North/ Blackwater	C3 and C5 with dead and downed accumulations along access road for Blackwater and Birkenhead Lake Provincial Park. Improve the only existing evacuation route and FireSmart around structures within the Blackwater community.
GL-10	GL-3 / 101	Moderate	8.1	Gates Lake	Hazardous fuels along Pemberton Portage road and adjacent to structures. Would lower fire intensity and enhance fuel break offered by transmission right of way and Pemberton Portage Road for structures to the North.
GL-11	GL-4 / 105	Moderate	5.8	Gates Lake	Hazardous fuels adjacent to values at risk. FireSmart fuel treatment is recommended.

Treatment Polygon	WUI Threat Plot No./ Fire Behaviour Score	Priority	Approximate Area (ha)	Study Area	Comments/ Rationale
GL-12	GL-1 / 100	Moderate	8.4	Gates Lake	GL-12 and GL-13 adjacent to current Gates Lake prescription area. GL-12 is hazardous fuels directly adjacent to neighbourhood (~20 structures). Treatment would offset a fire moving up valley towards neighbourhood.
GL-13	GL-6 / 101 GL-7 / 87	Moderate	33.9	Gates Lake	
OWL-1	OC-1 / 109 OC-2 / 102	High	44.6	Pemberton Surroundings	Hazardous fuels directly adjacent to Owl Ridge neighbourhood. FireSmart fuel treatments would decrease fire intensity close to homes. Polygon overlaps into Village of Pemberton CWPP area, but is entirely within SLRD Area C jurisdiction.
C-1	LLE-3 / 114 LLE-5 / 112 LLE-6 / 108	High	23.7	Lillooet Lake	Polygon identified in 2006 CWPP. Hazardous fuels surrounding Lillooet Lake Estates and multiple structures at risk. Geotechnical review and approval required due to known high landslide hazard. High use recreational site has high probability of ignition from unattended campfires.
LL-10	LLE-3 / 104	High	9.1	Lillooet Lake	FireSmart treatments between high-use recreational sites with high probability of ignition. Hazardous fuels.
LL-11	LL-2 / 98	Moderate	1.1	Lillooet Lake	

Treatment Polygon	WUI Threat Plot No./ Fire Behaviour Score	Priority	Approximate Area (ha)	Study Area	Comments/ Rationale
LB-10	LB-1 / 113	Moderate	37.7	Lizzie Bay	Hazardous fuels on steep, west aspect slopes adjacent to structures. Forms linear break adjacent to utility ROW.
BLE-10	BLE-1 / 82 BLE-4 / 111 BLE-5 / 102	Moderate	24.5	Birkenhead Lake Estates	In Birkenhead Lake Provincial Park: would require BC Parks approval and funding outside UBCM/SWPI program. Hazardous fuels surround Birkenhead Lake Estates.
BLE-12	BLE-7 / 129 BLE-3 / 107	Moderate	29.6	Birkenhead Lake Estates	Identified in 2006 CWPP as possible area for fuel break. Access is very challenging.
WW-10	WW-2 / 104 WW-3 / 117 WW-4 / 96	Moderate	51.8	Wedgewoods	Treatment objective to decrease fire intensity of fire from the south. Potential for commercial forestry – cooperate with licensee.
WW-11	WW-1 / 98	Moderate	9.5	Wedgewoods	FireSmart treatment adjacent to new homes in Wedgewoods.

7.5.2 LANDSCAPE LEVEL FUELBREAKS

The principles of fuelbreak design are described in detail in APPENDIX I: LANDSCAPE LEVEL FUELBREAK MANAGEMENT.

Landscape level fuelbreak locations for Area C have been identified within the Sea to Sky Fire Management Plan (S2S FMP) which currently remains in draft state. The plan focuses on leveraging and enhancing existing fuelbreaks, such as roads and transmission lines. The locations recommended in the S2S FMP are repeated here; one exception is that the polygons have been edited within the study areas where the landscape level fuelbreaks overlap with private land. Furthermore, polygon names have been added for ease of discussion and may not be consistent with naming in the S2S FMP. Recommended landscape level fuelbreaks are enumerated in Table 21 and are displayed in Figure 24.

Existing physical features and land ownership must be considered and further explored in establishing fuelbreak positions. These areas should be further examined for the opportunity for a landscape level fuel break in

cooperation with the RMOW, Village of Pemberton, Lil'Wat First Nation and N'Quatqua Band, Ministry of Transportation and Infrastructure (MOTI), BCWS, and MFLNRO. It is recommended that fuelbreaks work towards managing for, or enhancing, multiple values, such as safe evacuation routes, wildlife habitat, ecosystem restoration, recreation, and fire risk reduction, as applicable for the specific polygon and the overlapping values within.

Landscape level fuelbreaks do not qualify for UBCM funding under the current program. It should be noted that the Province has announced the new Forest Enhancement Program, which aims, in part, to undertake wildfire risk reduction and fuel management operations opportunities which exist outside the current UBCM/SWPI funding structure.[36] The program will concentrate activities on four main areas:

- Wildfire risk reduction activities, such as thinning, pruning, and surface fuel reduction in key areas;
- Forest rehabilitation, such as clearing and/or reforesting areas impacted by wildfire;
- Wildlife habitat restoration and ensuring that fuel management and rehabilitation activities also promote desired wildlife habitat characteristics, such as enhancing mule deer winter range; and,
- FireSmart program and raising awareness among both local governments and rural property owners regarding steps they can take to protect homes and property from wildfire.[37]

FESBC funding applications for some of these areas have been submitted by MFLNRO in the first intake and funding has been secured for treatment along the access roads to Birkenhead Lake Estates and Birkenhead Lake North/ Blackwater. Through consultation with the Sea to Sky District, it has been expressed that MFLNRO is interested in meetings with the SLRD to share information and develop partnerships with the objective of prioritizing future FESBC applications. FESBC applications would be based upon the reduction of wildfire hazard around isolated communities and high-use recreation areas, and to improve access corridors to those locations. The Sea to Sky District has shown commitment to improving the delivery of fuel treatments on Crown land with these objectives in mind. It is recommended that the SLRD prioritize these meetings.

[36] Specific details regarding the FEP program and FESBC funding applications can be found at: http://fesbc.ca/.

[37] BC Government News. https://news.gov.bc.ca/releases/2016FLNR0018-000284. Accessed 30 May, 2016.

Table 21. Landscape level fuelbreak locations for Area C, as identified in the S2S FMP draft.

Polygon Name	Likely Partners	Approximate Area (ha)	Study Area(s)
BWLANDSCAPE-11	BC Parks, N'Quatqua Band, MFLNRO, BCWS	114	Birkenhead Lake North/ Blackwater
BLELANDSCAPE-1	BC Parks, MFLNRO, BCWS	275	Birkenhead Lake Estates; Devine/ Birken/ Gramsons
GBGDLANDSCAPE-1	MFLNRO, BCWS	251	Devine/ Birken/ Gramsons
PSLANDSCAPE-1	Village of Pemberton, Lil'Wat First Nation, BC Hydro, MFLNRO, BCWS	453	Pemberton Surroundings
PSLANDSCAPE-2	Village of Pemberton, MFLNRO, BCWS	307	Pemberton Surroundings
ALLANDSCAPE-1	N'Quatqua Band, MFLNRO, BCWS	111	Within N'Quatqua Band CWPP study area; overlaps with SLRD jurisdiction
WHISTLERLANDSCAPE-1	RMOW, Whistler Community Forest, MOTI, MFLNRO, BCWS, SLRD Electoral Area D	2,858	Wedgewoods

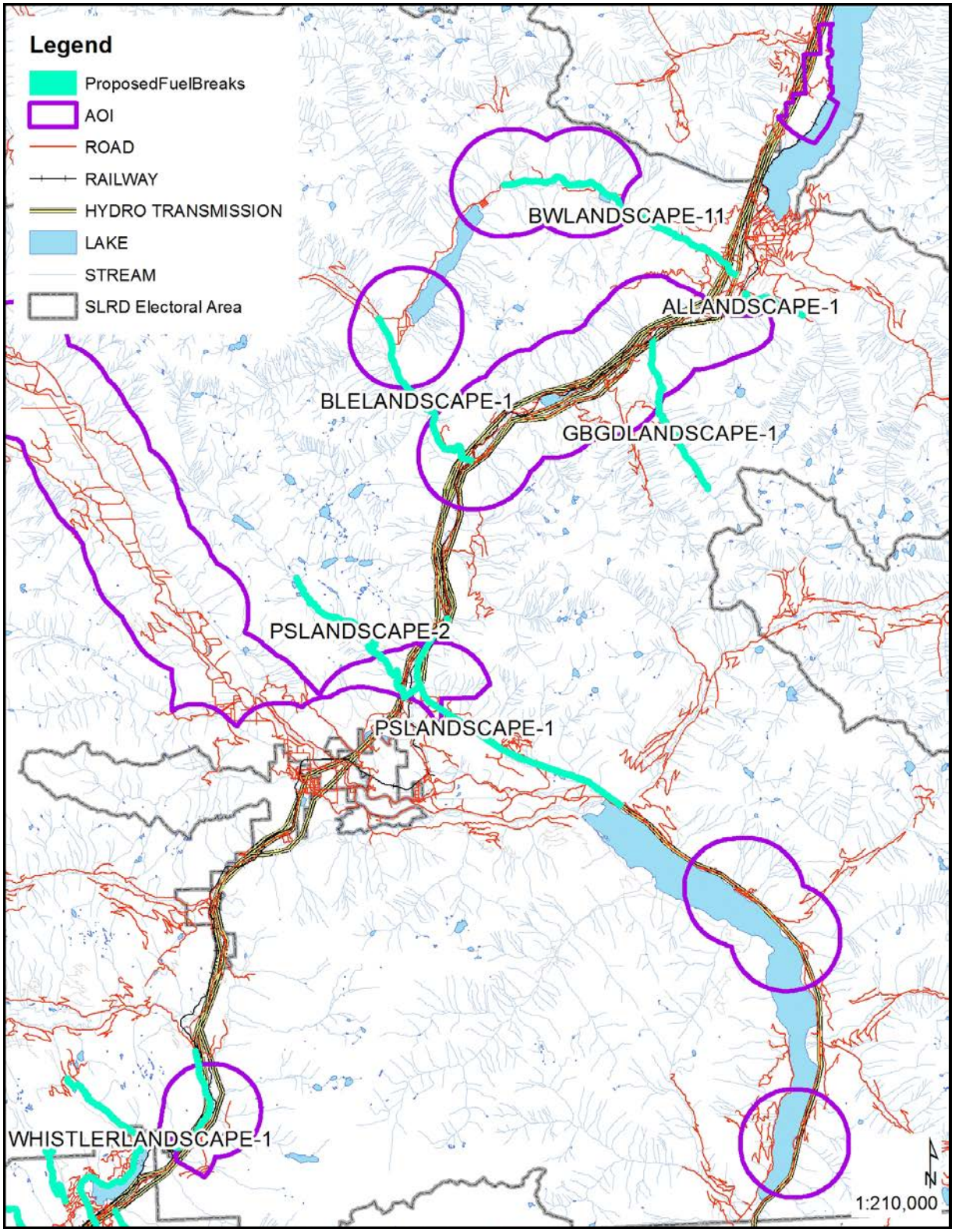


Figure 24. Recommended landscape level fuelbreak locations, as determined by the S2S FMP draft and its underlying analysis.

7.5.3 FUEL MANAGEMENT RECOMMENDATIONS SUMMARY

Table 22. Summary of Fuel Management recommendations. Recommendations which are potentially eligible for UBCM/ SWPI funding are identified with an asterisk.

Fuel Management			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: Reduce wildfire threat on private and public lands through fuel management.			
33*	High	• Apply for UBCM/SWPI funding to implement operational fuel management projects for shovel ready projects identified in Section 7.5.1.2.	UBCM SWPI Funding / Municipal Funding (up to 90% of project cost)
34*	High	• Proceed with detailed assessment, prescription development and treatment of hazardous fuel units identified in this CWPP. Collaboration with BCTS, woodlot owners, and other licensees may facilitate larger projects.	UBCM SWPI Funding / Municipal Funding (up to 75% of prescription development cost)
Objective: Maintain previously treated areas under an acceptable level of wildfire fire threat (moderate).			
35*	N/A (7 – 10 years after treatment)	• Complete monitoring and maintenance, as necessary, on previously treated areas. Treated areas should be assessed by a Registered Professional Forester, specific to actions required in order to maintain treated areas in a moderate or lower hazard. **NB: This recommendation does not apply currently, but will likely be relevant within the potential shelf-life of this document (7 – 10 years post-treatment).**	UBCM SWPI Funding/ Municipal Funding
Objective: Reduce the wildfire threat to Area C and neighbouring jurisdictions with a cooperative regional approach.			
36	High	• Submit phase 1 application for FES funding for those landscape level fuelbreaks identified as high priority, particularly focusing on those areas which also help to maintain or improve safe evacuation routes for SLRD residents. Consultation with neighbouring local and First Nations governments, BCWS, and MFLRNO should be started prior to submitting application to ensure cooperative approach.	FESBC funding

8.0 CONCLUSION

The SLRD's Area C is ecologically diverse, ranging from higher elevation coastal ecosystems in Wedgewoods to more interior climates in Ponderosa. The study areas are generally rural and some quite isolated with only one access/ evacuation route. Further challenges exist due to the communities' geographic distance from each other and from emergency services. Area C is situated in a fire-prone area; there have been significant wildfires in the past in the region and undoubtedly there will be more in the future. The areas of particular threat (high or extreme wildfire behaviour threat and high or extreme WUI threat have been highlighted in this document and vegetation management (fuel treatment) locations recommended accordingly.

The success of the plan, and reduction in wildfire threat to the study area, will require significant commitment and resources, as well as cooperation among agencies and neighbouring jurisdictions. There are a number of potential opportunities to share these costs with other Electoral Areas and member municipalities through cooperative efforts and implementation. The SLRD has displayed a commitment to reduce the overall threat posed by wildfire to the communities; implementation of this plan is the next step towards protecting the long-term health and safety of the Electoral Area's citizens, structures, and infrastructure, as well as the many other ecological and social values at risk.

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APPENDIX A: STATUS OF 2006 CWPP RECOMMENDATIONS

Table 23. Status of 2006 CWPP recommendations. Please note: recommendations are quoted from the 2006 CWPP; some agency names may have been updated since the authoring of this document (*e.g.* MoFR is now FLNRO). In addition, the SLRD has completed fuel management projects which are not noted in this document, as they are outside Area C.

#	Action Item	Status
Rec # 1	Utilizing this report, embark on fuel management projects as part of a "SLRD Fuel Management Strategy".	Needs attention; 2016 CWPP updates recommended treatment polygons
Rec # 2	Consult with qualified professionals to develop fuel treatment plans and prescriptions for hazardous fuel areas.	Ongoing - 1 completed in Area C
Rec # 3	Pursue funding for fuel management pilot projects and fuel management operational projects.	Ongoing
Rec # 4	Dialogue with the MoFR (Forest Districts and Regions) to address wildfire risk and fuel management in higher level planning for those areas adjacent to the SLRD.	Ongoing
Rec # 5	Partner with local First Nations and other local governments to investigate pursuing the new timber license for harvesting crown timber that is a hazard to communities.	Needs attention
Rec # 6	Work with the Squamish, Whistler, Lillooet and Pemberton to ensure any future developments within SLRD boundary are FireSmart.	Ongoing (Wedgewoods)
Rec # 7	Monitor, and work with, the BC Transmission Corporation (BCTC) to ensure they mitigate the slash hazard on the transmission corridors.	Ongoing
Rec # 8	Work with private land owners, First Nations, CN Rail, and other agencies to address the fuel hazard on their associated lands.	Ongoing
Rec # 9	Develop procedures for dealing with traffic flow should the major transportation corridors become impassable due to a wildfire.	Ongoing
Rec # 10	Work with Ministry of Transportation to mitigate ignition fuels adjacent to the Highway.	Responsibility of Ministry – SLRD advocates when and where necessary
Rec # 11	New developments in the interface should follow FireSmart guidelines and the recommendations in this report.	Needs attention (Partial implementation depending on development location)
Rec # 12	A Fuel Hazard and Fire Risk Assessment report should be completed for each new development.	Needs attention (Partial implementation depending on development location)
Rec # 13	Ensure contractors have a Fire Prevention Plan completed prior to conducting development operations.	Complete
Rec # 14	Manage natural lands within the SLRD using the recommendations within this report.	Ongoing

#	Action Item	Status
Rec # 15	Trained professionals should determine which areas require treatment and develop treatment prescriptions.	Ongoing – CWPP update to identify areas which qualify for provincial funding, use of BCWS staff to identify areas of hazardous fuels, consultation with District staff (FLNRO) regarding possible landscape level initiatives, one prescription completed in study area.
Rec # 16	Establish trail standards that will ensure that trails act as surface fuelbreaks and provide access for suppression crews.	Needs attention
Rec # 17	Develop standards for the abatement of residual activity fuels associated with trail building.	Needs attention
Rec # 18	Consider constructing trails into remote wooded areas with poor access (for suppression purposes).	Needs attention
Rec # 19	Develop a GPS database of waterways within the SLRD that have an adequate supply for suppression purposes during the fire season.	Ongoing – database of waterways is complete, attribution of water availability for suppression is incomplete.
Rec # 20	For new developments, consider establishing or enhancing water bodies within the development area that could serve as emergency water sources.	Needs attention
Rec # 21	Work with schools to promote wildfire awareness and prevention.	Needs attention
Rec # 22	Engage in public education programs to reduce human caused ignition.	Ongoing – FireSmart information is available online and handed out at public events, SLRD supports community preparedness programs, such as S-100 training for members of isolated communities.
Rec # 23	Work with CN rail to ensure their ROW does not contain light cured fuels prior to the fire season.	Ongoing
Rec # 24	Work with BCTC and BC Hydro to ensure that distribution lines and transmission corridors are assessed regularly for tree risk and that the SLRD is kept informed of this activity.	Ongoing
Rec # 25	Use the Future Desired Condition descriptions, in conjunction with the Current Stand Conditions, as guidelines when developing site specific fuel treatment prescriptions.	Ongoing
Rec # 26	Treat all identified interface polygons in prioritized sequence as funds become available.	Needs attention – 2016 CWPP updates hazardous polygons

#	Action Item	Status
Rec # 27	Dialogue with adjacent landowners and governments when treating interface areas to ensure the maximum benefit is realized from the treatment through treating larger areas.	Ongoing – obliquely included as part of the SLRD's Wildfire Fuel Management Policy
Rec # 28	Consider adopting the recommendations resulting from the review of the official policy and guidelines.	Ongoing
Rec # 29	Future development of official community plans, bylaws, Regional Growth Strategy and guidelines should consider the need to abate wildfire risk.	Ongoing
Rec # 30	Prior to granting a development permit, ensure construction contractors operating within the SLRD are aware of their responsibilities as described within the Wildfire Act.	N/A (no DPAs in Area C)
Rec # 31	Consider developing bylaws which restrict certain construction activities during high and extreme fire danger periods.	Needs attention
Rec # 32	Develop an annual training session to ensure SLRD staff are familiar with the fire management plan.	Needs attention – See Recommendation #47
Rec # 33	Ensure Fire Department(s) within the SLRD have S-100 training.	Ongoing - Birken FD has members with current S-100 training and 'train the trainers' certifications.
Rec # 34	Strategically place suppression equipment in high risk interface areas.	Ongoing – Birken FD has some wildfire suppression equipment available.
Rec # 35	Consider conducting annual, multi-agency training sessions involving mock interface drills.	Needs attention
Rec # 36	Ensure local fire departments have the necessary equipment to deal with an interface fire prior to the arrival of wildland fire crews.	Ongoing – some funding for wildfire suppression equipment for local fire departments
Rec # 37	Make FireSmart brochures available at: fire halls, insurance agencies, real estate offices, city halls and Regional District, recreation centers and other public locations. Consider disseminating FireSmart information in an annual mail out (with the tax assessment mailing).	Ongoing – SLRD distributes FireSmart information at public events
Rec # 38	Include a wildfire management link on the SLRD website.	Complete – website has links to FireSmart, BCWS, SLRD's fuel management program, emergency planning, and wildfire detection and reporting.
Rec # 39	Conduct a public presentation prior to engaging in any fuel management work and disseminate project information accordingly.	As required
Rec # 40	Hold annual FireSmart information sessions.	Currently engaged with several communities in Area C around FireSmart, and continuing to develop relationships with additional communities

#	Action Item	Status
Rec # 41	Promote FireSmart principles through the public education system utilizing the local fire department and Protection Branch.	Needs attention; has been identified as low priority for the Regional District due to limited time and resources.
Rec # 42	In the event of a wildfire within, or adjacent to, the interface of the SLRD should conduct an Ecosystem Impact Assessment to determine the short and long term fire-effects on the SLRD.	This recommendation is beyond the mandate, resources and capabilities of the Regional District
Rec # 43	Keep a log of all human caused fires within and adjacent to the SLRD to assist with future abatement strategies.	BCWS retains this data
Rec # 44	Ensure burned areas are rehabilitated in a manner that is ecologically appropriate. Native species should be utilized wherever possible.	This recommendation is beyond the mandate, resources and capabilities of the Regional District
Rec # 45	Conduct post-fire tree risk assessments to ensure public safety.	As required
Rec # 46	Address post-fire erosion concerns before they arise.	Ongoing – SLRD has Landslide and Flooding Risks After Wildfire document available on website
Rec # 47	Develop a SLRD Fire Management Plan or other plan that encompasses communication and evacuation plans in the event of an approaching wildfire.	Ongoing
Rec # 48	During the fire season, post the wildfire reporting number at key locations within the SLRD.	Ongoing – signage (fire danger and reporting) is available at many key locations
Rec # 49	Utilize a Fuel Treatment Template to ensure consistency between fuel treatments.	Complete - Required for, and provided by, UBCM/ SWPI funded projects
Rec # 50	Consider all options for treatment regardless of controversy. Determine the level of social acceptability of each treatment method prior to engaging in treatments.	Ongoing
Rec # 51	Develop feedback loops within the SLRD as a means of collecting the public's sentiment regarding fuel management.	Ongoing
Rec # 52	Employ adaptive management in regards to wildfire and fuels management.	Complete – hire qualified professionals with expertise in wildfire and fuels management and application of adaptive management

APPENDIX B: SPECIES AT RISK WITHIN STUDY AREA

Table 24. Publicly available occurrences of Blue and Red-listed species recorded within the study area. Data current as of date accessed: 2 September, 2016.[38]

Species	Scientific Name	Category	BC List
Western screech-owl	*Megascops kennicottii macfarlanei*	Bird	Red
Sharp-tailed Snake	*Contia tenuis*	Reptile	Red
Dun Skipper	*Euphyes vestris*	Insect	Red
Geyer's onion	*Allium geyeri* var. *tenerum*	Vascular Plant	Blue
North American Racer	*Coluber constrictor*	Reptile	Blue
least moonwort	*Botrychium simplex* var. *compositum*	Vascular Plant	Blue

The red-list includes ecological communities, indigenous species and subspecies in British Columbia that are at the greatest risk of being lost.

The Blue-list includes ecological communities, indigenous species and subspecies in BC that are of special concern.[39]

[38] CDC Data accessed through Data BC's online Data Distribution Service.

[39] www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/species-ecosystems-at-risk/conservation-data-centre Web. Accessed Jan 11, 2017.

APPENDIX C: WUI THREAT PLOT DETAILS

Table 25 displays a summary of all WUI threat plots completed during CWPP field work. The original WUI threat plot forms have been submitted as a separate document.

Table 25. Summary of WUI Threat Assessment Worksheets.

WUI Plot #	Geographic Location	WUI Threat Worksheet Components				Wildfire Behaviour Threat Score (/240)	WUI Threat Score (/55)
		Fuel	Weather	Topography	Structural		
GCE-1	Gates Creek Estates	81	11	22	28	114 (High)	28 (High)
GL-1	Gates Lake	54	11	35	43	100 (High)	43 (Extreme)
GL-2	Gates Lake	79	11	15	33	105 (High)	33 (High)
GL-3	Gates Lake	69	11	21	38	101 (High)	38 (High)
GL-4	Gates Lake	64	11	30	38	105 (High)	38 (High)
GL-5	Gates Lake	43	11	14	45	68 (Moderate)	45 (Extreme)
GL-6	Gates Lake	73	11	24	32	108 (High)	32 (High)
GL-7	Gates Lake	59	11	14	43	84 (Moderate)	43 (Extreme)
BLE-1	Birkenhead Lake Estates (Provincial Park)	54	11	17	38	82 (Moderate)	38 (High)
BLE-3	Birkenhead Lake Estates	67	11	29	25	107 (High)	38 (High)
BLE-4	Birkenhead Lake Estates	78	16	17	38	111 (High)	38 (High)
BLE-5	Birkenhead Lake Estates	69	16	17	38	97 (High)	38 (High)
BLE-7	Birkenhead Lake Estates	79	11	39	33	129 (High)	33 (High)
BLE-8	Birkenhead Lake Estates	87	11	17	38	115 (High)	38 (High)
BCD-1	Birkenhead Lake North	58	11	17	40	86 (Moderate)	40 (N/A)
BCD-2	Birkenhead Lake North	67	11	21	45	99 (High)	45 (Extreme)
BCD-3	Birkenhead Lake North	71	11	21	45	103 (High)	45 (Extreme)
BLP-1	Birkenhead Lake Provincial Park	70	11	40	25	121 (High)	25 (Moderate)
LL-2	Lillooet Lake	50	11	37	45	98 (High)	45 (Extreme)
LL-3	Lillooet Lake	67	11	32	45	110 (High)	45 (Extreme)
LL-6	Lillooet Lake	65	11	32	30	108 (High)	30 (High)

LLE-1	Lillooet Lake Estates	63	11	22	33	96 (High)	33 (High)
LLE-3	Lillooet Lake Estates	66	11	19	43	96 (High)	43 (Extreme)
LLE-5	Lillooet Lake Estates	65	11	27	30	103 (High)	30 (High)
LB-1	Lizzie Bay	73	11	29	40	113 (High)	40 (Extreme)
OC-1	Owl Creek	59	11	44	48	114 (High)	48 (Extreme)
OC-2	Owl Creek	70	11	26	38	107 (High)	38 (High)
PM-1	Pemberton Meadows	70	11	27	30	108 (High)	30 (High)
P-1	Ponderosa	68	20	17	32	105 (High)	32 (High)
WW-1	Wedgewoods	72	4	22	43	98 (High)	43 (Extreme)
WW-2	Wedgewoods	66	4	34	32	104 (High)	32 (High)
WW-3	Wedgewoods east	77	6	34	21	117 (High)	21 (Moderate)
WW-4	Wedgewoods east	70	4	22	21	96 (High)	21 (Moderate)

APPENDIX D: THREAT RATING MAPS BY STUDY AREA

Full-sized (11” x 17”), georeferenced working maps found in Appendix B have been submitted separately.

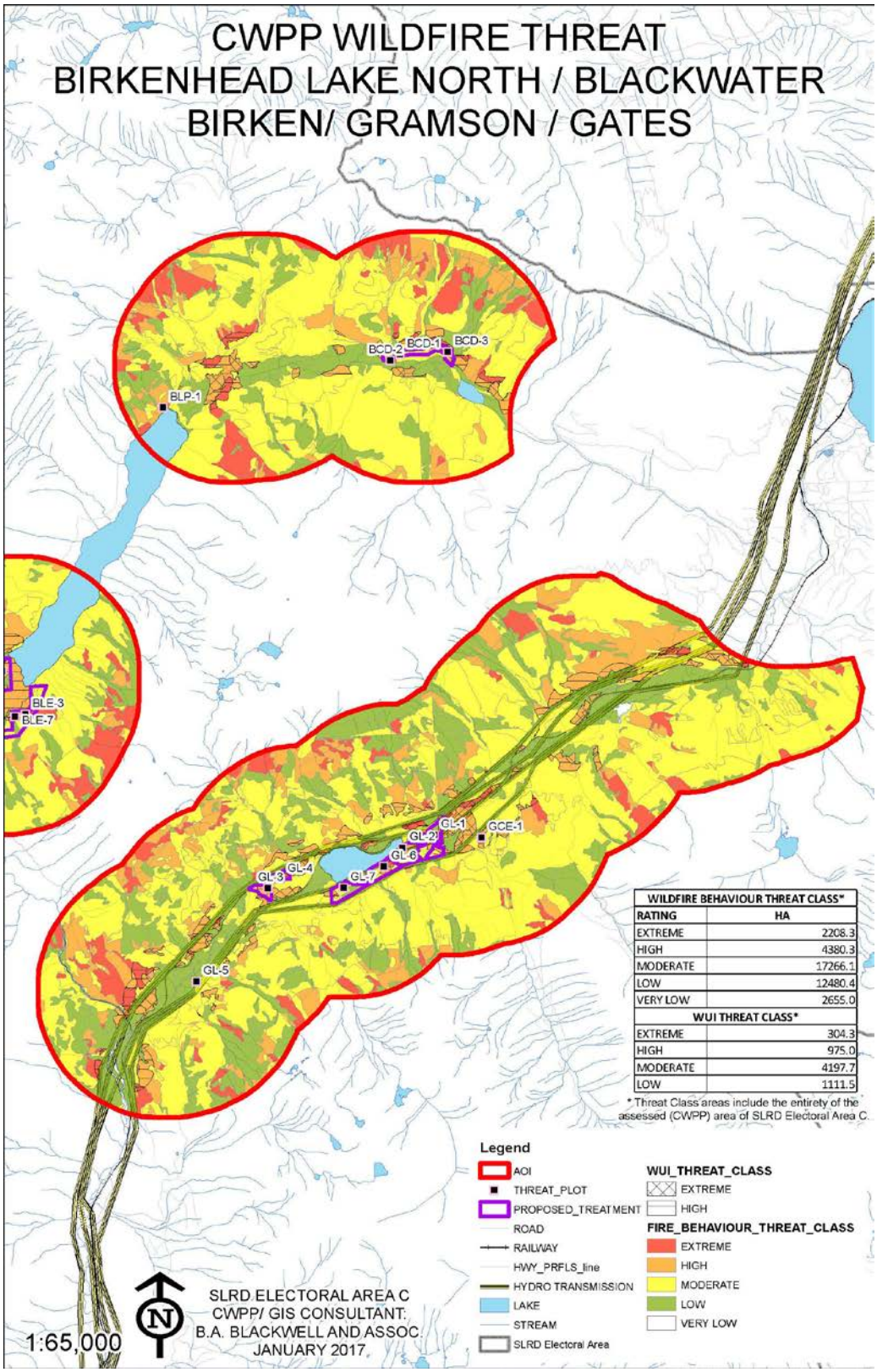

Figure 25. Wildfire behaviour threat classes and WUI threat classes for the Birken/ Gramsons/ Gates and Birkenhead Lake North/ Blackwater study areas.

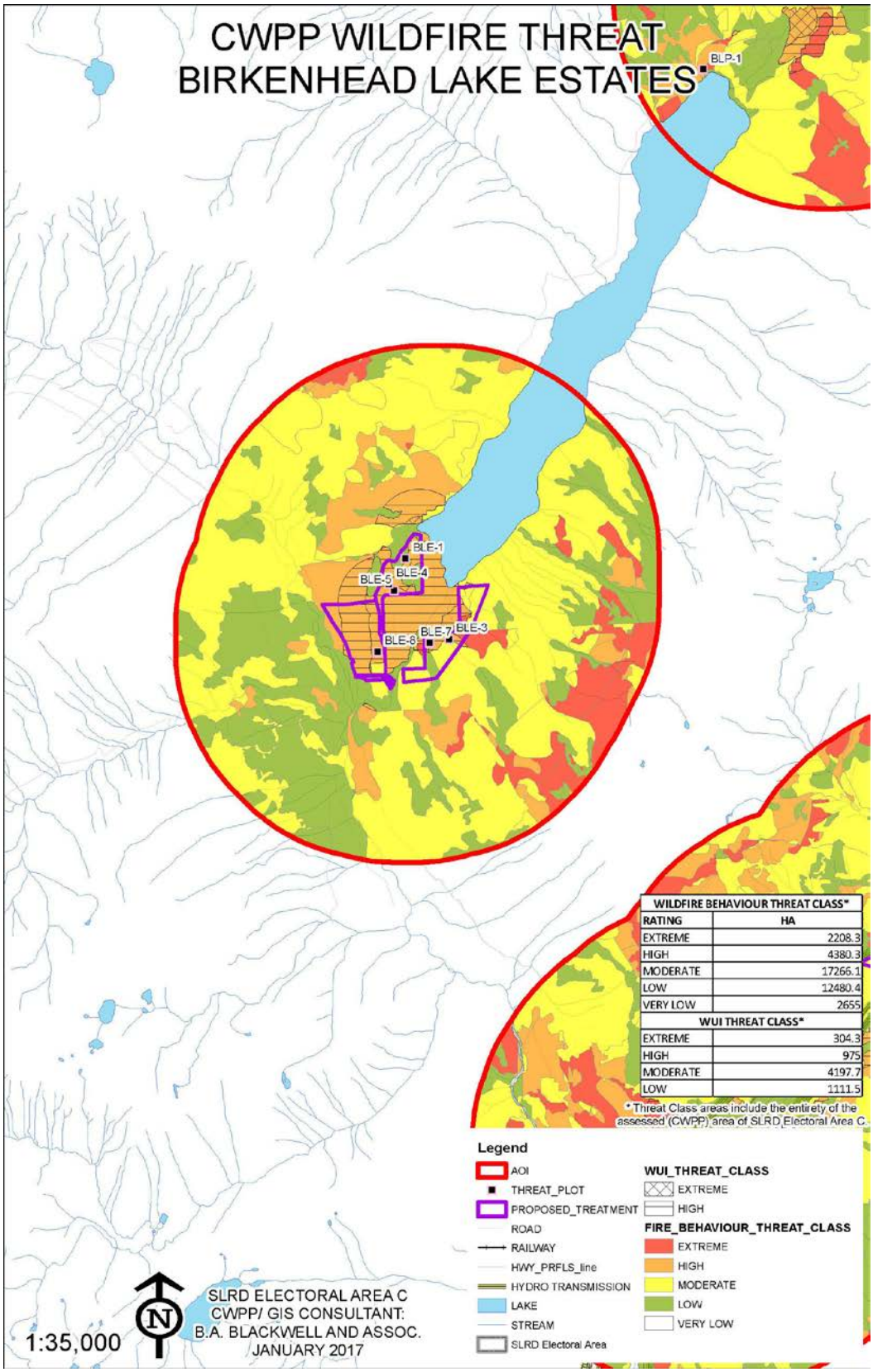

Figure 26. Wildfire behaviour threat classes and WUI threat classes for the Birkenhead Lake Estates study area.

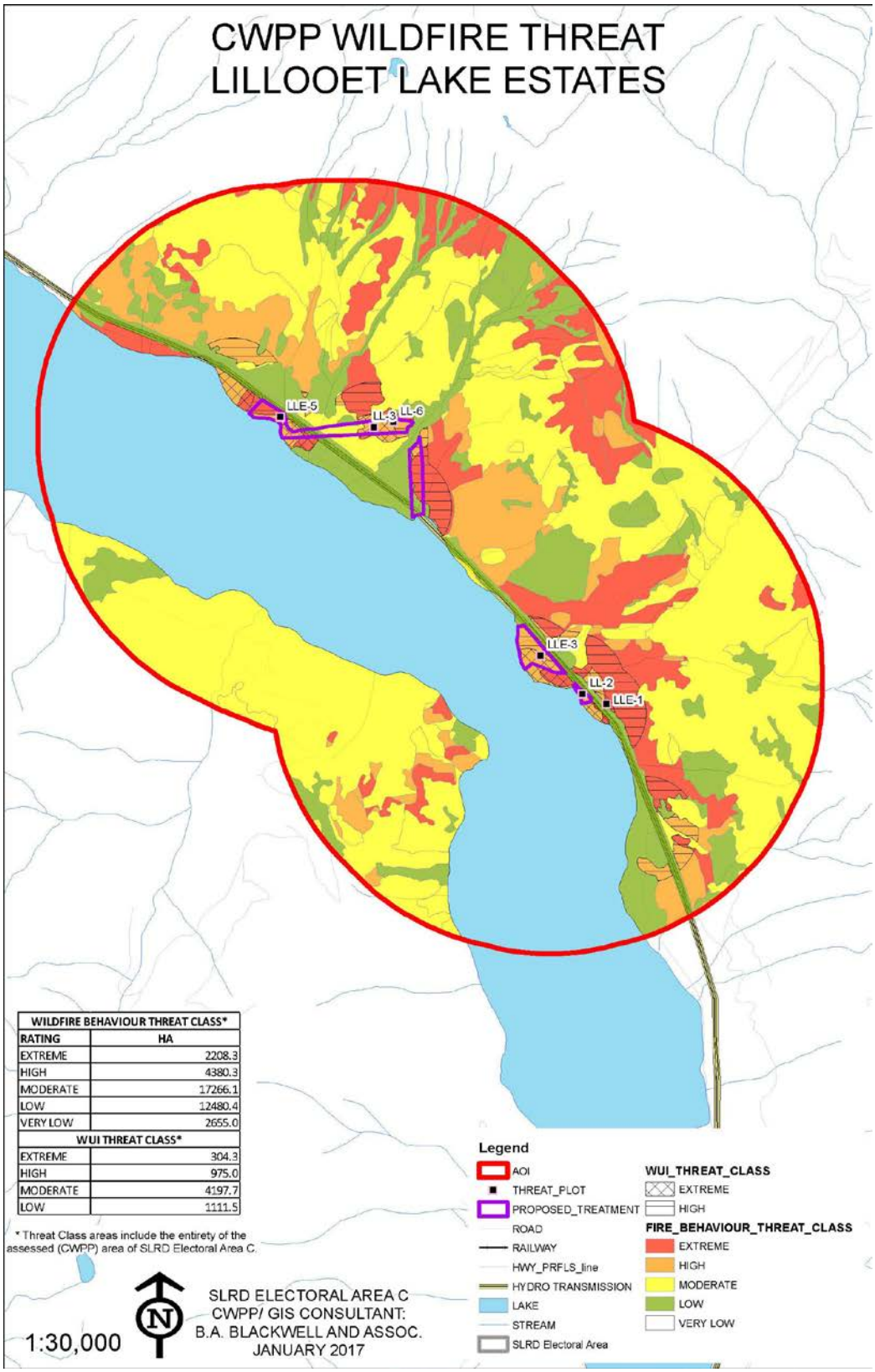

Figure 27. Wildfire behaviour threat classes and WUI threat classes for the Lillooet Lake Estates study area.

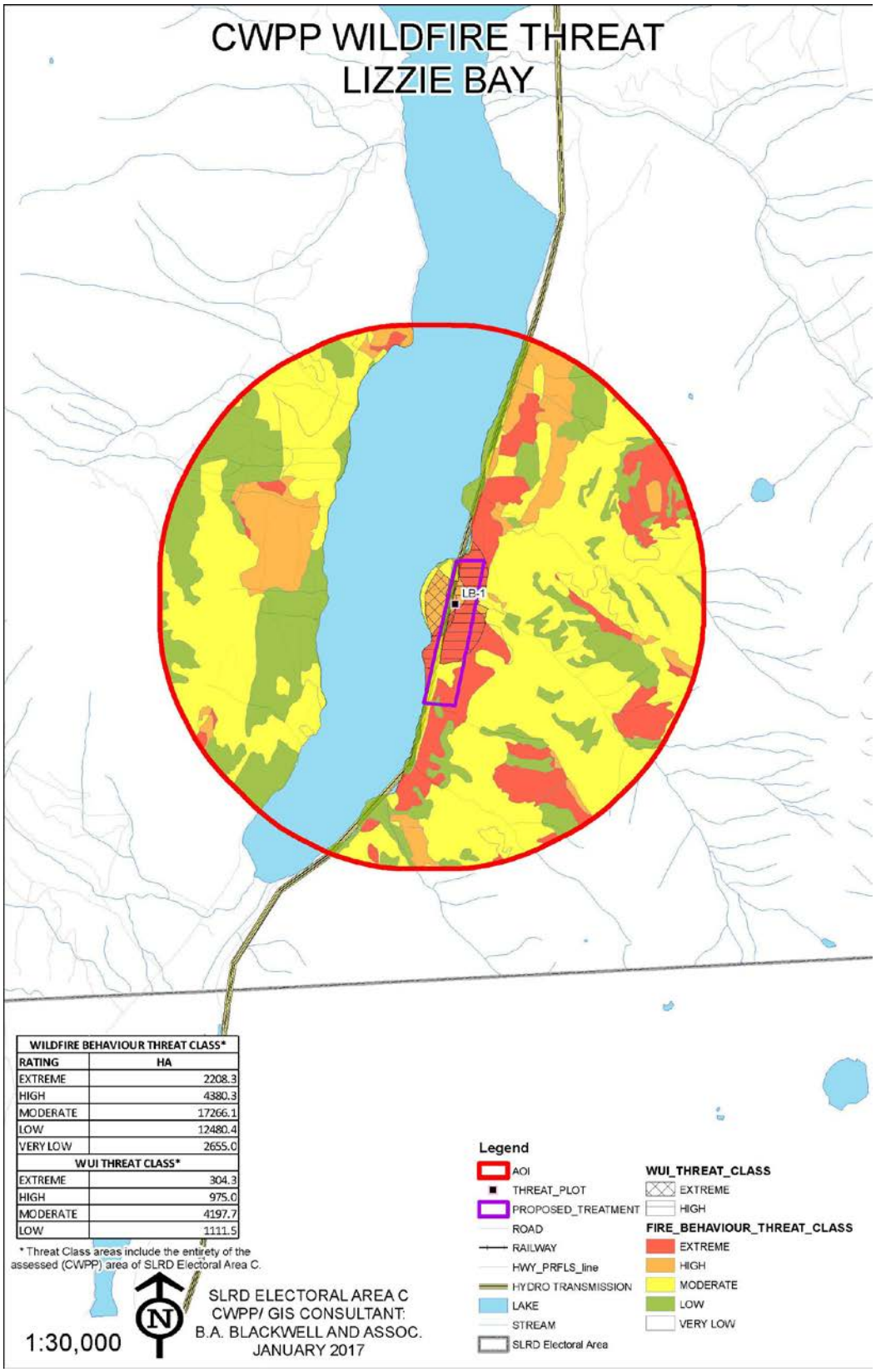

Figure 28. Wildfire behaviour threat classes and WUI threat classes for the Lizzie Bay study area.

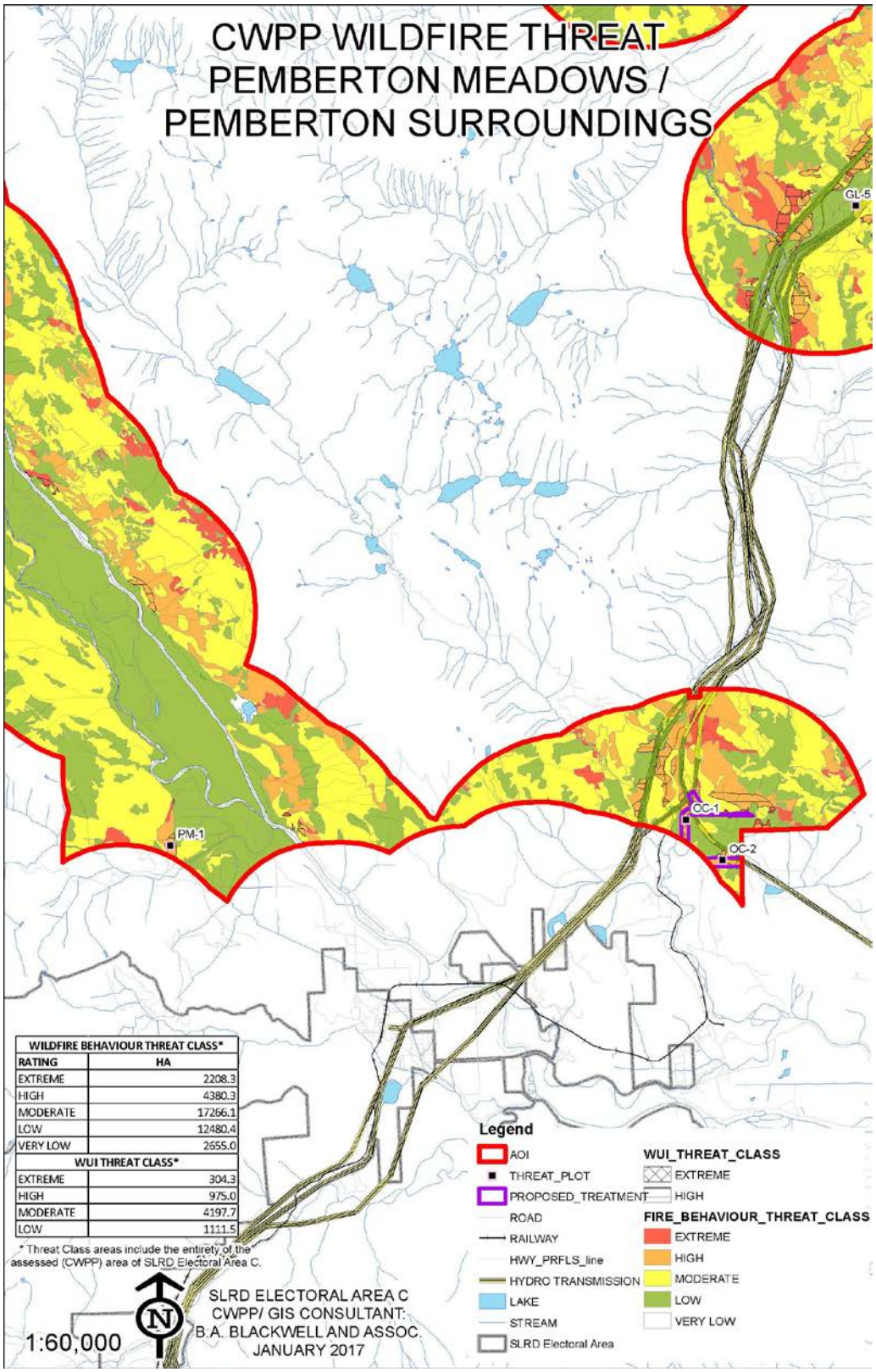

Figure 29. Wildfire behaviour threat classes and WUI threat classes for the eastern portion of the Pemberton Meadows/ Pemberton surrounds study area.

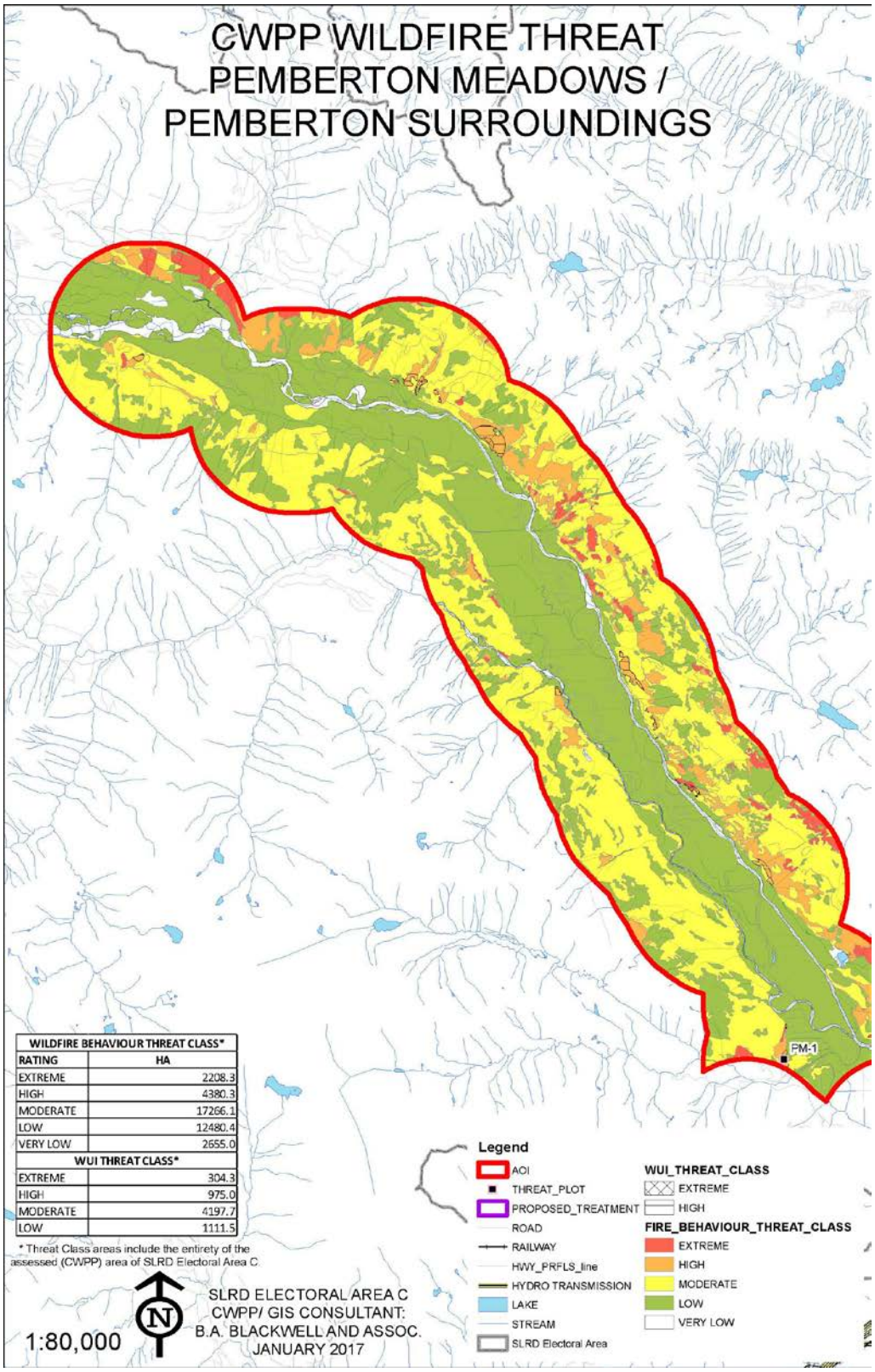

Figure 30. Wildfire behaviour threat classes and WUI threat classes for the western portion of the Pemberton Meadows/ Pemberton surrounds study area.

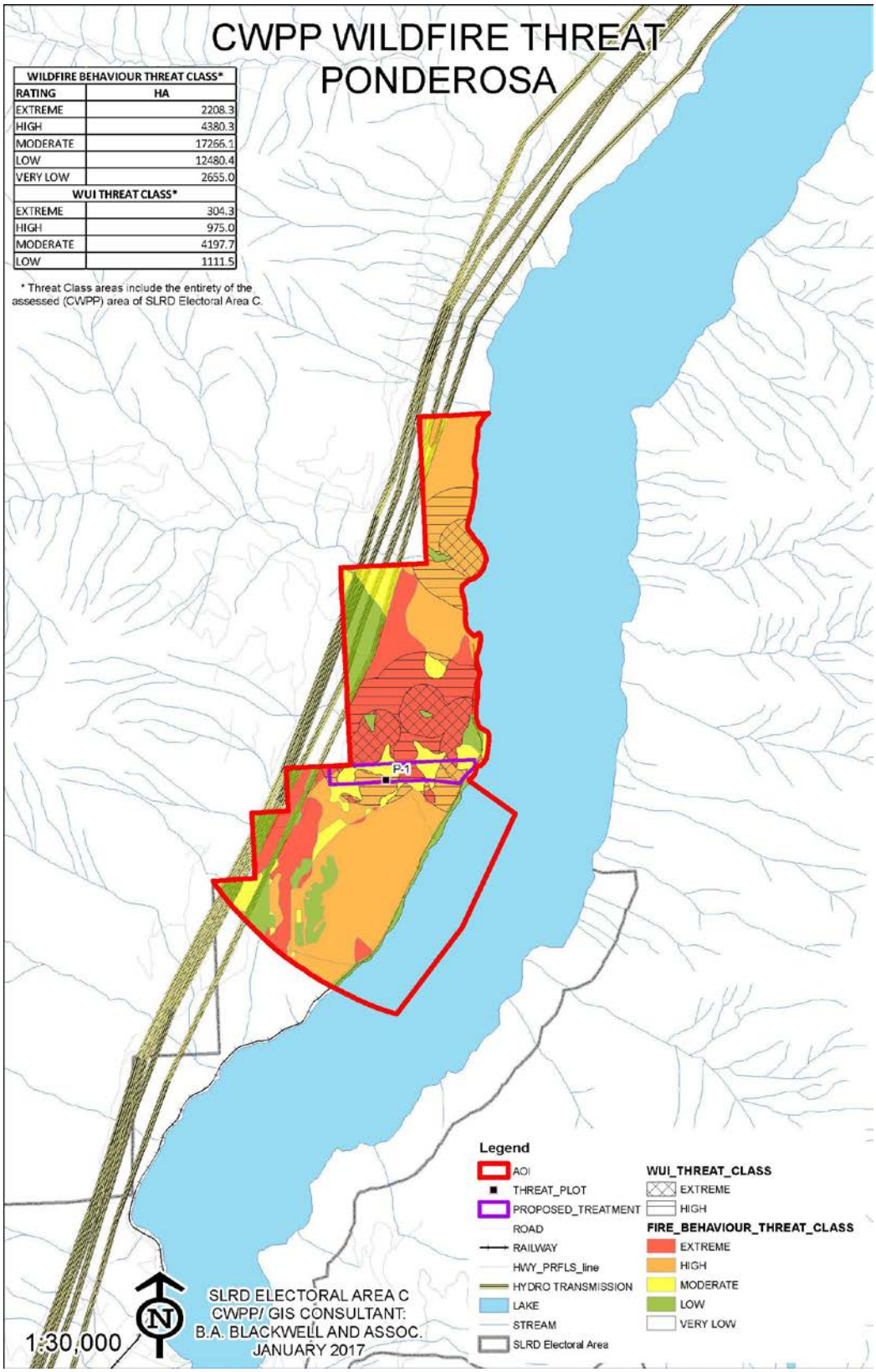

Figure 31. Wildfire behaviour threat classes and WUI threat classes for the Ponderosa study area.

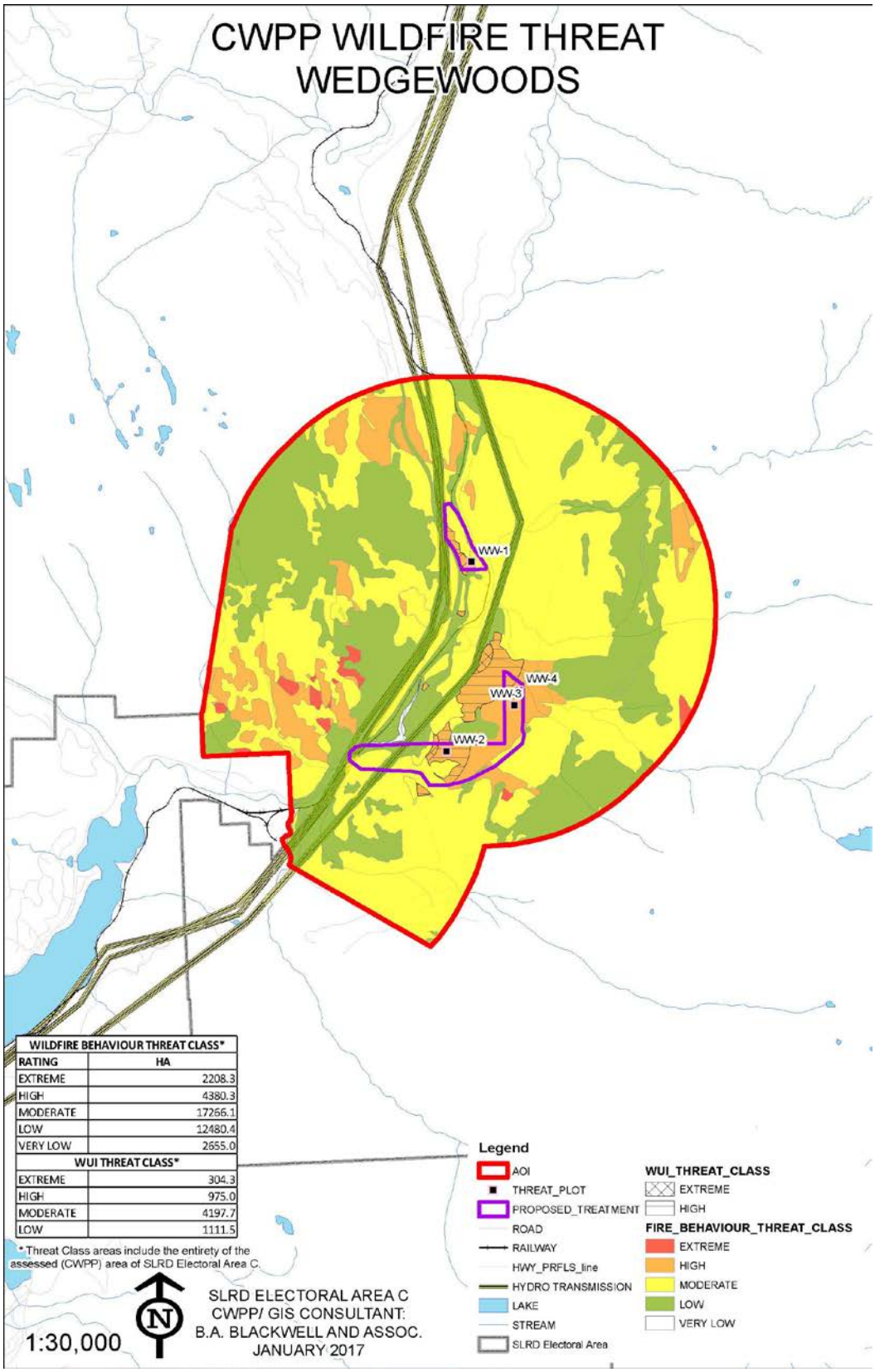

Figure 32. Wildfire behaviour threat classes and WUI threat classes for the Wedgewoods study area.

APPENDIX E: WUI THREAT ASSESSMENT METHODOLOGY

As part of the CWPP process, spatial data submissions are required to meet the defined standards in the Program and Application Guide. As part of the program, proponents completing a CWPP or CWPP update are provided with the Provincial Strategic Threat Analysis (PSTA) dataset. This dataset includes:

- Current Fire Points
- Current Fire Polygons
- Fuel Type
- Historical Fire Points
- Historical Fire Polygons
- Mountain pine beetle polygons
- PSTA Head Fire Intensity
- PSTA Historical Fire Density
- PSTA Spotting Impact
- PSTA Threat Rating
- Structure Density
- Structures (sometimes not included)
- Wildland Urban Interface Buffer Area

The required components for the spatial data submission are detailed in the Program and Application Guide Spatial Appendix – these include:

- AOI
- Fire Threat
- Fuel Type
- Photo Location
- Proposed Treatment
- Structures
- Threat Plot
- Wildland Urban Interface

The provided PSTA data does not necessarily transfer directly into the geodatabase for submission, and several PSTA feature classes require extensive updating or correction. In addition, the Fire Threat determined in the PSTA is fundamentally different than the Fire Threat feature class that must be submitted in the spatial data package. The Fire Threat in the PSTA is based on provincial scale inputs - fire density; spotting impact; and head fire intensity, while the spatial submission Fire Threat is based on the components of the Wildland Urban Interface Threat Assessment Worksheet. For the scope of this project, completion of WUI Threat Assessment plots on the entire AOI is not possible, and therefore an analytical model has been built to assume Fire Threat based on spatially explicit variables that correspond to the WUI Threat Assessment worksheet.

FIELD DATA COLLECTION

The primary goals of field data collection are to confirm or correct the provincial fuel type, complete WUI Threat Assessment Plots, and assess other features of interest to the development of the CWPP. This is accomplished by

traversing as much of the study area as possible (within time, budget and access constraints). Threat Assessment plots are completed on the latest version (2013) form, and as per the Wildland Urban Interface Threat Assessment Guide.

For clarity, the final threat ratings for the study area were determined through the completion of the following methodological steps:

1. Update fuel-typing using orthophotography provided by the client and field verification.
2. Update structural data using critical infrastructure information provided by the client, field visits to confirm structure additions or deletions, and orthophotography
3. Complete field work to ground-truth fuel typing and threat ratings (completed 33 WUI threat plots on a variety of fuel types, aspects, and slopes and an additional 120 field stops with qualitative notes, fuel type verification, and/or photographs)
4. Threat assessment analysis using field data collected and rating results of WUI threat plots – see next section.

SPATIAL ANALYSIS

Not all attributes on the WUI Threat Assessment form can be determined using a GIS analysis on a landscape/polygon level. To emulate as closely as possible the threat categorization that would be determined using the Threat Assessment form, the variables in Table 7 were used as the basis for building the analytical model. The features chosen are those that are spatially explicit, available from existing and reliable spatial data or field data, and able to be confidently extrapolated to large polygons.

WUI Threat Sheet Attribute	Used in Analysis?	Comment
FUEL SUBCOMPONENT		
Duff depth and Moisture Regime	No	Many of these attributes assumed by using 'fuel type' as a component of the Fire Threat analysis. Most of these components are not easily extrapolated to a landscape or polygon scale, or the data available to estimate over large areas (VRI) is unreliable.
Surface Fuel continuity	No	
Vegetation Fuel Composition	No	
Fine Woody Debris Continuity	No	
Large Woody Debris Continuity	No	
Live and Dead Coniferous Crown Closure	No	
Live and Dead Conifer Crown Base height	No	
Live and Dead suppressed and Understory Conifers	No	
Forest health	No	
Continuous forest/slash cover within 2km	No	
WEATHER SUBCOMPONENT		

BEC zone	Yes	
Historical weather fire occurrence	Yes	
TOPOGRAPHY SUBCOMPONENT		
Aspect	Yes	
Slope	Yes	Elevation model was used to determine slope.
Terrain	No	
Landscape/ topographic limitations to wildfire spread	No	
STRUCTURAL SUBCOMPONENT		
Position of structure/ community on slope	No	
Type of development	No	
Position of assessment area relative to values	Yes	Distance to structure is used in analysis; position on slope relative to values at risk is too difficult to analyze spatially.

The field data is used to correct the fuel type polygon attributes provided in the PSTA. The corrected fuel type layer is then used as part of the initial spatial analysis process. The other components are developed using spatial data (BEC zone, fire history zone) or spatial analysis (aspect, slope). A scoring system was developed to categorize resultant polygons as having relatively low, moderate, high or extreme Fire Threat, or Low, Moderate, High or Extreme WUI Threat.

These attributes are combined to produce polygons with a final Fire Behaviour Threat Score. To determine the Wildland Urban Interface Score, only the distance to structures is used. Buffer distances are established as per the WUI Threat Assessment worksheet (<200, 200-500 and >500) for polygons that have a 'high' or 'extreme' Fire Behaviour Threat score. Polygons with structures within 200m are rated as 'extreme', within 500m are rated as 'high', within 2km are 'moderate', and distances over that are rated 'low'.

There are obvious limitations in this method, most notably that not all components of the threat assessment worksheet are scalable to a GIS model, generalizing the Fire Behaviour Threat score. The WUI Threat Score is greatly simplified, as determining the position of structures on a slope, the type of development and the relative position are difficult in an automated GIS process. This method uses the best available information to produce the initial threat assessment across the study area in a format which is required by the UBCM SWPI program.

Upon completion of the initial spatial threat assessment, individual polygon refinement was completed. In this process, the WUI threat plots completed on the ground were used in the following ways:

- fuel scores were reviewed applied to the fuel type in which the threat plot was completed;
- conservative fuel scores were then applied to the polygons by fuel type to check the initial assessment;
- high and extreme Wildfire Behaviour Threat Class polygons were reviewed in google earth to confirm their position on slope relative to values at risk.

In this way, we were able to consider fuel attributes outside the fuel typing layer, as well as assessment area position on slope relative to structures, which are included in the WUI threat plot worksheet.

APPENDIX F: FIRESMART CONSTRUCTION AND LANDSCAPING

FIRESMART CONSTRUCTION

Roofing Material:

Roofing material is one of the most important characteristics influencing a home's vulnerability to fire. Roofing materials that can be ignited by burning embers increases the probability of fire related damage to a home during an interface fire event.

In many communities, there is no fire vulnerability standard for roofing material. Homes are often constructed with unrated materials that are considered a major hazard during a large fire event. In addition to the vulnerability of roofing materials, adjacent vegetation may be in contact with roofs, or roof surfaces may be covered with litter fall from adjacent trees. This increases the hazard by increasing the ignitable surfaces and potentially enabling direct flame contact between vegetation and structures.

Soffits and Eaves

Open soffits or eaves provide locations for embers to accumulate, igniting a structure. Soffits and eaves should be closed. Vents which open into insulated attic space are of particular concern, as they provide a clear path for embers to a highly flammable material inside the structure. Any exhaust or intake vents that open into attic spaces should resist ember intrusion with non-combustible wire mesh no larger than 3 mm.

Building Exterior - Siding Material:

Building exteriors constructed of vinyl or wood are considered the second highest contributor to structural hazard after roofing material. These materials are vulnerable to direct flame or may ignite when sufficiently heated by nearby burning fuels. The smoke column will transport burning embers, which may lodge against siding materials. Brick, stucco, or heavy timber materials offer much better resistance to fire. While wood may not be the best choice for use in the WUI, other values from economic and environmental perspectives must also be considered. It is significantly less expensive than many other materials, supplies a great deal of employment in BC, and is a renewable resource. New treatments and paints are now available for wood that increase its resistance to fire and they should be considered for use.

Balconies and Decking:

Open balconies and decks increase fire vulnerability through their ability to trap rising heat, by permitting the entry of sparks and embers, and by enabling fire access to these areas. Closing these structures off limits ember access to these areas and reduces fire vulnerability.

Combustible Materials:

Combustible materials stored within 10 m of residences are also considered a significant issue. Woodpiles, propane tanks and other flammable materials adjacent to the home provide fuel and ignitable surfaces. Locating these fuels away from structures helps to reduce structural fire hazards and makes it easier and safer for suppression crews to implement suppression activities adjacent to a house or multiple houses.

Gutters, downspouts, and connectors should be viewed as a location of potential combustible material accumulation. Homeowners should maintain their gutters in a fuel free state by removing accumulations from gutters and crevices annually (or more often, as needed)

Chimneys and wood burning appliances

Spark arrestors should be installed on all wood burning appliances to prevent embers from escaping and igniting a wildfire.

FIRESMART LANDSCAPING

Future landscaping choices should be limited to plant species with low flammability within 10 m of the building. Coniferous vegetation such as Juniper, Cypress, Yew or Cedar hedging or shrubs of any height should not be planted within this 10 m zone as these species are considered highly flammable under extreme fire hazard conditions.

Decorative bark mulch, often used in home landscapes is easily ignitable from wildfire embers or errant cigarettes and can convey fire to the home. Alternatives to bark mulch include gravel, decorative rock, or a combination of wood bark and decorative rock.[40]

LANDSCAPING ALTERNATIVES

The landscaping challenges faced by many homeowners pertain to limited space, privacy and the desire to create visually explicit edge treatments to demarcate property ownership from adjacent lots with evergreen vegetation screens. Additionally, many homeowners like to maintain their property in an 'unaltered' forested state (*i.e.* retain all trees and vegetation). On smaller lots in more developed areas within the SLRD, the former can be a challenge. In more rural areas and on larger properties, the latter is generally the larger hurdle.

In regards to landscaping, ornamental plant characteristics fulfilling the above criteria have an upright branching habit, compact form, dense foliage, as well as a moderate growth rate. Dwarf and ornamental conifers such as Arborvitae hedging are popular choices and grow well in the study area. Yet conifers such as these which have needle or scale-like foliage are highly flammable and not compliant with FireSmart principles and should be omitted from the 10 m Fire Priority Zone of the planned home footprint.

There are a number of broadleaved deciduous and evergreen plants with low flammability which can be used for landscaping within FireSmart PZ 1 (within 10 m of structures). Landscaping should be selected for the appropriate Canadian Plant Hardiness Zone (see www.planthardiness.gc.ca for the Hardiness Zone specific to the various study areas). The majority of the areas would be within Zone 7. Hedge and shrub examples which thrive in Zone 7 and are low flammability include, but are not limited to: boxwood, wolf willow, Oregon grape, mock orange, euonymus, cranberry contoneaster, firethorn, Cheyenne privet, and rose.

Plants that are fire resistant/ have low flammability generally have the following characteristics:

[40] *Fire Resistant Plants for Home Landscapes: Selecting plants that may reduce your risk from wildfire*. 2006. A Pacific Northwest Extension Publication (PNW 590).

- Foliage with high moisture content (moist and supple),
- Little dead wood and do not tend to accumulate dry and dead foliage or woody materials, and
- Sap that is water-like and without a strong odour.[3]

It is important to note that even fire resistant plants can burn if not maintained. Grass, shrubs, and herbs must be maintained in a state that reduces fire hazard by maintaining foliar moisture content. This can be accomplished by:

- Choosing plant species that are well-adapted to the site (microclimate and soil conditions of the parcel);
- Incorporating a landscape design where shrubs, herbs, and grasses are planted in discrete units manageable by hand watering;
- Removal of dead and dying foliage; and/or,
- Installing irrigation.

Depending solely on irrigation to maintain landscaping in a low flammability state can be limiting, and may actually increase the fire hazard on the parcel, particularly in times of drought and watering restrictions. Lack of irrigation in times of watering restrictions may create a landscape which is unhealthy, unsightly, as well as dead, dry, and highly flammable.

There are a number of resources available to aid in development of FireSmart compliant landscaping curriculum or educational material; links can be found below.

- http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/20921/*pnw590.pdf [41]
- https://www.firesmartcanada.ca/images/uploads/resources/FireSmart-Guide-to-Lanscaping.pdf [42]

The Canadian and US systems for determining Plant Hardiness Zones differ.

- The USDA bases hardiness zones on minimum winter temperatures only: http://planthardiness.ars.usda.gov/PHZMWeb/Default.aspx,
- The Canadian system bases them on seven climatic factors including frost free days, and minimum and maximum temperature: http://www.planthardiness.gc.ca/

[41] A Pacific Northwest Extension Publication: Oregon State University, Washington State University, University of Idaho. August 2006.

[42] FireSmart Canada.

APPENDIX G: PRINCIPLES OF FUEL MANAGEMENT

Fuel or vegetation management is a key element of the FireSmart approach. Given public concerns, fuel management is often difficult to implement and must be carefully rationalized in an open and transparent process. Vegetation management should be strategically focused on minimizing impact while maximizing value to the community. The decision whether or not to implement vegetation management must be evaluated against other elements of wildfire risk reduction to determine the best avenue for risk reduction. The effectiveness of fuel treatments is dependent on the extent to which hazardous fuels are modified or removed and the treatment area size and location (strategic placement considers the proximity to values at risk, topographic features, existing fuel types, etc.) in addition to other site specific considerations. The longevity of fuels treatments varies by the methods used and site productivity.

What is fuel management?

Fuel management is the planned manipulation and/or reduction of living and dead forest fuels for land management objectives (*e.g.*, hazard reduction). Fuels can be effectively manipulated to reduce fire hazard by mechanical means, such as tree removal or modification, or abiotic means, such as prescribed fire. The goal of fuel management is to lessen potential fire behavior proactively, thereby increasing the probability of successful containment and minimizing adverse impacts to values at risk. More specifically, the goal is to decrease the rate of fire spread, and in turn reduce fire size and intensity, as well as crowning and spotting potential (Alexander, 2003).

Fire Triangle:

Fire is a chemical reaction that requires fuel (carbon), oxygen and heat. These three components make up the fire triangle and if one is not present, a fire will not burn. Fuel is generally available in adequate quantities in the forest. Fuel comes from living or dead plant materials (organic matter). Trees and branches lying on the ground are a major source of fuel in a forest. Such fuel can accumulate gradually as trees in the stand die. Fuel can also build up in large amounts after catastrophic events such as insect infestations. Oxygen is present in the air. As oxygen is used up by fire it is replenished quickly by wind. Heat is needed to start and maintain a fire. Heat can be supplied by nature through lightning or people can be a source through misuse of matches, campfires, trash fires and cigarettes. Once a fire has started, it provides its own heat source as it spreads through a fuel bed capable of supporting it.

Forest Fuels:

The amount of fuel available to burn on any site is a function of biomass production and decomposition. Many of the forest ecosystems within BC have the potential to produce large amounts of vegetation biomass. Variation in the amount of biomass produced is typically a function of site productivity and climate. The disposition or removal of vegetation biomass is a function of decomposition. Decomposition is regulated by temperature and moisture. In wet maritime coastal climates, the rates of decomposition are relatively high when compared with drier cooler

continental climates of the interior. Rates of decomposition can be accelerated naturally by fire and/or anthropogenic means.

A hazardous fuel type can be defined by high surface fuel loadings, high proportions of fine fuels (<1 cm) relative to larger size classes, high fuel continuity between the ground surface and overstorey tree canopies, and high stand densities. A fuel complex is defined by any combination of these attributes at the stand level and may include groupings of stands.

Surface Fuels:

Surface fuels consist of forest floor, understorey vegetation (grasses, herbs and shrubs, and small trees), and coarse woody debris that are in contact with the forest floor. Forest fuel loading is a function of natural disturbance, tree mortality and/or human related disturbance. Surface fuels typically include all combustible material lying on or immediately above the ground. Often roots and organic soils have the potential to be consumed by fire and are included in the surface fuel category.

Surface fuels that are less than 7 cm in diameter contribute to surface fire spread; these fuels often dry quickly and are ignited more easily than larger diameter fuels. Therefore, this category of fuel is the most important when considering a fuel reduction treatment. Larger surface fuels greater than 7 cm are important in the contribution to sustained burning conditions, but, when compared with smaller size classes, are often not as contiguous and are less flammable because of delayed drying and high moisture content. In some cases, where these larger size classes form a contiguous surface layer, such as following a windthrow event or wildfire, they can contribute an enormous amount of fuel, which will increase fire severity and the potential for fire damage.

Aerial Fuels:

Aerial fuels include all dead and living material that is not in direct contact with the forest floor surface. The fire potential of these fuels is dependent on type, size, moisture content, and overall vertical continuity. Dead branches and bark on trees and snags (dead standing trees) are important aerial fuels. Concentrations of dead branches and foliage increase the aerial fuel bulk density and enable fire to move from tree to tree. The exception is for deciduous trees where the live leaves will not normally carry fire. Numerous species of moss, lichens, and plants hanging on trees are light and easily ignited aerial fuels. All of the fuels above the ground surface and below the upper forest canopy are described as ladder fuels.

Two measures that describe crown fire potential of aerial fuels are the height to live crown and crown closure (Figure 33 and Figure 34). The height to live crown describes fuel continuity between the ground surface and the lower limit of the upper tree canopy. Crown closure describes the inter-tree crown continuity and reflects how easily fire can be propagated from tree to tree. In addition to crown closure, tree density is an important measure of the distribution of aerial fuels and has significant influence on the overall crown and surface fire conditions (Figure 35). Higher stand density is associated with lower inter tree spacing, which increases overall crown continuity. While high density stands may increase the potential for fire spread in the upper canopy, a combination of high crown closure and high stand density usually results in a reduction in light levels associated with these stand types. Reduced light levels accelerate self-tree pruning, inhibit the growth of lower branches, and decrease the cover and biomass of understory vegetation.

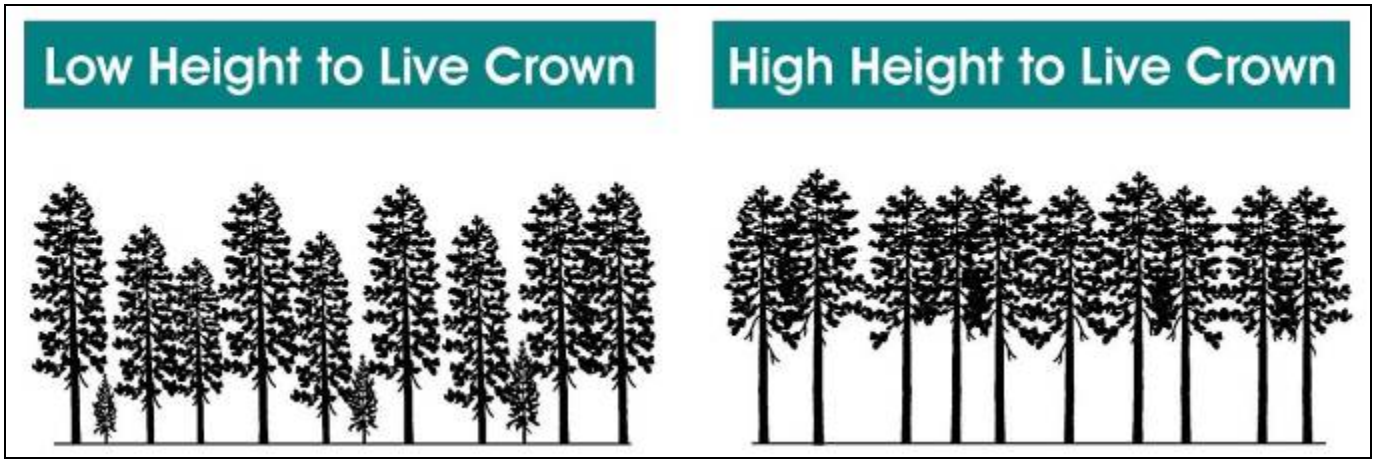

Figure 33. Comparison of stand level differences in height-to-live crown in an interior forest, where low height to live crown is more hazardous than high height to live crown.

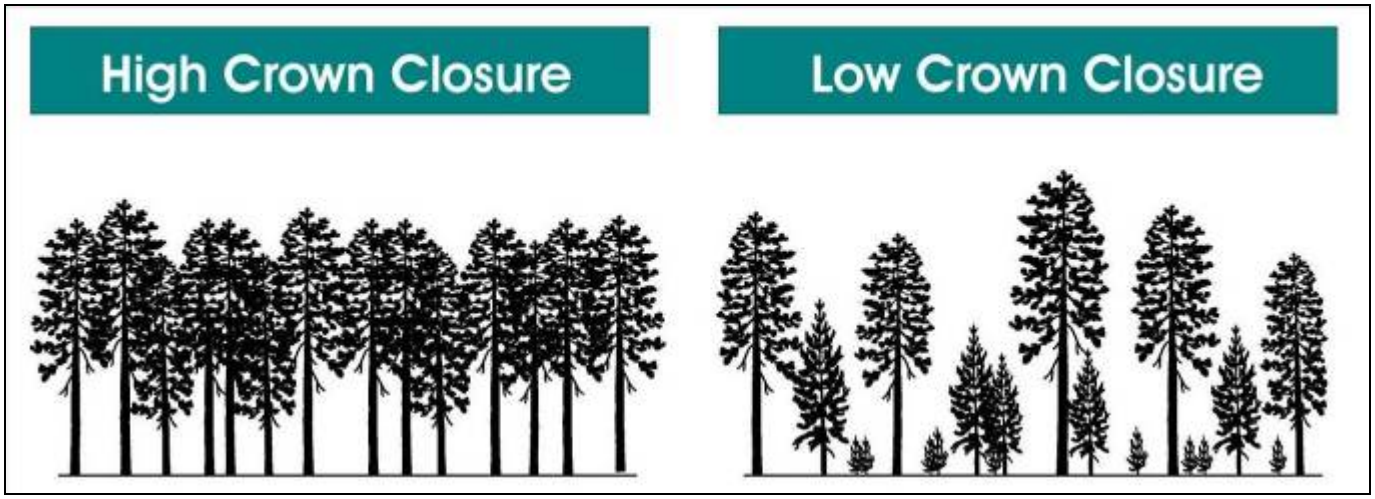

Figure 34. Comparison of stand level differences in crown closure, where high crown closure/continuity contributes to crown fire spread, while low crown closure reduces crown fire potential.

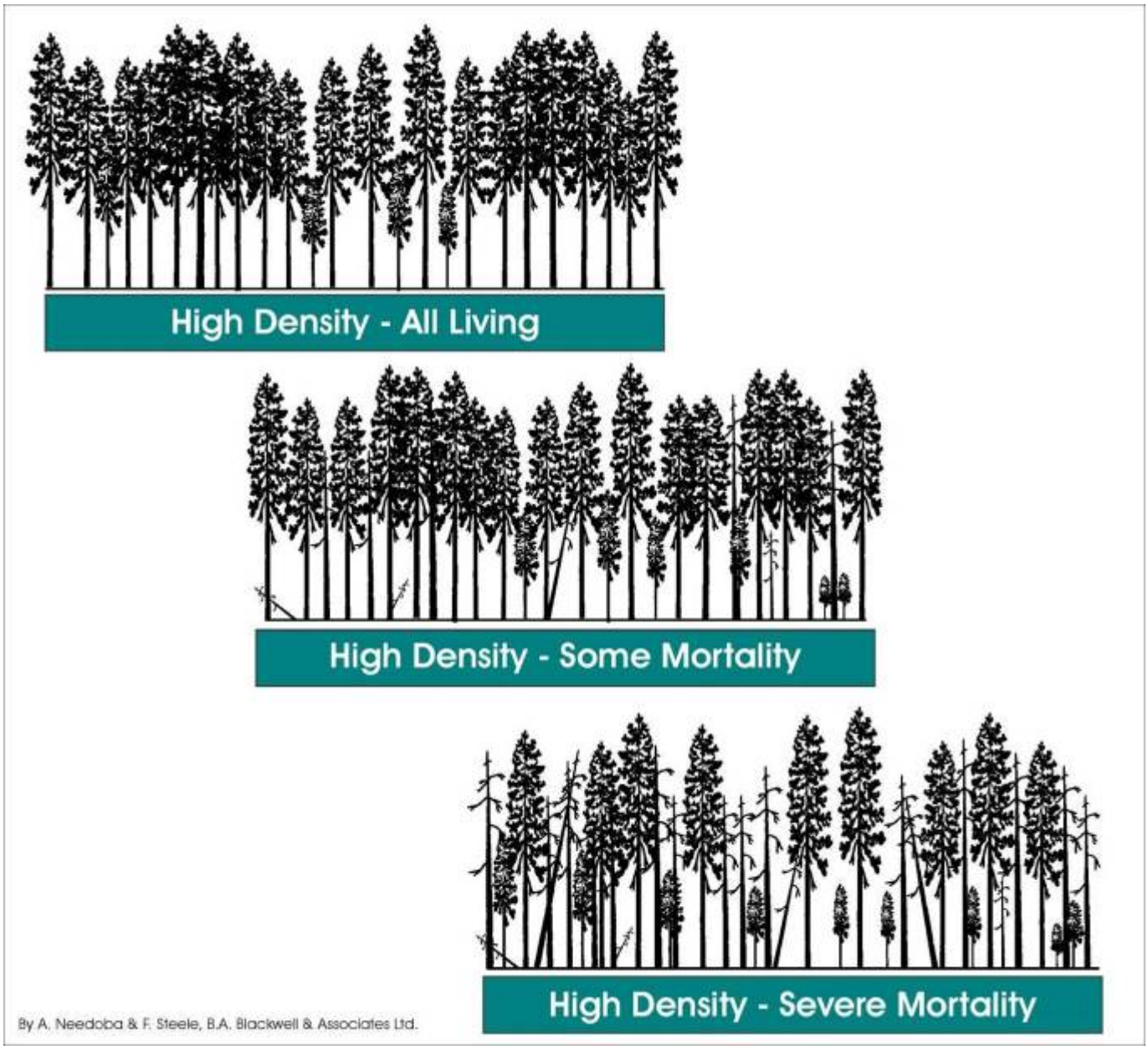

Figure 35. Comparison of stand level differences in density and mortality, and the distribution of live and dead fuels in these types of stands.

Thinning is a preferred approach to fuel treatment (Figure 44.) and offers several advantages compared to other methods:

- Thinning provides the most control over stand level attributes such as species composition, vertical structure, tree density, and spatial pattern, as well as the retention of snags and coarse woody debris for maintenance of wildlife habitat and biodiversity.
- Unlike prescribed fire treatments, thinning is comparatively low risk, and is less constrained by fire weather windows.

- Thinning may provide marketable materials that can be utilized by the local economy.
- Thinning can be carried out using sensitive methods that limit soil disturbance, minimize damage to leave trees, and provide benefits to other values such as wildlife.

The main wildfire objective of thinning is to shift stands from having a high crown fire potential to having a low surface fire potential. In general, the goals of thinning are to:

- Reduce stem density below a critical threshold to minimize the potential for crown fire spread;
- Prune to increase the height to live crown to reduce the potential of surface fire spreading into tree crowns; and
- Remove slash created by spacing and pruning to minimize surface fuel loadings while still maintaining adequate woody debris to maintain ecosystem function.

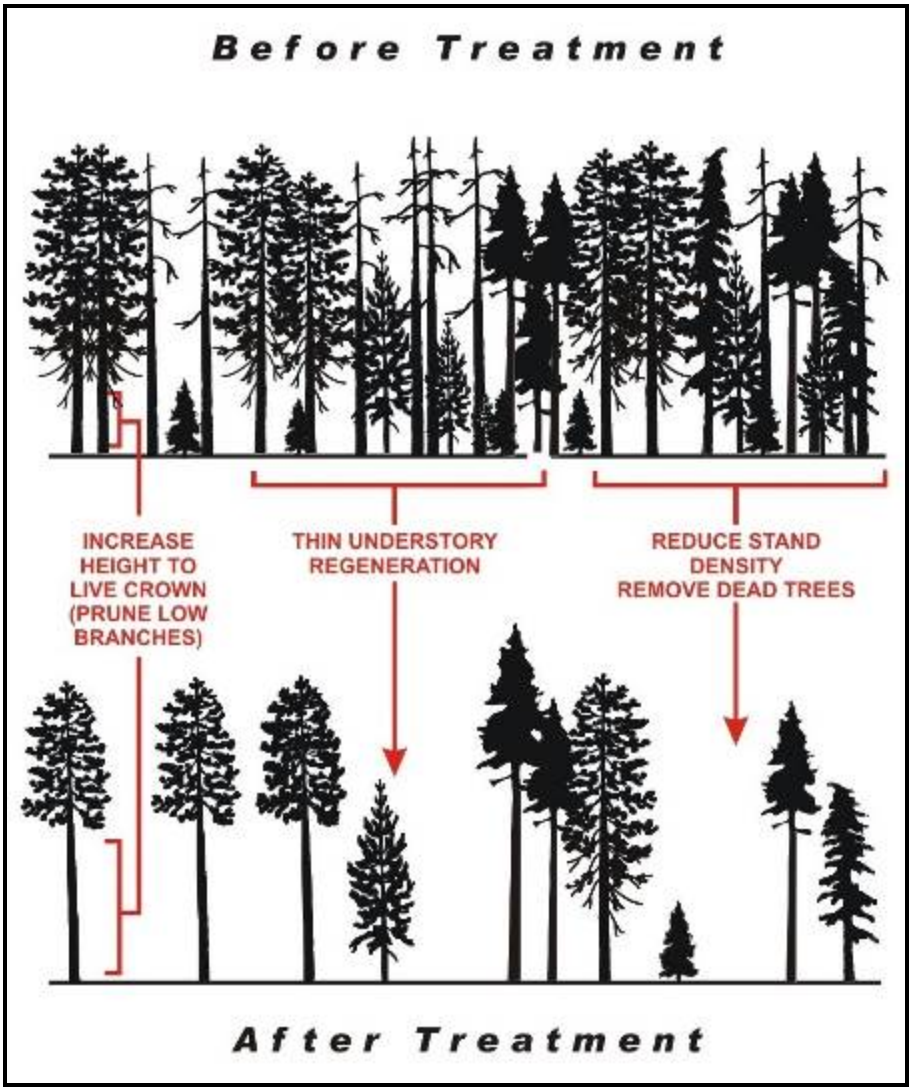

Figure 36. Illustration of the principles of thinning to reduce the stand level wildfire hazard.

Fuel type, weather and topography are all primary factors that influence the spread of fires. The three most important components of weather include wind, temperature and humidity. Topography is differentiated by slope, aspect and terrain. Fuel type and slope are primary concerns related to fire spread along the forested areas on slopes in the Regional District. The steepness of a slope can affect the rate and direction a fire spreads and generally fires move faster uphill than downhill, and fire will move faster on steeper slopes. This is attributed to (MFLNRO, 2014):

- *On the uphill side, the flames are closer to the fuel;*
- *The fuels become drier and ignite more quickly than if on level ground;*
- *Wind currents are normally uphill and this tends to push heat flames into new fuels;*
- *Convected heat rises along the slope causing a draft which further increases the rate of spread; and*
- *Burning embers and chunks of fuel may roll downhill into unburned fuels, increasing spread and starting new fires.*

APPENDIX H: RECOMMENDED FUEL TREATMENT MAPS BY STUDY AREA

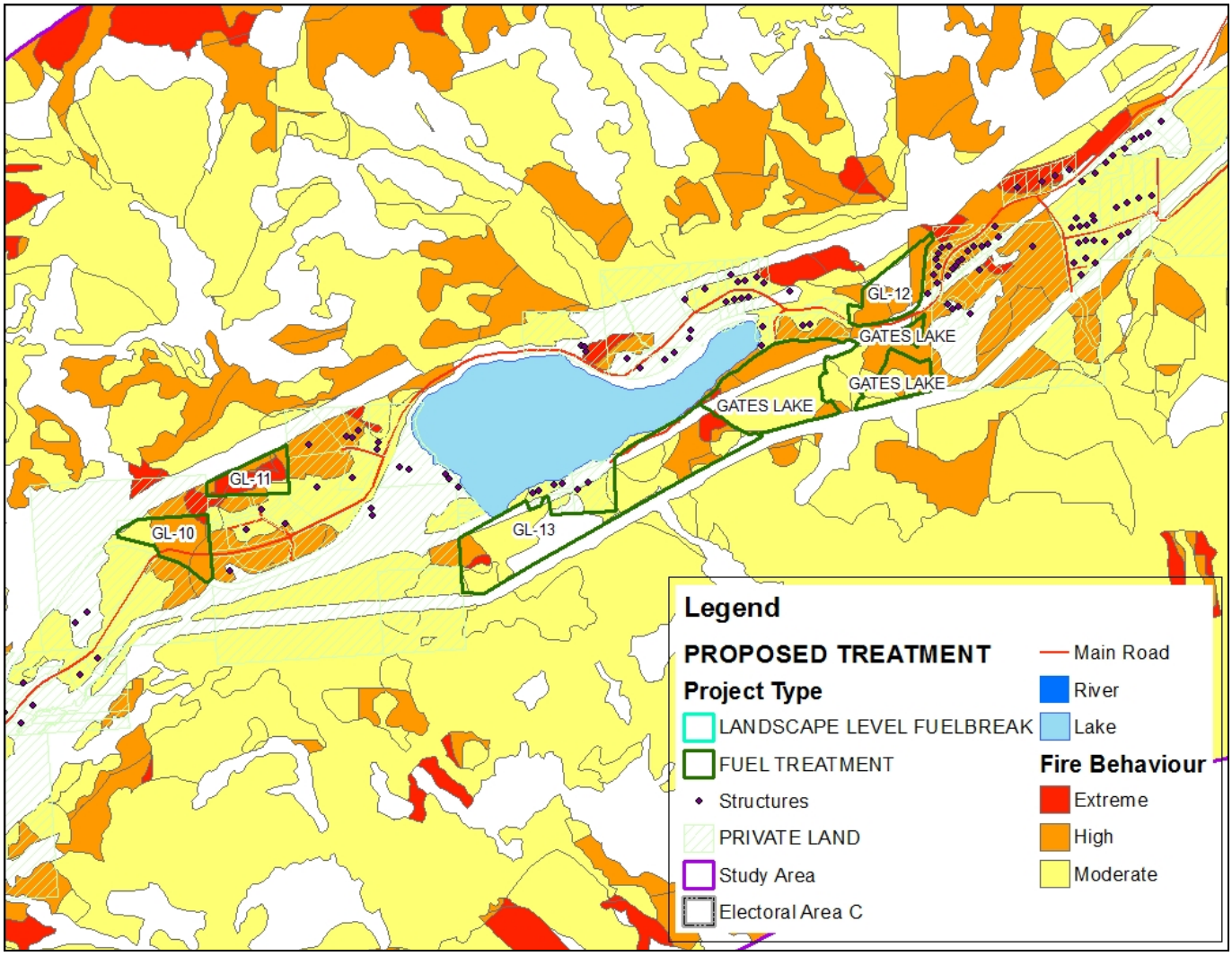

Figure 37. Recommended treatment areas for the Birken/ Gramsons/ Gates study area.

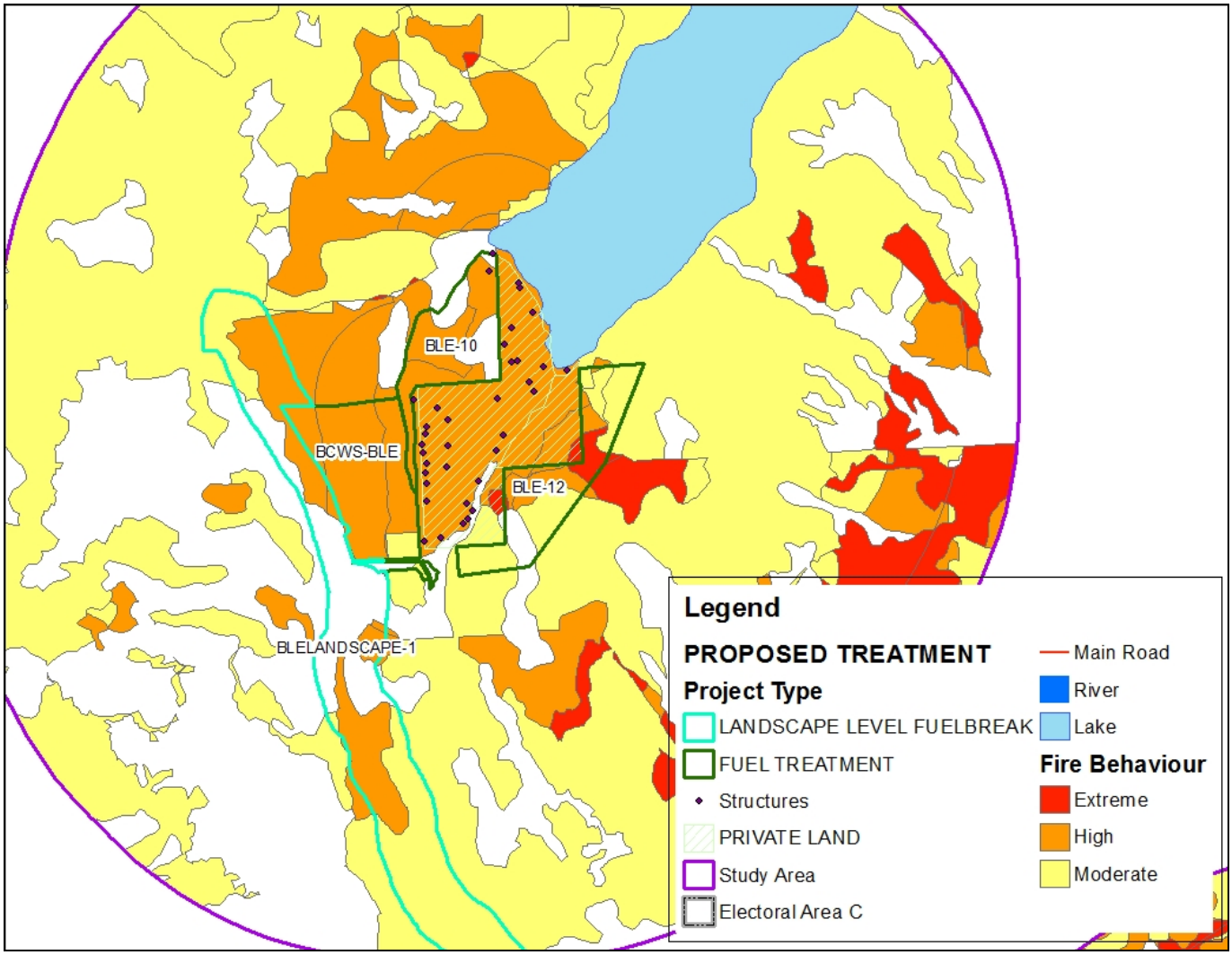

Figure 38. Recommended treatment areas for the Birkenhead Lake Estates study area.

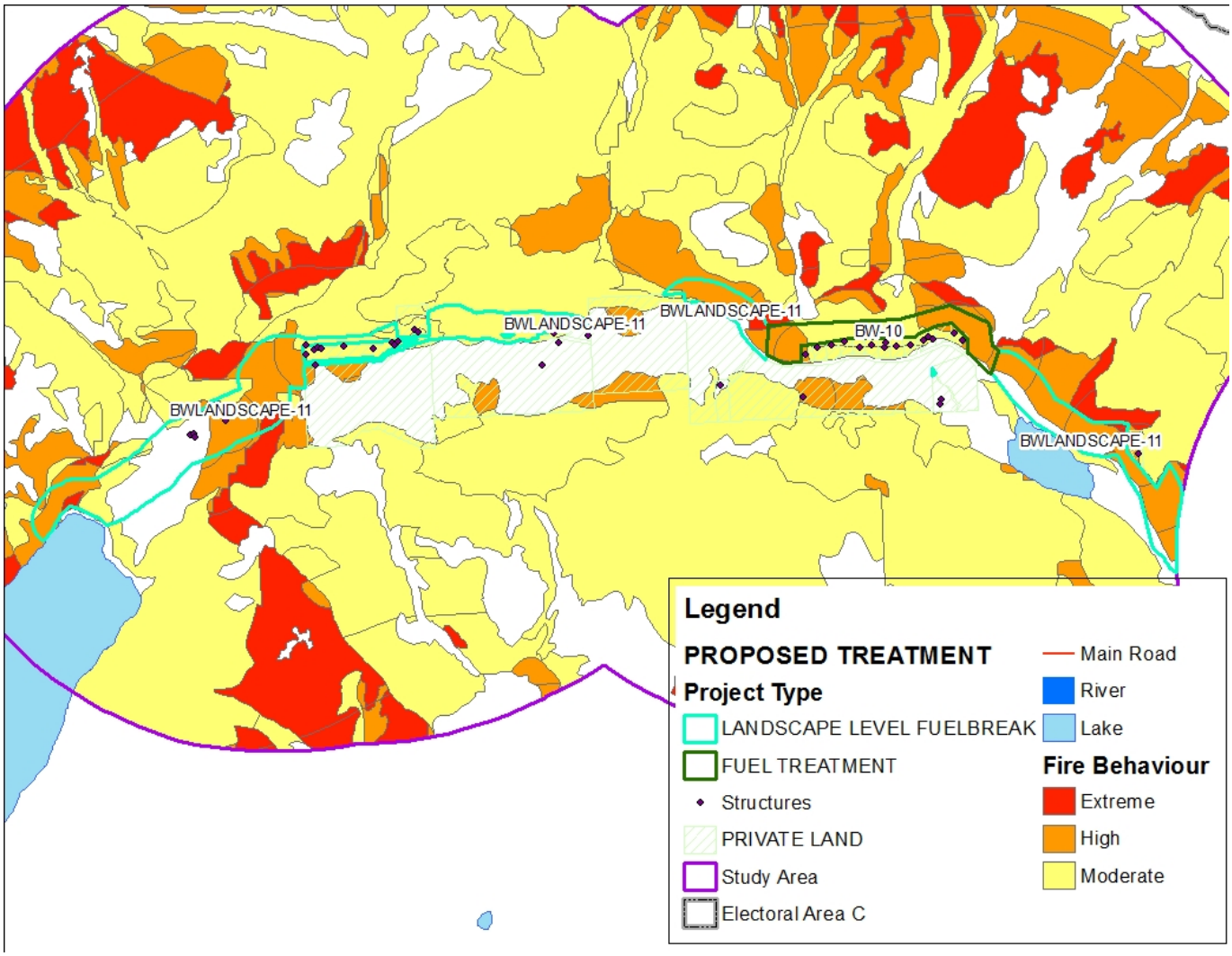

Figure 39. Recommended treatment areas for the Birkenhead Lake North and Blackwater study area.

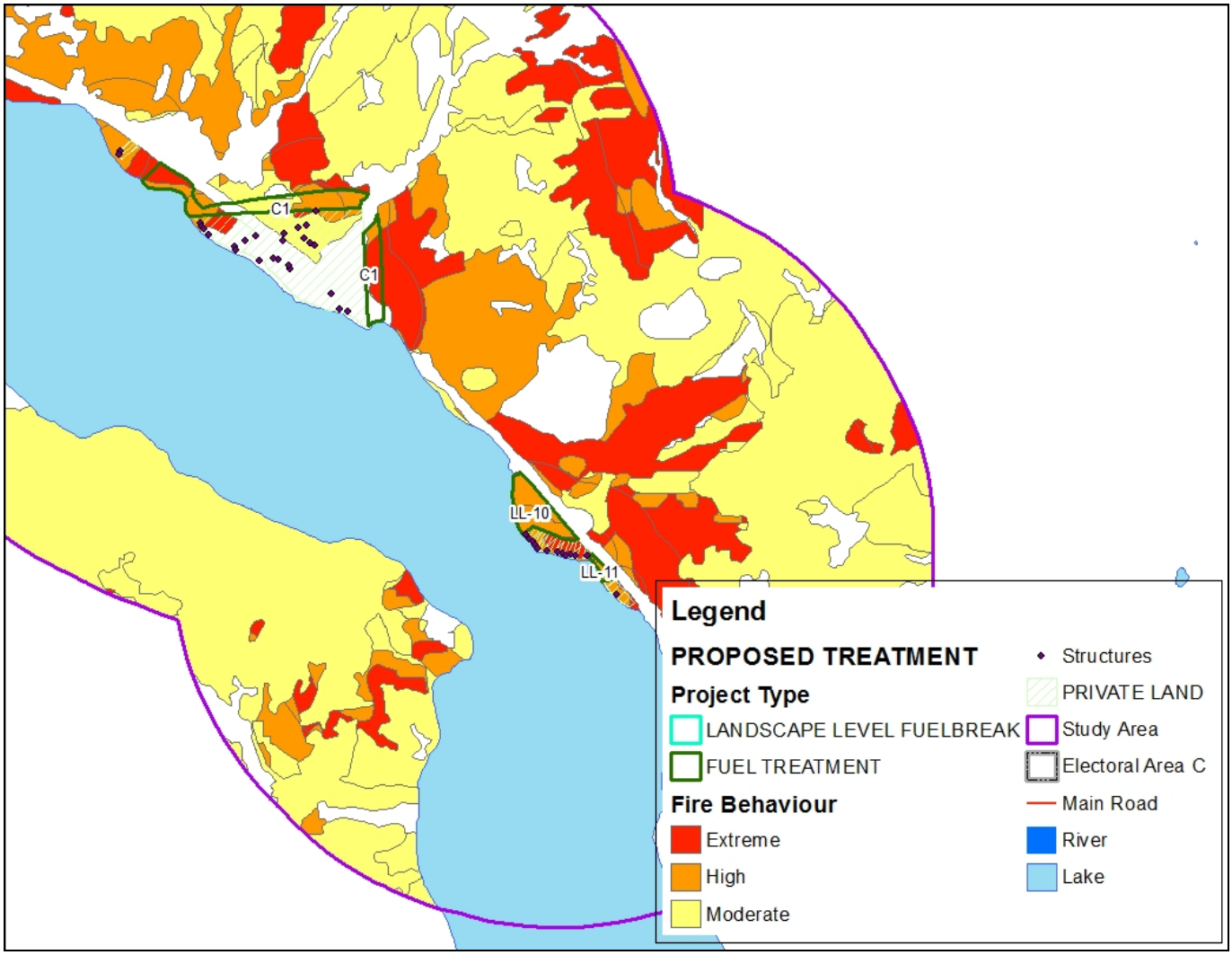

Figure 40. Recommended treatment areas for the Lillooet Lake study area.

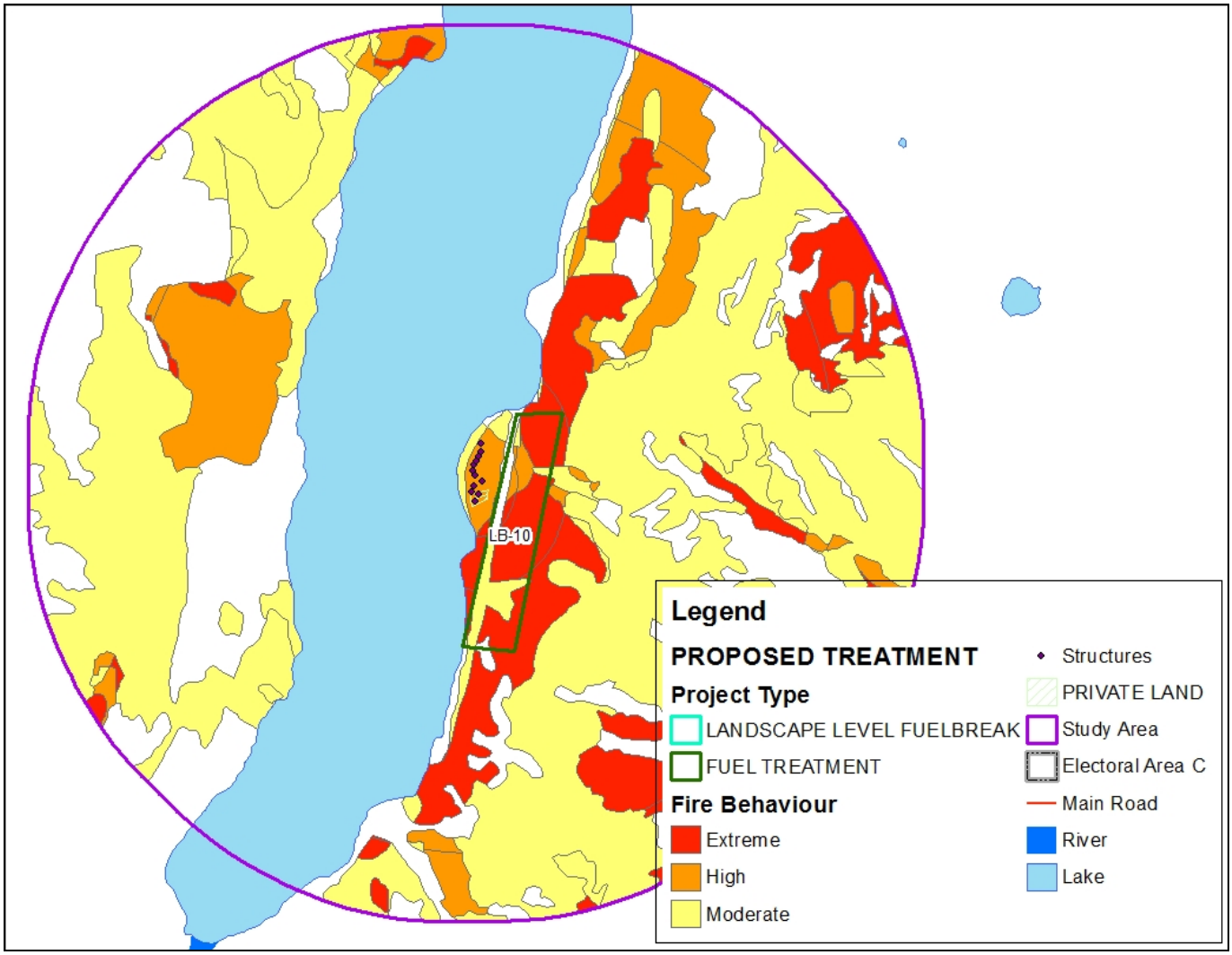

Figure 41. Recommended treatment areas for the Lizzie Bay study area.

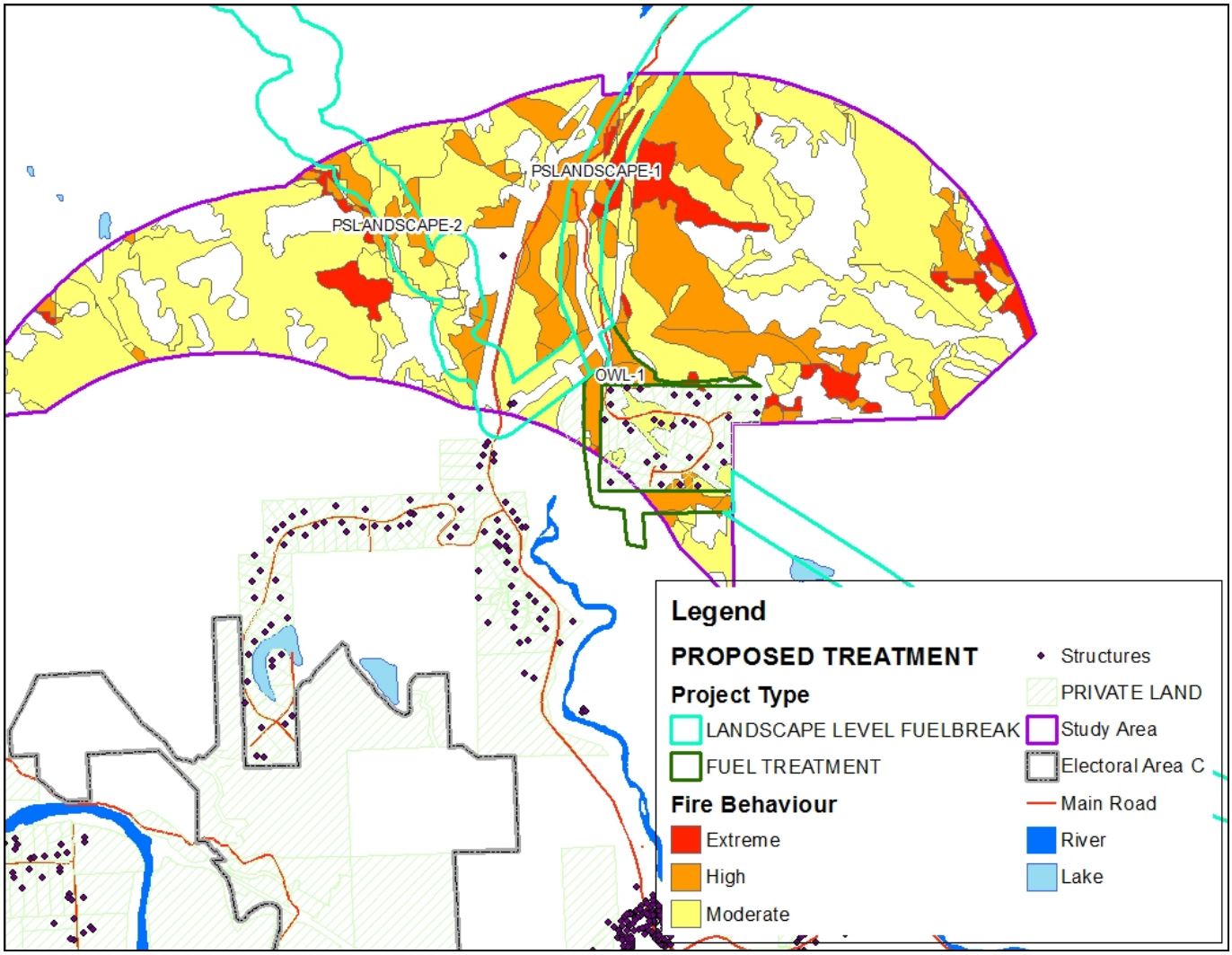

Figure 42. Recommended treatment areas for the Pemberton Meadows/ Pemberton Surroundings study area.

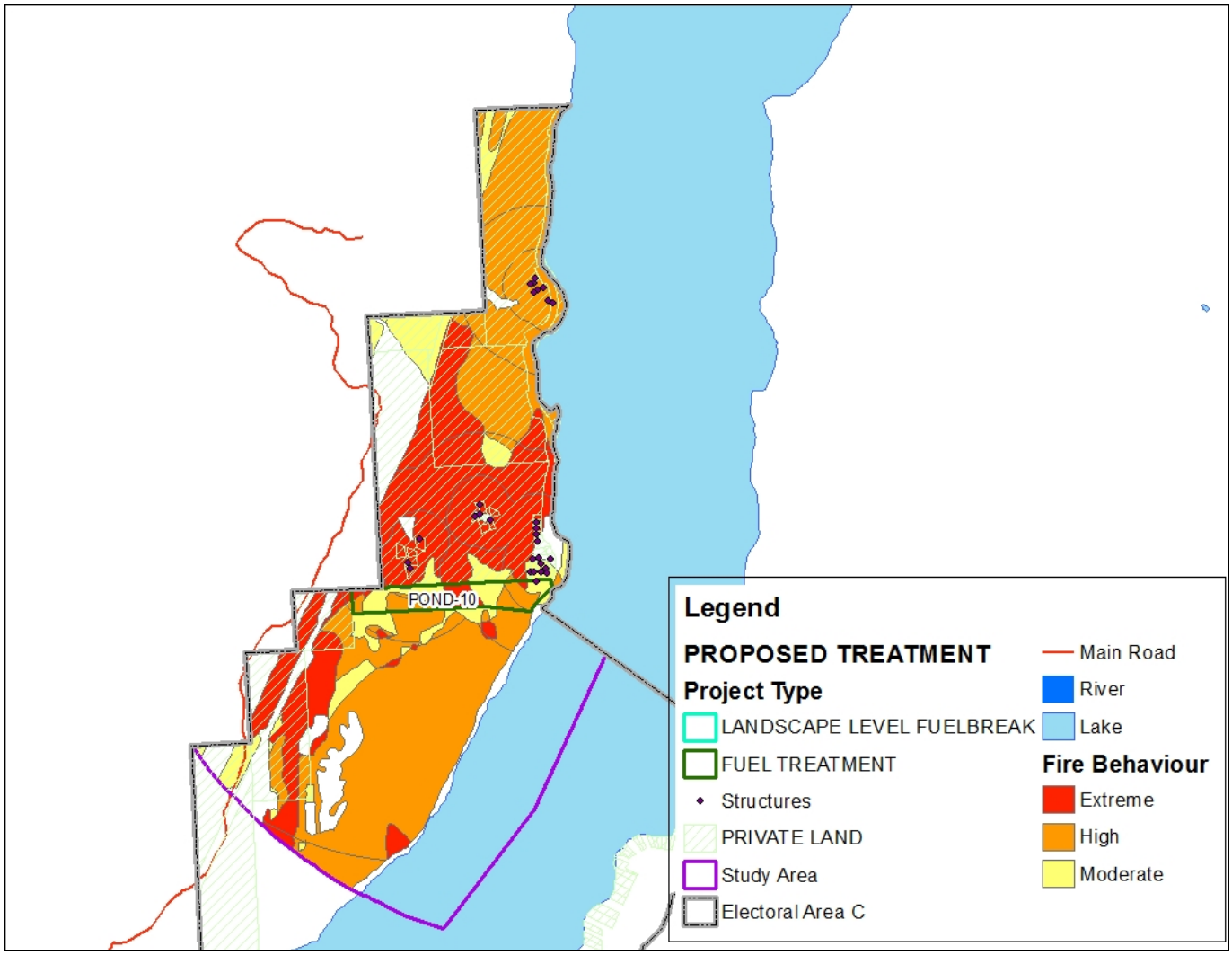

Figure 43. Recommended treatment area for the Ponderosa study area.

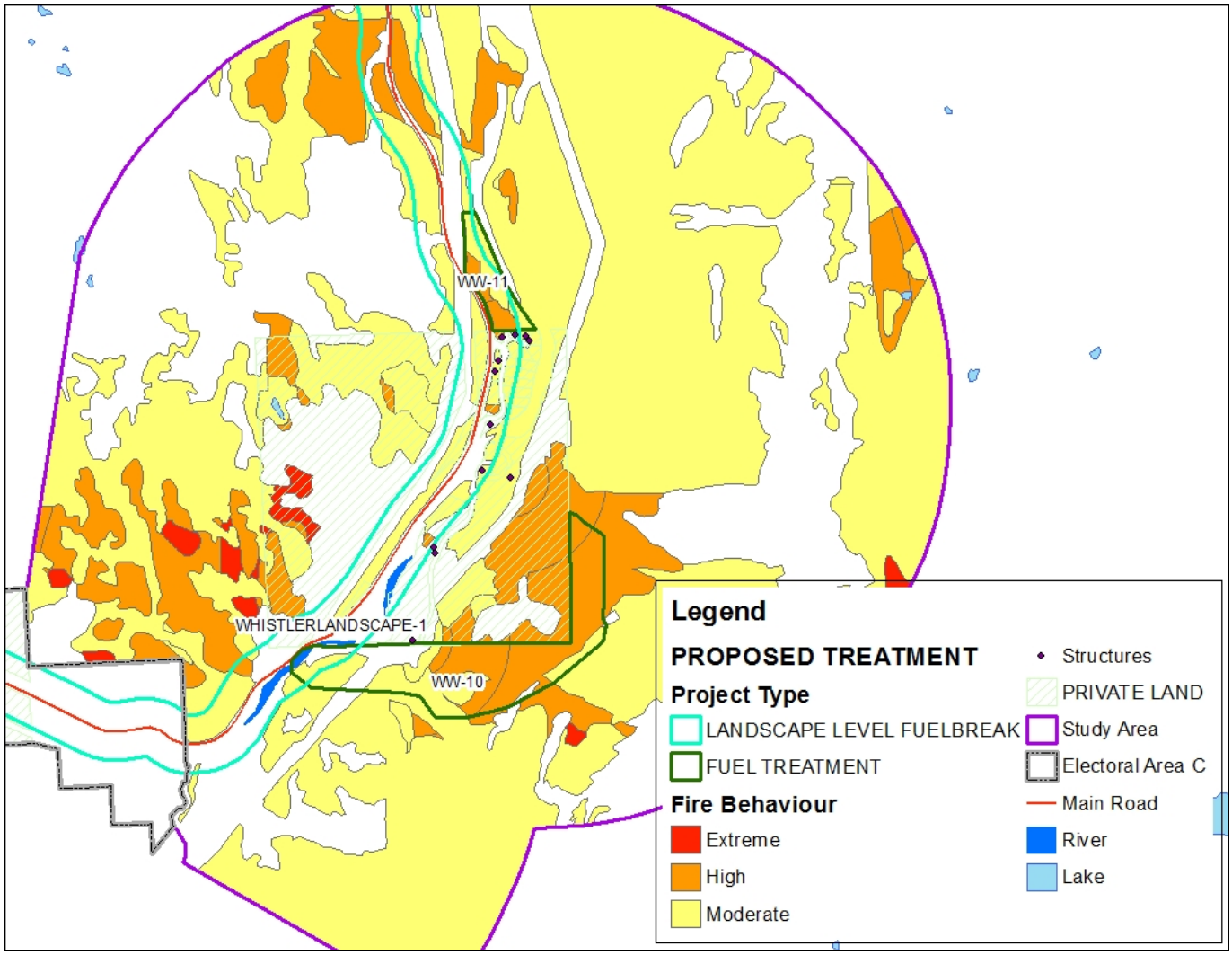

Figure 44. Recommended treatment areas for the Wedgewoods study area.

APPENDIX I: LANDSCAPE LEVEL FUELBREAK MANAGEMENT

The information contained within this section has been inserted from "The Use of Fuelbreaks in Landscape Fire Management" by James K. Agee, Benii Bahro, Mark A. Finney, Philip N. Omi, David B. Sapsis, Carl N. Skinner, Jan W. van Wagtendonk, and C. Phill Weatherspoon. This article succinctly describes the principles and use of fuelbreaks in landscape fire management.

The principal objective behind the use of fuelbreaks, as well as any other fuel treatment, is to alter fire behaviour over the area of treatment. As discussed above, fuelbreaks provide points of anchor for suppression activities.

Surface Fire Behaviour:

Surface fuel management can limit fireline intensity (Byram 1959) and lower potential fire severity (Ryan and Noste 1985). The management of surface fuels so that potential fireline intensity remains below some critical level can be accomplished through several strategies and techniques. Among the common strategies are fuel removal by prescribed fire, adjusting fuel arrangement to produce a less flammable fuelbed (e.g., crushing), or "introducing" live understory vegetation to raise average moisture content of surface fuels (Agee 1996). Wildland fire behaviour has been observed to decrease with fuel treatment (Buckley 1992), and simulations conducted by van Wagtendonk (1996) found both pile burning and prescribed fire, which reduced fuel loads, to decrease subsequent fire behaviour. These treatments usually result in efficient fire line construction rates, so that control potential (reducing "resistance to control") can increase dramatically after fuel treatment.

The various surface fuel categories interact with one another to influence fireline intensity. Although more litter and fine branch fuel on the forest floor usually results in higher intensities; however, that is not always the case. If additional fuels are packed tightly (low fuelbed porosity), they may result in lower intensities. Although larger fuels (>3 inches) - are not included in fire spread models, as they do not usually affect the spread of the fire (unless decomposed [Rothennel 1991]), they may result in higher energy releases over longer periods of time when a fire occurs, having significant effects on fire severity, and they reduce rates of fireline construction.

The effect of herb and shrub fuels on fireline intensity is not simply predicted. First of all, more herb and shrub fuels usually imply more open conditions. These should be associated with lower relative humidity and higher surface windspeeds. Dead fuels may be drier - and the rate of spread may be higher - because of the altered microclimate compared to more closed canopy forest with less understory. Live fuels, with higher foliar moisture while green, will have a dampening effect on fire behaviour. However, if the grasses and forbs cure, the fine dead fuel can increase fireline intensity and localized spotting.

Conditions That Initiate Crown Fire:

A fire moving through a stand of trees may move as a surface fire, an independent crown fire, or as a combination of intermediate types of fire (Van Wagner 1977). The initiation of crown fire behaviour is a function of surface fireline intensity and of the forest canopy: its height above ground and moisture content (Van Wagner 1977). The critical surface fire intensity needed to initiate crown fire behaviour can be calculated for a range of crown base heights and foliar moisture contents, and represents the minimum level of fireline intensity necessary to initiate crown fire (Table 1); Alexander 1988, Agee 1996). Fireline intensity or flame length below this critical level may result in fires that do not crown but may still be of stand replacement severity. For the limited range of crown

base heights and foliar moistures shown in Table 11, the critical levels of flame length appear more sensitive to height to crown base than to foliar moisture (Alexander 1988).

Table 26. Flame lengths associated with critical levels of fireline intensity that are associated with initiating crown fire, using Byram's (1959) equation.

Foliar Moisture Content (%)	Height of Crown Base Separation			
	2 meters	6 meters	12 meters	20 meters
	6 feet	20 feet	40 feet	66 feet
	M (ft)	M (ft)	M (ft)	M (ft)
70	1.1 (4)	2.3 (8)	3.7 (12)	5.3 (17)
80	1.1 (4)	2.5 (8)	4.0 (13)	5.7 (19)
90	1.3 (4)	2.7 (9)	4.3 (14)	6.1 (20)
100	1.3 (4)	2.8 (9)	4.6 (15)	6.5 (21)
120	1.5 (5)	3.2 (10)	5.1 (17)	7.3 (24)

If the structural dimensions of a stand and information about foliar moisture are known, then critical levels of fireline intensity that will be associated with crown fire for that stand can be calculated. Fireline intensity can be predicted for a range of stand fuel conditions, topographic situations such as slope and aspect, and anticipated weather conditions, making it possible to link on-the-ground conditions with the initiating potential for crown fires. In order to avoid crown fire initiation, fireline intensity must be kept below the critical level. Managing surface fuels can accomplish this, such that fireline intensity is kept well below the critical level; raising crown base heights such that the critical fireline intensity is difficult to reach is another option. In the field, the variability in fuels, topography and microclimate will result in varying levels of potential fireline intensity, critical fireline intensity, and therefore, varying crown fire potential.

Conditions That Allow Crown Fire To Spread:
The crown of a forest is similar to any other porous fuel medium in its ability to burn and the conditions under which crown fire will or will not spread. The heat from a spreading crown fire into unburned crown ahead is a function of the crown rate of spread, the crown bulk density, and the crown foliage ignition energy. The crown fire rate of spread is not the same as the surface fire rate of spread, and often includes effects of short-range spotting. The crown bulk density is the mass of crown fuel, including needles, fine twigs, lichens, etc., per unit of crown volume (analogous to soil bulk density). Crown foliage ignition energy is the net energy content of the fuel and varies primarily by foliar moisture content, although species differences in energy content are apparent (van Wagtendonk et al. 1998). Crown fires will stop spreading, but not necessarily stop torching, if either the crown fire rate of spread or crown bulk density falls below some minimum value.

If surface fireline intensity rises above the critical surface intensity needed to initiate crown fire behaviour, the crown will likely become involved in combustion. Three phases of crown fire behaviour can be described by critical levels of surface fireline intensity and crown fire rates of spread (Van Wagner 1977, 1993): 1) a passive crown fire, where the crown fire rate of spread is equal to the surface fire rate of spread, and crown fire activity is limited to individual tree torching; 2) an active crown fire, where the crown fire rate of spread is above some

minimum spread rate; and 3) an independent crown fire, where crown fire rate of spread is largely independent of heat from the surface fire intensity. Scott and Reinhardt (in prep.) have defined an additional class, 4) conditional surface fire, where the active crowning spread rate exceeds a critical level, but the critical level for surface fire intensity is not met. A crown fire will not initiate from a surface fire in this stand, but an active crown fire may spread through the stand if it initiates in an adjacent stand.

Critical conditions can be defined as the level below which active or independent crown fire spread is unlikely. To derive these conditions, visualize a crown fire as a mass of fuel being carried on a "conveyor belt" through a stationary flaming front. The amount of fine fuel passing through the front per unit time (the mass flow rate) depends on the speed of the conveyor belt (crown fire rate of spread) and the density of the forest crown fuel (crown bulk density). If the mass flow rate falls below some minimum level (Van Wagner 1977) crown fires will not spread. Individual crown torching, and/or crown scorch of varying degrees, may still occur.

Defining a set of critical conditions that may be influenced by management activities is difficult. At least two alternative methods can define conditions such that crown fire spread would be unlikely (that is, mass flow rate is too low). One is to calculate critical windspeeds for given levels of crown bulk density (Scott and Reinhardt, in prep.), and the other is to define empirically derived thresholds of crown fire rate of spread so that critical levels of crown bulk density can be defined (Agee 1996). Crown bulk densities of 0.2 kg m^{-3} are common in boreal forests that burn with crown fire (Johnson 1992), and in mixed conifer forests, Agee (1996) estimated that at levels below 0.10 kg m^{-3} crown fire spread was unlikely, but no definitive single "threshold" is likely to exist.

Therefore, reducing surface fuels, increasing the height to the live crown base, and opening canopies should result in a) lower fire intensity, b) less probability of torching, and c) lower probability of independent crown fire. There are two caveats to these conclusions. The first is that a grassy cover is often preferred as the fuelbreak ground cover, and while fireline intensity may decrease in the fuelbreak, rate of spread may increase. Van Wagtendonk (1996) simulated fire behaviour in untreated mixed conifer forests and fuelbreaks with a grassy understory, and found fireline intensity decreased in the fuelbreak (flame length decline from 0.83 to 0.63 m [2.7 to 2.1 ft]) but rate of spread in the grassy cover increased by a factor of 4 (0.81 to 3.35 m/min [2.7-11.05 ft/min]). This flashy fuel is an advantage for backfiring large areas in the fuelbreak as a wildland fire is approaching (Green 1977), as well as for other purposes described later, but if a fireline is not established in the fuelbreak, the fine fuels will allow the fire to pass through the fuelbreak quickly. The second caveat is that more open canopies will result in an altered microclimate near the ground surface, with somewhat lower fuel moisture and higher windspeeds in the open understory (van Wagtendonk 1996).

Fuelbreak Effectiveness:

The effectiveness of fuelbreaks continues to be questioned because they have been constructed to varying standards, "tested" under a wide variety of wildland fire conditions, and measured by different standards of effectiveness. Green (1977) describes a number of situations where traditional fuelbreaks were successful in stopping wildland fires, and some where fuelbreaks were not effective due to excessive spotting of wildland fires approaching the fuelbreaks.

Fuelbreak construction standards, the behaviour of the approaching wildland fire, and the level of suppression each contribute to the effectiveness of a fuelbreak. Wider fuelbreaks appear more effective than narrow ones. Fuel treatment outside the fuelbreak may also contribute to their effectiveness (van Wagtendonk 1996). Area treatment such as prescribed fire beyond the fuelbreak may be used to lower fireline intensity and reduce spotting as a wildland fire approaches a fuelbreak, thereby increasing its effectiveness. Suppression forces must be willing and able to apply appropriate suppression tactics in the fuelbreak. They must also know that the fuelbreaks exist, a common problem in the past. The effectiveness of suppression forces depends on the level of funding for people, equipment, and aerial application of retardant, which can more easily reach surface fuels in a fuelbreak. Effectiveness is also dependent on the psychology of firefighters regarding their safety. Narrow or unmaintained fuelbreaks are less likely to be entered than wider, well-maintained ones.

No absolute standards for width or fuel manipulation are available. Fuelbreak widths have always been quite variable, in both recommendations and construction. A minimum of 90 m (300 ft) was typically specified for primary fuelbreaks (Green 1977). As early as the 1960's, fuelbreaks as wide as 300 m (1000 ft) were included in gaming simulations of fuelbreak effectiveness (Davis 1965), and the recent proposal for northern California national forests by the Quincy Library Group (see web site http://www.qlg.org for details) includes fuelbreaks 390 m (0.25 mi) wide. Fuelbreak simulations for the Sierra Nevada Ecosystem Project (SNEP) adopted similar wide fuelbreaks (van Wagtendonk 1996, Sessions et al. 1996).

Fuel manipulations can be achieved using a variety of techniques (Green 1977) with the intent of removing surface fuels, increasing the height to the live crown of residual trees, and spacing the crowns to prevent independent crown fire activity. In the Sierra Nevada simulations, pruning of residual trees to 3 m (10 ft) height was assumed, with canopy cover at 1-20% (van Wagtendonk 1996). Canopy cover less than 40% has been proposed for the Lassen National Forest in northern California. Clearly, prescriptions for creation of fuelbreaks must not only specify what is to be removed, but must describe the residual structure in terms of standard or custom fuel models so that potential fire behaviour can be analyzed.