District of Squamish Community Wildfire Protection Plan 2017 Update

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SQUAMISH

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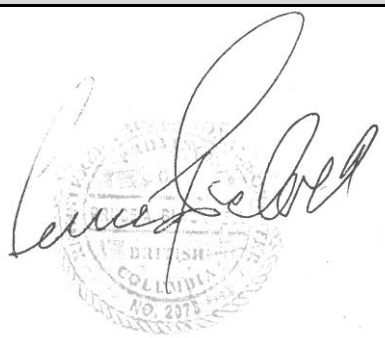
This report would not be possible without the Strategic Wildfire Prevention Initiative (SPWI) Program and funding from the Union of British Columbia Municipalities (UBCM).

REGISTERED PROFESSIONAL SIGN AND SEAL

RPF PRINTED NAME	
Bruce A. Blackwell	RPF 2073
DATE SIGNED	
September 28, 2018	
I certify that the work described herein fulfills the standards expected of a member of the Association of British Columbia Forest Professionals and that I did personally supervise the work.	
Registered Professional Forester Signature and Seal	
	

EXECUTIVE SUMMARY/ SUMMARY OF CWPP RECOMMENDATIONS

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 Strategic Wildfire Prevention Working Group, CWPPs aim to develop strategic recommendations to assist in improving safety and to reduce the risk of damage to property from wildfires.

The CWPP will provide the District of Squamish (District) with a framework that can be used to review and assess areas of identified high fire risk. Additionally, the information contained in this report should help to guide the development of emergency plans, emergency response, evacuation plans, communication and education programs (including FireSmart), bylaw development in areas of fire risk, and the management of potentially hazardous forest lands adjacent to the community.

Wildfire management requires a multi-faceted approach for greatest efficacy and risk reduction outcomes. A total of 48 strategic recommendations are found in a tabularized format within this Executive Summary. In addition, these recommendations are more thoroughly discussed in their appropriate sections within the document and are found in written format. Because the area of interest (aka, study area) extends outside the District boundary onto private land and therefore outside District jurisdiction, the District's role may be limited to that of an influencer in some instances, while other recommendations can be directly implemented by the District. The recommendations are displayed in totality in Table 1. Ultimately, the recommendations within this strategy should be considered a toolbox of options to help reduce the wildfire threat to the community. There is not one combination or course of action which is the answer; the District of Squamish will have to further prioritize based on resources, strengths, constraints, and availability of funding and regularly update the prioritization and course of action as variables change through time.

Table 1. Summary of truncated CWPP Recommendations by Document Section.

Document Section	REC. No.	Recommendation/ Next Steps	Objective/ Priority	Responsibility/Level of Effort	Estimated Resources
Section 2: Local Area Description	**#1.**	Identification of a Growth Management Boundary with special consideration of proximity to forested fuels, position on slope, limitations to access / egress, increased emergency response time, and limitations to municipal water / hydrants.	Reduce interface/intermix developments vulnerable to wildfire: **Moderate Priority**	Various District planning and policy staff employees; Medium Level of Effort	~20 in-house hours

Document Section	REC. No.	Recommendation/ Next Steps	Objective/ Priority	Responsibility/Level of Effort	Estimated Resources
Cont. Section 2: Local Area Description	**#2.**	Continue with current biomass disposal/diversion programs and explore alternative wood waste disposal methods.	Effectively reduce fuel loading in interface: **High Priority**	Various District departmental staff; *Low level of effort*	~15 in-house hours
	#3.	Allow open burning for woody debris if other options for debris disposal are unavailable or operationally impractical.		Various District departmental staff (SFR, planning, bylaw enforcement); *Low level of effort*	Negligible in-house hours
	#4.	Use updated threat assessments to identify areas of unacceptable vulnerability to wildfire.	Follow direction in OCP Section 11: Reduction in wildfire threat and to become a FireSmart community: **High Priority**	Emergency Program Manager, SFR and Planning Department; *Low Level of effort*	~10 in-house hours
	#5.	Engage the development community in the DPA process to inform and allow input through a mix of approaches and involve multidisciplinary professionals.		Various District departmental staff; *Moderate level of effort*	Packets: approximately $500-1000 total. Developer workshops: apprx. $500/workshop
	#6.	Establish a suitable wildfire DPA for the District, first establishing DPA area objectives.		Various District staff; in particular Planning and bylaw staff; *High level of effort*	~25-50 in-house hours
	#7.	Create streamlined information packets and workshops for developers on the wildfire hazard development permit area (DPA) process.		Various District departmental staff, *Low level of effort*	Email and communication campaign; Low cost
	#8.	Develop a list of District FireSmart landscaping plants along with landscaping and spacing guidelines.		Consultant and/or Parks/Emergency/Bylaw District departmental staff; *Low level of effort*	~15 hours
	#9.	During parks acquisition, include a qualified professional with experience in operational wildland / interface fire suppression in the planning and strategic siting of future trails and parks.	Include wildfire vulnerability prioritization into the planning process of the trail system. Create spatial data/maps and provide recommendations. **Moderate Priority**	Consultant and/or Parks/Planning District departmental staff to	~20 hours

Document Section	REC. No.	Recommendation/ Next Steps	Objective/ Priority	Responsibility/Level of Effort	Estimated Resources
Cont. Section 2: Local Area Description	**#10.**	Consider projected changes in fire season and fire risk in fire management decisions. Consider and incorporate wildfire risk reduction into climate change adaptation projects and strategies.	Account for changes in future risk assessment due to climate change: **Low/Moderate Priority**	Consultant and/or SFR, Emergency District departmental staff; *Moderate level of effort*	~20 hours
	#11.	Complete business continuity planning for the District.	Continual delivery of critical services or products in a crisis or disaster: **Moderate Priority**	Planning/Business departmental District staff; *High level of effort*	~30 in-house hours
	#12.	Continue establishment of a community forest in partnership with the SFN and stakeholders such as MFLNRORD, applying recommendations/principles found within this Update to drive management activities.	Multi-purpose stewardship of forested land for ecosystem health, recreation, tourism, and economic development: **Moderate Priority**	Consultant and/or Planning District staff; *Low level of effort*	Negligible in-house time (<5 hours)
	#13.	Maintain open communications with BCWS regarding fire management planning.		Ongoing Emergency and SFR District staff; *Low level of effort*	Negligible in-house time
	#14.	Review and amend Bylaw No. 1822 to include a requirement to remove combustible construction materials promptly during fire season.	Update existing legislation to comport with fire management and prevention goals: **High Priority**	Planning/Emergency/bylaw District departmental staff; *Low level of effort*	~15 in-house hours
	#15.	Require two points of access for new subdivisions.		Planning/bylaw District departmental staff; *Low level of effort*	Negligible in-house hours
	#16.	Review subdivision bylaw and consider amending to comply with NFPA 1141.		Planning/bylaw District departmental staff; *Low level of effort*	Negligible in-house hours
	#17.	Have subdivision development applications reviewed by fire officials to ensure that hydrant placement and access is acceptable for emergency response and suppression.		SFR/Emergency/Planning District departmental staff; *Low level of effort*	Negligible in-house hours

Document Section	REC. No.	Recommendation/ Next Steps	Objective/ Priority	Responsibility/Level of Effort	Estimated Resources
Cont. Section 2: Local Area Description	**#18.**	Include suppression access and fuel break information in trail inventory database, such as grade, substrate, width, and clearance for Squamish Fire Rescue/BCWS use during suppression activities.	Enhance SFR/BCWS suppression activities: **Moderate Priority**	Planning/Parks/bylaw District departmental staff; *High level of effort*	~40 in-house hours
	#19.	Review the Trails Master Plan to ensure that the guidance and direction in the plan consider, and are not in conflict with, wildfire risk reduction strategies. Review and amend Appendix E to address residual fuel disposal methods, acceptable post-construction surface fuel levels, and trail building crew obligations under the Wildfire Act and Wildfire Regulation.	Update existing legislation to comport with fire management and prevention goals: **Moderate Priority**	Planning/Parks/bylaw District departmental staff; *Low level of effort*	Negligible in-house hours
	#20.	Review the parkland acquisition guidelines and amend to include interface fire management and risk reduction considerations. Consider creating a decision-matrix to help guide parkland acquisition.		Planning/Parks/bylaw District departmental staff; *Moderate level of effort*	~15 in-house hours
Section 3: Values at Risk	**#21.**	Consider use of fire resistant construction materials, building design, and landscaping approaches for all CI when completing upgrades or establishing new infrastructure. Ensure vegetation setbacks around CI are compliant with FireSmart guidelines. Consider deploying secondary power sources to reduce CI vulnerability.	Reduce structure vulnerability to wildfire: **Mod/High Priority**	Planning/Parks/bylaw District departmental staff; *Moderate level of effort*	Negligible in-house hours

Document Section	REC. No.	Recommendation/ Next Steps	Objective/ Priority	Responsibility/Level of Effort	Estimated Resources
Cont'd Section 3 – Values-at-Risk	**#22.**	Employ utility right-of-way best management practices (e.g., regular brushing of woody debris/shrubs to reduce fire threat, utility pole damage, and outages.		Planning/Parks/bylaw District departmental staff; *Moderate level of effort*	Negligible in-house hours
	#23.	Squamish Fire Rescue should review or establish a mock emergency shut-down procedure for hazardous values and conduct FireSmart assessments of these hazardous values.	Enhance preparedness and resilience to wildfire threats: **Moderate Priority**	SFR and Emergency District departmental staff; *High level of effort*	Variable cost, however will require available funds for mock procedure (approx. $1,000 per event)
	# 24	Conduct a more thorough inventory and review of hazardous infrastructure within the District.			
Section 5: Risk Management and Mitigation Factors	**#25**	Include fire management considerations during harvest planning and incorporate Forest Stewardship Plan updates.	Review upcoming harvest plans to identify wildfire risk **High Priority**	All District departmental staff, *Low Level of effort*	Negligible in-house hours
	#26	The District should apply for fuel treatment prescription development following prioritization within this document.	Develop fuel treatment prescriptions – **High Priority**	All District departmental staff, *Moderate Level of effort*	variable cost. Engage a forest consultant for prescription development
	#27	Promote FireSmart literature through various means and outlets to reduce access limitations and increase public awareness.	Increase implementation of FireSmart organizational goals: **Very High Priority**	All District departmental staff, *Low level of effort*	Negligible in-house hours

Document Section	REC. No.	Recommendation/ Next Steps	Objective/ Priority	Responsibility/Level of Effort	Estimated Resources
Cont. Section 5: Risk Management and Mitigation Factors	**#28**	Apply for a FireSmart demonstration grant through the Community Resiliency Investment (CRI) Program [1] to exhibit practices and principles of FireSmart activities to the public.		Emergency/SFR District departmental staff; *Low level of effort*	Negligible in-house hours
	#29	Develop and implement a community chipper program with the help of neighbourhood representatives.	Promote fuel management: **High Priority**	Emergency/SFR District departmental staff; *Moderate level of effort*	$10,000 for two neighbourhoods/year
	#30	Hire a qualified professional to assist community compliance with FireSmart principles at the lot level.	Ensure and improve FireSmart compliance: **Moderate Priority**	Consultant and/or SFR, Emergency District departmental staff; *Moderate level of effort*	~25 in-house hours
	#31	Make this CWPP Update available to District residents, businesses and the public. Update should be published online and advertised by the District.	Effective communication, capacity building, and education efforts: **High Priority**	SFR, Emergency District departmental staff; *Low level of effort*	Negligible in-house hours
	#32	The Wildfire Working Group should discuss the options within this Update to develop a strategic plan including a communication plan, FireSmart execution strategy, and an education plan and shared with all.		SFR, Emergency, Planning, Bylaw and GIS District departmental staff; *Low level of effort*	Negligible in-house hours
	#33	The District or its Wildfire Working Group should consider leading the establishment of a local interface steering committee to coordinate wildfire risk reduction efforts.		SFR, Emergency, Planning, Bylaw and GIS District departmental staff; *Low level of effort*	Negligible in-house hours

[1] Note that the UBCM SWPI funding stream has very recently transitioned into a new Community Resiliency Investment (CRI) Program. Refer to Section 5.1 and the Union of BC Municipality's website (https://www.ubcm.ca/EN/main/funding/lgps/community-resiliency-investment.html) for further information.

Document Section	REC. No.	Recommendation/ Next Steps	Objective/ Priority	Responsibility/Level of Effort	Estimated Resources
Cont. Section 5: Risk Management and Mitigation Factors	**#34**	Encourage all local schools (private and public) to adopt and deploy existing school education programs to engage youth in wildfire management and risk reduction.		SFR and Emergency District departmental staff; *Low level of effort*	Negligible in-house hours
	#35	Explore potential partnerships with local literacy programs to incorporate FireSmart and emergency preparedness into currently existing programming and/or to facilitate development of an environmental literacy class with information not limited to FireSmart, emergency preparedness, and bear aware.		SFR and Emergency District departmental staff; *Low level of effort*	Negligible in-house hours
	#36	The District should expand its public education and outreach initiative and continue to hold Community Wildfire Preparedness Days into the future. The District should also consider having school fire education programs.		SFR and Emergency District departmental staff; *Low level of effort*	~ 20-40 District staff hours
	#37	Provide more public education that targets tourists/visitors to the area (e.g. Mountain FM and speed corridor signs with messaging).			~ 5-10 hours to prepare materials and disseminate information
	#38	Promote and provide information to private landowners related to residential sprinklers as a FireSmart measure.			~ 10-20 hours to prepare materials and disseminate information to landowners
	#39	Construct and operate a fire danger sign northbound along Highway 99, south of Squamish. Consider an electronic sign capable of being updated remotely.			~$10,000

Document Section	REC. No.	Recommendation/ Next Steps	Objective/ Priority	Responsibility/Level of Effort	Estimated Resources
Section 6: Wildfire Response Resources	**#40**	Participate in regular testing of and updates to the evacuation plan.	To improve access and egress, and to enhance emergency preparedness: **Moderate Priority**	SFR and Emergency District departmental staff; *High level of effort*	~35 in-house hours and 8 hours to complete testing.
	#41	Strategically plan and develop recreational trails for multiple outcomes, not only supporting ATV/recreational purposes but also to increase local fire department access interface areas. These also can act as fuel breaks for ground fires, particularly in natural areas. Further, consider gate installation or other barriers to minimize access by unauthorized users.		SFR, Emergency, Planning and Bylaw District departmental staff; *Moderate level of effort*	~25 hours. Low ongoing costs.
	#42	Develop a Parks or Total Access Plan, to guide effective use of (recreational) trails as crew access or as fuel breaks during suppression efforts. The plan should be available to SFR and BCWS and updated every five years to incorporate changes.	To expand the view of the trail system to include a planning process prioritizing wildfire vulnerability: **High Priority**	Consultant and/or SFR, Emergency, Planning and Bylaw District departmental staff; *High level of effort*	A budget of ~$8,000-$10,000 is recommended to build plan, map, populate attributes, and update.
	#43	Create a map book or spatial file displaying the trail network available for SFR to access during an emergency or for fire suppression planning. This information must accompany any fire access trail building activities.		Consultant and/or SFR, Emergency, Planning and Bylaw District departmental staff; *Moderate level of effort*	$1,500-$2,500 total costs
	#44	The District should cooperatively identify potential wildfire risk reduction opportunities with local BCWS.	Enhance preparedness and resilience to wildfire threats: **High Priority**	SFR, Emergency, Planning and Bylaw District departmental staff; *Low level of effort*	Negligible in-house hours

Document Section	REC. No.	Recommendation/ Next Steps	Objective/ Priority	Responsibility/Level of Effort	Estimated Resources
Cont'd Section 6: Wildfire Response Resources	**#45**	Continue the frequency of annual training with BCWS and include mock wildfire simulations in interface training. Coordinate with other FDs in the area to enhance regional firefighting capabilities.		SFR, Emergency, Planning and Bylaw District departmental staff; *Low level of effort*	Negligible in-house hours
	#46	The wildfire response truck should have a larger gross vehicle weight (GVW) and greater tank capacity.	Ensure adequate infrastructure and equipment exists to address wildfire threats or events: **High Priority**	SFR, Emergency, Planning and Bylaw District departmental staff; *High level of effort*	Significant capital costs
	#47	Investigate options for installation of additional strategically located dry hydrants.		SFR, Emergency, Planning and Bylaw District departmental staff; *Moderate level of effort*	~25 in-house hours.
	#48	The provision of a water tender.		SFR, Emergency, Planning and Bylaw District departmental staff; *Moderate level of effort*	Significant capital costs

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COMMONLY USED ACRONYMS

BCWS	British Columbia Wildfire Service
BEC	Biogeoclimatic Ecosystem Classification
CFFDRS	Canadian Forest Fire Danger Rating System
CRI	Community Resiliency Investment Program
CWPP	Community Wildfire Protection Plan
CWPP Update	Community Wildfire Protection Plan Update
DPA	Development Permit Application
FBP	Fire Behaviour Prediction System
FESBC	Forest Enhancement Society of British Columbia
FMP	Fire Management Plan
FSCCRP	FireSmart Canada Community Recognition Program
GAR	Government Actions Regulation
GPZ	Groundwater Protection Zone
HIZ	Home Ignition Zone
LRMP	Land and Resource Management Plan
MFLNRORD	Ministry of Forests, Lands, Natural Resource Operations, and Rural Development
MOTI	Ministry of Transportation and Infrastructure
NFPA	National Fire Protection Agency
OFC	Office of the Fire Commissioner
PSTA	Provincial Strategic Threat Analysis
SFR	Squamish Fire Rescue
SLRD	Squamish-Lillooet Regional District
SWPI	Strategic Wildfire Prevention Initiative
TSA	Timber Supply Area
UBCM	Union of British Columbian Municipalities
WUI	Wildland Urban Interface

SECTION 1: INTRODUCTION

In 2017, B.A. Blackwell and Associates Ltd. was retained to assist the District of Squamish (District) in developing an update to the Community Wildfire Protection Plan (CWPP); hereinafter referred to as the CWPP Update. The previous CWPP was developed in 2007 and was titled *District of Squamish Community Wildfire Protection Plan* (hereinafter referred to as the 2007 CWPP). The District staff recognized that there have been significant changes since 2007, which have a direct impact on wildfire mitigation activities and programs. The District has experienced significant growth in the last decade since the previous decade and this includes extensive building development. Furthermore, the previous CWPP is thought to be generally outdated in its recommendations and pre-dates the methods and datasets utilized in the current CWPP program.

The data and methodology used to assess wildfire threat have also been updated since the initial 2007 CWPP was developed. Specifically, the Provincial Strategic Threat Analysis (PSTA) data has been updated by the Ministry of Forests, Lands, Natural Resource Operations, and Rural Development (MFLNRORD). The wildfire threat analysis methodology has also been updated and improved since the original CWPP was produced. Appendix F outlines the steps and methods used to determine wildfire threat within this CWPP Update.

Although forest fires are both inevitable and essential to the health of forested ecosystems, the 2003, 2004, 2009, 2010, 2015 and 2017 wildfire seasons resulted in significant economic, social and environmental losses in BC. The 2017 BC wildfire season was the most extensive, in terms of area burned, and although final suppression costs for the 2017 season have not yet been made public, it is expected to be the most expensive season on record for suppression costs. Recent wildfire disasters like those experienced in Slave Lake, Alberta (2011), Washington State (2014 and 2015), Fort McMurray, Alberta (2016) and BC and California (2017) all display the vulnerability of communities and the potential toll of wildfires on families, neighbourhoods and the economy of entire regions. These events, along with critical lessons learned and important advances in knowledge and loss prevention programs have spurred the need for greater consideration and due diligence with respect to fire risk in the wildland urban interface[2] (WUI).

1.1 PURPOSE

The purpose of this CWPP Update is to identify and update the wildfire risks within and surrounding the District of Squamish, to describe the potential consequences if a wildfire was to impact the community, and to examine options and strategies to reduce the wildfire risks. Each community has a unique risk profile. This CWPP update provides a reassessment of the level of risk with respect to changes in the area that have occurred since 2007 and gives the District a current and accurate understanding of the threats faced by their community to human life, property and critical infrastructure from wildfires. The

[2] Wildland/urban interface is defined as the presence of structures in locations in which conditions result in the potential for their ignition from flames and firebrands/embers of a wildland fire (National Fire Protection Association).

goal of this CWPP Update, in addition to defining the threats, is to identify measures necessary to mitigate these threats, and outline a plan of action for implementing these measures. Specifically, this CWPP is intended to serve as a framework to inform the implementation of specific actions and strategies that will serve to: 1) reduce the likelihood of wildfire entering the community, 2) reduce the impacts and losses to property and critical infrastructure if wildfire were to enter, and 3) reduce the negative economic and social impacts of wildfire to the community.

1.2 CWPP UPDATE PLANNING PROCESS

This CWPP Update is a review and synthesis of the background information and current data related to the Area of Interest (AOI) which represents a two-kilometer spotting buffer around values at risk (structures) within the District. The CWPP Update consists of four general phases:

1) Consultation involving key local government representatives, structural and wildfire specialists, stakeholders. Information sharing with First Nations at various stages of the Plan development and ensuring linkages with relevant existing land use plans, legislation, and policy currently in place.
2) Identification of the values at risk and assessment of the local wildfire threat. Wildfire threat assessment takes into consideration Natural Fire Regime and Ecology, Provincial Strategic Threat Analysis (2017), and field work, fuel type verification, completion of WUI Threat Forms and GIS wildfire threat analyses.
3) Developing a risk mitigation strategy. A guide for the District to implement mitigation and risk reduction activities. The risk mitigation strategy accounts for prioritization of fuel treatments, FireSmart Activities, and wildfire response recommendations that will reduce wildfire threat locally.
4) Building a community engagement and education strategy. This phase includes presentation of the CWPP update to the Board or Council, the formation of a Wildfire Working Group as well as comprehensive outside consultation with First Nations, government and non-governmental agencies (See Section 1.2.1 for specifics).

1.2.1 Consultation

Broad engagement with local government, Provincial government landowner representatives, stakeholders and First Nations played a key role in developing this CWPP.

The first step in the consultation process was to assemble the key players in the 'Wildfire Working Group'. This group was composed of key internal District staff, which included: Emergency Program Coordinators, the GIS/Mapping Supervisor, the Fire Chief and Deputy Fire Chief, District Planner, and an Operations/Parks representative. At the initial meeting of the Wildfire Working Group, the objective was to obtain information on wildfire risk mitigation initiatives currently in place or completed, existing plans and policies, current resources, identify areas of concern, identify District vulnerabilities, and to determine priorities and potential mitigation strategies. Members of the Working Group were consulted on an ongoing basis throughout plan development and were integral in providing Plan review and

approval. The Wildfire Working Group was integral in the review of the draft of this CWPP and provided ongoing support throughout the CWPP process.

BCWS representatives from the Pemberton Fire Zone and Coastal Fire Centre (Fire Prevention Officer) were consulted as follows: 1) at the onset of the project planning phase and 2) throughout the CWPP update development process, both via the submission of Fuel Type Change Rationales and questionnaires regarding concerns and priorities of BCWS with respect to wildfire and emergency planning in the District of Squamish; and 3) revision of draft document upon plan completion.

Information sharing took place with the Squamish and Tsleil-Waututh First Nations, and the Musqueam Indian Band as identified through the Consultative Areas Database and in consultation with MFLNRORD, regarding the CWPP and locations or potential for possible cultural values at risk requiring protection consideration. Information sharing consisted of an initial phone call, and subsequent distribution of a referral letter and information package (maps, explanation of CWPP, and CWPP draft).

Additional stakeholders were consulted to identify synergies, opportunities for collaboration, and ensure linkages with adjacent and overlapping planning. These stakeholders included the MFLNRORD Sea to Sky Natural Resource District's Land and Resource Specialist (Frank DeGagne), BC Parks representatives (Vicki Haberl, Kevin Wagner, Chris Platz), the Squamish Off Road Cycling Association representatives (Tim Tallevi and John Burns), Woodfibre LNG Limited power generation plant's Health and Safety Office (Natalia Timacheva) and a representative from the newly formed Squamish Community Forest Corporation (Jeff Fisher).

1.2.2 Identification of Values at Risk and Local Wildfire Threat Assessment

The risks associated with wildfire must be clearly identified and understood before a CWPP can define strategies or actions to mitigate risks. The identified values at risk are described in Section 3. The wildfire threat in the District of Squamish was assessed through a combination of the following approaches:

- Natural fire regime and ecology (Section 4.1);
- Provincial Strategic Threat Analysis (section 4.2); and
- Local wildfire threat analysis (Section 4.3).

The relationship between wildfire hazard, threat and risk is defined as follows:

$$\textit{Wildfire risk} = \textit{Probability x Consequence}$$

Where:

- Wildfire risk is defined as the potential losses incurred to human life, property and critical infrastructure within a community in the event of a wildfire;
- Probability is the likelihood of fire occurring in an area and is related to the susceptibility of an area to fire (fuel type, climate, probability of ignition etc.); and

- Consequences refer to the repercussions associated with fire occurrence in a given area (higher consequences are associated with densely populated areas, or areas of high biodiversity etc.).

1.2.3 Development of a Risk Management Strategy

An effective risk management strategy was developed considering a full range of activities relating to the following:

- Fuel management;
- FireSmart planning and activities;
    - Structure protection
    - Removal of flammable vegetation
    - Landscaping guidelines
- Community communication and education;
- Other prevention measures;
- Structure protection and planning (i.e., FireSmart activities);
- Emergency response and preparedness;
- Evacuation and access; and
- Planning and development.

1.2.4 Building of Community Engagement and Education Strategy

Engaging the community from local government staff and officials, to key stakeholders and residents in wildfire protection planning activities is key to ensuring successful implementation. A community engagement and education strategy is described in Section 5.3.

A presentation to District Council will aim to ensure high level approval and support for this CWPP.

SECTION 2: LOCAL AREA DESCRIPTION

This section describes the community of Squamish within the AOI. It also summarizes the current community engagement in wildfire prevention and mitigation and identifies linkages to other plans and policies with relevance to wildfire planning.

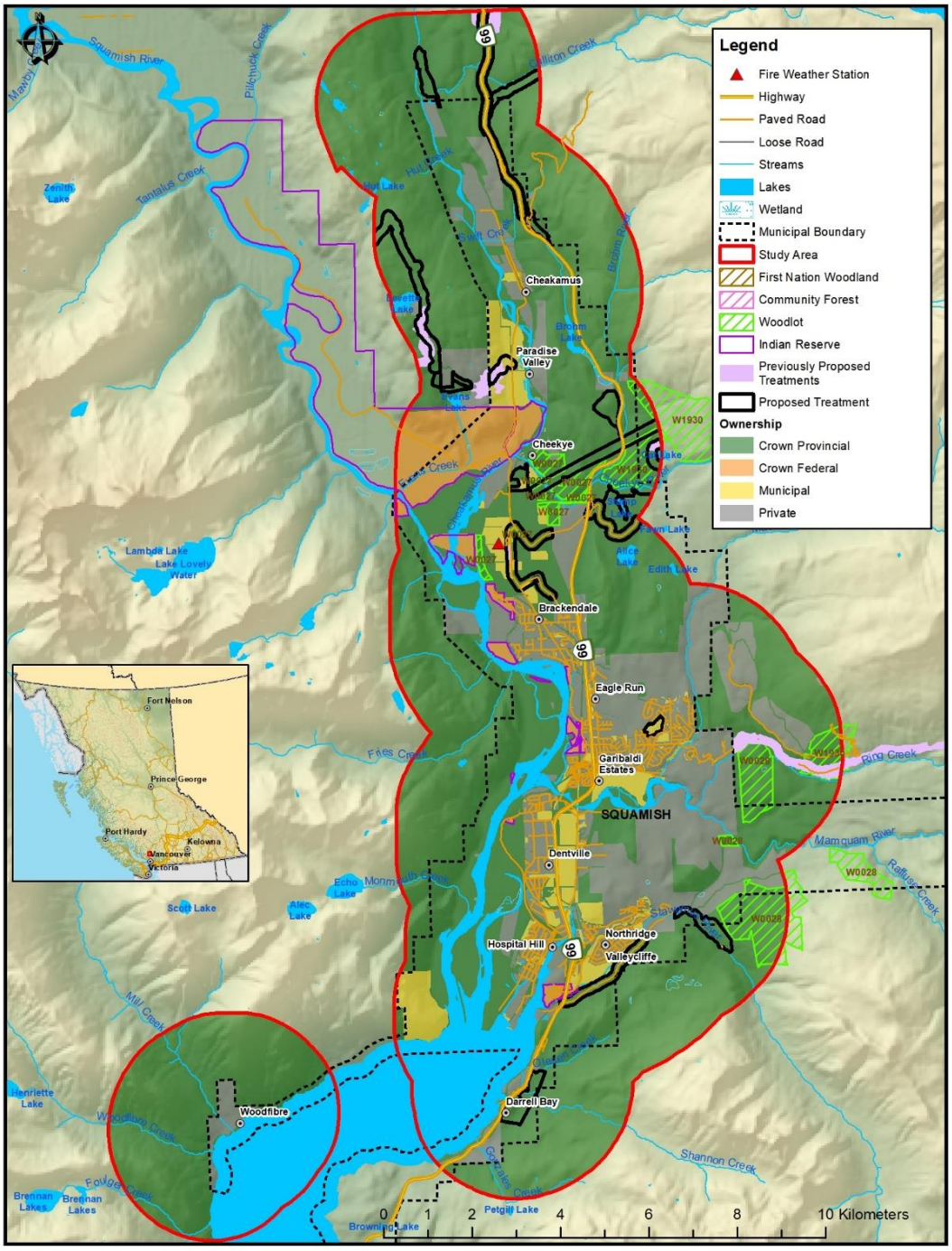
2.1 AREA OF INTEREST

The District of Squamish is located at the north end of Howe Sound in the Sea to Sky corridor, approximately 70km north of Vancouver.

The AOI for the CWPP is illustrated below in Map 1. The AOI represents a two-kilometer (km) spotting buffer around values at risk (structures) within the District. The current AOI differs significantly from the previous CWPP's AOI which only incorporated lands within the District boundary. These include the eastern end of Mamquam Forest Service Road and Murrin Provincial Park. The northern end of the AOI extends 1.5km beyond Culliton Creek and to approximately Gonzales creek on the southern end, south of Shannon Falls Provincial Park. It also includes an isolated area of 2 km around Woodfibre, a former pulp mill site on which a liquified natural gas (LNG) processing and export facility is planned. The AOI encompasses 19,892 ha of land in total. A breakdown of the AOI's land ownership is provided in Table 2.

Table 2. Summary of AOI by land ownership.

Land Ownership	Hectares
Private	3,285
Local Government	775
Provincial Crown	15,206
Federal Crown	626
Total	**19,892**



Map 1. Area of Interest (AOI).

It should be noted that "Previously Proposed Fuel Treatment" in map above refers to polygons recommended for fuel treatment and described within either the Squamish First Nation Community Wildfire Protection Plan (2017) or the Squamish-Lillooet Regional District Electoral Area D Community Wildfire Protection Plan Update (2016). These proposed treatments have not yet been implemented and are located on either Provincial or Municipal Crown lands.

2.2 COMMUNITY DESCRIPTION

The Howe Sound region has been inhabited by the Coast Salish Aboriginal Peoples since before recorded time. The Skwxwú7mesh Úxwumixw (Squamish Nation) are descendants of the Coast Salish and continue to live in this region, some within the ten Indian Reserves within the District boundary. Squamish was incorporated as a Village in 1948. Between 1956 and 1958, the opening of the railway which connected Squamish to Vancouver and the completion of the Sea to Sky highway (Highway 99) allowed for improved access to the community. This resulted in a substantial increase in population, which eventually lead to the incorporation of Squamish as a municipal district in 1964.

The District is located approximately 70 km north of Vancouver and is one of four-member municipalities in the Squamish-Lillooet Regional District. The total area of the District is 12,112 ha. The Squamish Valley is nestled within several Coastal Range mountains, including Mt. Tantalus, Mt. Garibaldi and Mamquam Mountain. Five large rivers flow through the District which create a vast floodplain area within the valley; the Mamquam, Squamish, Cheakamus, Cheekye, and Stawamus Rivers. Due to this mountainous topography and extensive drainage network, the elevation varies significantly within the District boundary, from sea level to over 900 m.

The District of Squamish economy was historically driven by forestry (Woodfibre Pulp Mill), mining (Britannia Copper Mine), and agriculture [3]. In recent decades, the economic focus of the District has shifted to outdoor recreation and eco-tourism, however, forestry remains an important economic driver. Squamish Mills dryland sort operation is located directly adjacent to the town centre, on the shores of Howe Sound, and receives timber from throughout the Sea to Sky corridor. Specialty wood manufacturers such as AJ Forest Products, FraserWood Industries, and BC Timber Frame are also located within the AOI. Further, Squamish Terminals ship's cargo and goods internationally from a deep-water port facility at the mouth of the Squamish River and construction of the Woodfibre LNG Limited processing and export facility is slated to begin in 2018.

Fire protection within the AOI is the responsibility of Squamish Fire Rescue (SFR). The Fire Service area covers the jurisdictional boundaries of the District and provides emergency response services to approximately 20,000 residents. SFR does not service the isolated area of the District that surrounds the Woodfibre LNG Limited power generation facility. This isolated area would be actioned by the BCWS. Fire services are not provided by SFR outside of the District boundary without prior agreement by Council[4]. For those areas in the 2km buffer but outside the District boundary, fire services will be provided by BCWS. In the event of a wildfire, the District has limited emergency egress routes. The Sea to Sky Highway, which runs north and south from the community, is the only reliable, paved access route. Many developments within the District are located on single access roads which branch off of Highway 99, which also limits the ability of Squamish Fire Rescue to respond to fires and safely evacuate residents.

[3] https://www.squamishhistory.ca/historyofsquamish

[4] District of Squamish Fire Service Bylaw No. 2314, 2014

Since the 2007 CWPP, the principal changes in the community are nine new areas which are currently being developed or have been developed in these intervening years. This includes Skyridge on Dowad Drive, the Squamish Oceanfront Peninsula development (Newport Beach), the Sea to Sky Gondola, Ravenswood on Loggers Lane, Crumpit Woods, the Sea to Sky Business Park and University Heights.

2.3 PAST WILDFIRES, EVACUATIONS AND IMPACTS

BCWS Pemberton Fire Zone staff communicated that the majority of past wildfire activity within the AOI was the result of industrial logging activities and recreational activities. Within the past 15 years, BCWS staff reported that approximately 30 ha have burned of which 90% was industrial logging slash. Logging slash was the fuel type posing the highest threat within the District because consequence does not form part of the equation. Overall, BCWS described the historical consequences of wildfire to the District as minimal.

The 2015 Boulder Creek Complex wildfires burned over 20,000 ha and caused the evacuation of the Innergex independent power project (IPP) facility as well as heavy smoke to the SLRD area and Metro Vancouver. These wildfires, in combination with the 2016 Fort McMurray and 2017 Province-wide wildfire events have alerted BCWS to the potential for large catastrophic wildfires occurring within and surrounding the present AOI.

The BC Wildfire Service's historical ignition dataset demonstrates that the proportion of human-caused fires within the Squamish AOI is substantially greater than that of the province as a whole.[5] This ignition data shows that within the Squamish study area, 87% of ignitions since 1950 have been human-caused, versus 55% in the province of BC[6]. This statistic may be explained by the high recreational use of many parts of the AOI, specifically for camping. And is further explained by the high population density relative to the entire province of BC.

2.4 CURRENT COMMUNITY ENGAGEMENT

There is widespread recognition and awareness, from both District staff and the community of the threat posed to the community by wildfire. There has been moderate community engagement in FireSmart initiatives to this point. Several District staff have completed the Local FireSmart Representatives course, and FireSmart and wildfire mitigation planning was integrated into the 2017 Official Community Plan update (Bylaw No. 2500; Title: #Squamish2040). Squamish Fire Rescue (SFR) frequently participates in community events in order to educate the public about FireSmart principles and the ways in which community members can reduce wildfire risk around their homes. The SFR focused on wildfire awareness and preparedness at their Annual Open House and has hosted multiple Hot Summer Nights events to promote FireSmart initiatives. FireSmart brochures are also distributed to the public when inquiries are made about open burning practices within the community.

[5] BC Wildfire Service: Fire Incident Locations - Historical
[6] BC Wildfire Service: Fire Incident Locations - Historical

The District of Squamish Official Community Plan (OCP)[7] is a long-range planning document that guides development in the District. The OCP establishes goals, objectives, policies, and guidelines. The OCP establishes land use designations and Development Permit Areas to guide development. The Zoning Bylaw regulates the use of land through the establishment of 'zones'. Any changes to the Zoning Bylaw must align with the OCP.

Within the District, Development Permit Areas (DPAs) regulate form and character, protecting and managing environmental assets, including riparian areas, and managing the risks associated with natural hazards. Building permits ensure compliance with the British Columbia Building Code (BCBC) and Plumbing Codes. There is no currently established wildfire DPA within the District.

2.5 LINKAGES TO OTHER PLANS AND POLICIES

Following is a summary of municipal and provincial policies and guidelines that relate to strategic wildfire management, wildfire threat reduction, operational fuel treatments and emergency planning.

2.5.1 Local Authority Emergency Plan

Emergency preparedness and response is managed by the District of Squamish Emergency Program (SEP) through authority from the District of Squamish Emergency Measures Bylaws No. 1483, 1997. The District of Squamish has a dedicated Emergency Operations Center which is activated in the event of an emergency incident or disaster. The SEP includes several volunteer groups including Squamish Search and Rescue, Royal Canadian Marine Search and Rescue, Emergency Social Services, and Emergency Radio Communications.

The District of Squamish has developed a Comprehensive Emergency Management Plan (CEMP) to inform emergency preparedness, response, recovery, and mitigation efforts in the community. The CEMP is structured so that all types of hazards and incidents may be addressed through the plan and will act as a toolbox for District staff in the event of an emergency situation. At present, the District has developed two documents which will contribute significantly to the CEMP: the *Community Risk Assessment Report*[8] and the *All Hazards Plan*[9]. The Community Risk Assessment Report provides the basis for the All Hazards Plan by identifying the hazards present within the community and ranking those hazards by likelihood of occurrence and degree of impact. The All Hazards Plan is a tool developed to optimize the response, resources and planning for emergency and disaster events.

The Squamish-Lillooet Regional District (SLRD) Emergency Program works with the four-member municipalities, including the District of Squamish, to coordinate and support emergency management in the wider regional district.[10]

[7] *District of Squamish Official Community Plan* (2017); Bylaw No. 2500; Title: #Squamish2040.

[8] District of Squamish, Community Risk Assessment Report. 2015.

[9] District of Squamish, All Hazards Plan. 2016.

[10] https://www.slrd.bc.ca/services/public-safety-health/emergency-planning

2.5.2 Affiliated CWPPs

CWPPs have been developed for the SLRD Electoral Area C (2016) and SLRD Electoral Area D (2016), the Squamish Nation (2016), and the Resort Municipality of Whistler (2005 and 2011). The AOIs of the SLRD Areas C and D as well as the Squamish Nation overlap significantly with that of the District of Squamish. These documents have been reviewed for synergistic project opportunities, as well as to confirm that there are no contradicting recommendations.

2.5.3 Local Government/First Nation Policies and Recommendations

The following municipal bylaws, strategies and policies are relevant to wildfire planning in the District.

Bylaw No. 2500, 2017: Official Community Plan

The Official Community Plan (OCP) provides guidance for land use, development, and community evolution within the District of Squamish and establishes the vision for Squamish over the next 25 years. The following sections contain objectives and policies which are directly relevant to wildfire risk reduction, emergency response, and community resilience post-disaster.

2017 OCP Section 9: Growth Management Boundary

The Growth Management Boundary was identified to promote compact infill development and to enable development to accommodate anticipated community growth. Future Residential Neighbourhoods are identified for long-term residential growth; they are not intended to accommodate development until substantial residential infill has occurred. The OCP recognizes that there are relevant guiding policies which are needed prior to development in the Future Residential Neighbourhoods, such as an updated CWPP which defines the wildfire threat in these areas and identifies wildfire risk reduction and mitigation measures with proposed implementation costs.

RECOMMENDATION #1: Identification of a Growth Management Boundary is an appropriate way to curb sprawling interface and intermix developments, which may be more vulnerable to wildfire. Developments further from the municipal core have the potential to be impacted by the following variables relevant to wildfire: proximity to forested fuels (expanding interface / intermix), position on slope (further distance from the municipal core is often upslope or on steeper slopes), limitations to access / egress, increased emergency response time, and limitations to municipal water / hydrants.

2017 OCP Section 10: Natural Environment

In order to meet the Air Quality objectives of maintaining regional air quality to protect human health and reduce particulates and other emissions from human created sources (transportation, industry, building, heating, etc.), the District currently restricts open air burning. The District supports alternatives for yard waste disposal, including programs currently running such as the biomass disposal/diversion programs.

Often times, burning of wood waste is the most cost-effective method of debris disposal for fuel management projects. Section 23 of the OCP identifies District policies regarding alternative wood waste and debris disposal options; these should be explored thoroughly if fuel management projects are to be

successful, socially acceptable, and economically feasible. Full utilization of fiber in fuel treatments, including what is often non-merchantable debris, will help to divert biomass from burn piles.

RECOMMENDATION #2: Continue with curbside biomass disposal/diversion programs which are currently operating[11]. Consider adding and advertising twice yearly offering for woody waste disposal in interface neighbourhoods (e.g. temporary dumpsters and / or chipping programs). In addition, explore alternative wood waste disposal and utilization methods, such as biomass conversion / biofuels and biomass composting, with the objective of utilization of as much fiber, as possible and diversion of all fiber from open burning (additional options of chipping/ mulching and firewood offering).

RECOMMENDATION #3: Allow open burning for woody debris disposal, if other options for debris disposal are unavailable or operationally unfeasible.

2017 OCP Section 11: Hazard Lands

Section 11 recognizes interface fire and wildfire as a hazard to non-specific areas of the District. The OCP identifies the existence of the CWPP to guide wildfire threat reduction and notes the main objective to become a FireSmart community.

This section also recognizes the anticipated impacts of climate change on these hazards, including increased wildfire hazard, and increased potential consequences as growth and development in the community continues.

The District's general objectives for natural hazards are to: assess and manage the natural hazards in Squamish and to maintain risk within acceptable levels; mitigate risks through protection, accommodation, avoidance or retreat; direct growth away from areas most vulnerable; consider the potential impacts of future climatic conditions on natural hazards and the associated risk.

The following policies were developed to facilitate achieving the above objectives and are of particular relevance to wildfire risk reduction:

- Prohibit development in areas with unacceptable vulnerability to natural hazards.
- Require a hazard assessment for land development applications within identified natural hazard areas.
- Develop and implement a public education program regarding natural hazards and mitigation methods, namely wildfire and flooding. Simplify and streamline information availability for developers and residents.

[11] At the time of this publication, the curbside compostable waste program offers weekly pickup of yard waste including shrubbery and hedge trimmings, grass clippings, leaves, weeds, small branches less than 2" in diameter no longer than 2 feet long. Wood products, including lumber, branches or pruning over 2" around must be taken to the landfill public depot for disposal at a cost of $65/tonne. Clean sawdust, wood chips, and wood shavings are accepted for free at the Whistler Compost Facility.

- Avoid re-building damaged critical infrastructure in areas where it is inappropriate, due to vulnerability to natural hazards.
- Require development proposals to include safe refuge areas (shelter in place) and / or secondary road access.

The OCP does not currently identify those areas with unacceptable vulnerability to wildfire, nor those areas which would require hazard assessments with development applications. This CWPP update will provide an accurate wildfire threat assessment for the District, which can be used to identify those areas most vulnerable to interface fire. Identification of a wildfire hazard Development Permit area can serve to define those areas where a hazard assessment is appropriate prior to allowing development.

Specific to Wildfire Interface Hazard, The District's objective is to protect vulnerable areas of the community from existing and potential climate change-induced wildfire interface hazard.

The OCP states the following policies to achieve this objective:

- Update the CWPP and assess projected impacts of climate change on wildfire threat to the community.
- Develop and adopt a Wildfire Hazard DPA designation for WUI areas.
- Incorporate FireSmart guidelines within 10 m of structures (Priority Zone 1) for residential development in high risk, interface areas, with respect to building materials and landscaping.
- Encourage the provincial government and SLRD to initiate a comprehensive regional fire risk mitigation strategy.
- Promote a FireSmart community through initiatives developed in consultation with wildfire management professionals and other key stakeholders in the community. See Section 5.2 (FireSmart Planning and Activities) for more information.

RECOMMENDATION #4: Use the updated fire threat assessment within this CWPP to identify areas of unacceptable vulnerability to wildfire.

RECOMMENDATION #5 It is advised that the District engage the development community in the DPA process to educate, inform, and allow for input. This can be accomplished in a variety of formats, including, but not limited to: workshops, informational sessions, or open-houses. Consider incorporating multiple disciplines of professionals to ensure that other values are considered and not compromised in the development of the DPA area (e.g. Geotechnical engineers, foresters, fire behaviour experts, hydrologists, and biologists).

RECOMMENDATIONS #6 and #7: Both the 2007 CWPP and the District of Squamish OCP recommend that a Wildfire DPA be established for the District. The OCP specifies that this should occur following the finalization of the CWPP Update. Other jurisdictions' wildfire DPAs serve as models for various

components.[12] The first step should be to establish DPA objectives (for example, minimize risk to property and people from wildland fires; minimize risk to forested area surrounding Squamish; conserve the visual and ecological assets of the forests surrounding Squamish; reduce the risk of post-fire landslides, debris flows, and erosion, *etc*.). The following components should be considered during the OCP review and DP area development process in order to help meet the established objectives:

- Use of fire resistant exterior construction materials within the established development permit area, based on recognized standards such as NFPA 1144 or FireSmart.
- Inclusion of minimum setbacks from forested edge and top of slope based on FireSmart principles.
- Use of FireSmart landscaping (low flammability plants, appropriate spacing and low flammability aggregates/ ground cover based on FireSmart principles).
- Underground servicing.
- Mitigation of fire hazard through fuel management activities based upon qualified professional recommendations (prescriptions and oversight). This is generally most applicable in the subdivision phase.
- Prompt removal of combustible construction materials, thinning/ fuel management debris, or clearing debris during the fire season.
- Review and approval process for submitted applications.
- Post-development inspections and sign-offs.
- Outline of responsibilities for staff and applicants.
- Enforcement and regulation (consequences of non-compliance).

For communication and educational purposes related to above: Create simple and streamlined information packets on the wildfire hazard DP process, including links to websites with FireSmart building and landscaping information, as well as simple and effective ways to meet the requirements. Consider developer workshops.

RECOMMENDATION #8: Develop a list of low flammability landscaping plants such as the FireSmart Guide to Landscaping which presents a palette of low trees, deciduous flowering shrubs, broadleaf evergreens, and perennials with low flammability foliage.[13] Consideration should be given to those plants which are also native, low maintenance (climate and microclimate adapted), and not wildlife attractants. Include low flammability landscaping material options and spacing guidelines (from home and from other plants).

[12] The District of North Vancouver has a robust and well-documented Wildfire Hazard Development Permit process. Other jurisdictions which may be worth reviewing include: RDEK (Rockyview and Wasa), Williams Lake, Prince George, and Maple Ridge.

[13]FireSmart Guide to Landscaping. Accessed July 14, 2018.
https://www.whistler.ca/sites/default/files/related/firesmart_guide_to_landscaping.pdf

2017 OCP Section 12: Residential Infill

The OCP supports residential infill, partially to avoid and / or mitigate risks from natural hazards, such as interface fire.

The importance of this section is similar to those described in 2017 OCP Section 9: Growth Management Boundary.

2017 OCP Section 18: Parks and Recreation

The objectives of the District are to: preserve, connect and enhance access to natural areas, open spaces and outdoor recreation; and to supply appropriate parklands to meet the needs of the community and accommodate growth. To that end, the following policies were developed:

- Develop an integrated network of neighbourhood and community parks.
- Secure quality, usable parkland through land development.
- Apply *Parks and Recreation Master Plan* Acquisition Guidelines, such as: locating parks adjacent to or in proximity to neighbourhood features.

Parks, open spaces, and outdoor recreation areas within the District provide many ecosystem services (wildlife corridors, storm water retention, carbon sequestration, etc.) and benefits (aesthetics, sense of place, recreational opportunities, etc.) to municipal residents; these values should not be understated. However, the current process is potentially creating a situation where the District is assuming liability for wildfire hazard lands which are outside the acceptable range of risk. The liability these lands represent must be recognized and lands should be managed accordingly; parcels should be received, and maintained in, a moderate or lower threat rating condition. Additionally, the parcels should be accessible for suppression crews. The issues associated with assumed parks include: ensuring that developers complete satisfactory mitigation prior to turning the land over; the location of lands in relation to values at risk and topography; and the viable access to the land for suppression crews and future maintenance activities.

RECOMMENDATION #9: At the planning phase of parks acquisition, review each proposed park assumed through a wildfire lens prior to acceptance. Ensure each park is within an acceptable range of threat (low or moderate threat class) and that access is such that future fuel treatments and maintenance can be completed feasibly, if required, and access is acceptable for suppression crews. Access should be included in the trail inventory updates. Include a qualified professional with experience in operational wildland / interface fire suppression in the planning and strategic siting of future trails and parks.

2017 OCP Section 19: Climate Change Mitigation

A recently developed document, *Adapting to Climate Change in Squamish: backgrounder report*, identified increased forest fires as a near-term priority (an issue relevant for Squamish that can lead to considerable consequence). The mitigation and adaptation policies for wildfires were incorporated into OCP Section 11. The OCP recognizes that potential climate change impacts will be significant and have subsequent impacts to the District's wildfire risk.

RECOMMENDATION #10: Consider projected changes in fire season and fire risk in fire management decisions. Consider wildfire risk reduction as climate change adaptation projects and incorporate wildfire risk into climate change adaptation strategies.

Section 21: Municipal Infrastructure

Municipal infrastructure includes public assets, such as water supply, sewer, roads, storm water drainage, diking, and waste management and recycling.

Policies within the OCP which are relevant to wildfire risk reduction and emergency response include:

- Ensure new and retrofitted developments are serviced in accordance with District bylaws.
- Review water, sewer, and storm water master plans every 5 years to identify capacity, upgrading requirements, and long-term viability of the infrastructure.

The Subdivision and Development Control Bylaw is reviewed below. Regular review of water, sewer and other critical infrastructure is an appropriate practice to ensure that municipal infrastructure is functioning as intended, and vulnerabilities and limitations are recognized and addressed.

2017 OCP Section 22: Public Safety

Public safety for the District is supplied by four municipal agencies working collaboratively: SFR, SEP, Bylaw Services, and the Squamish RCMP Detachment. The objective is to have a safe and disaster-resilient community, achieved through risk reduction, emergency response, and creating conditions that reduce the incidence of crime, abuse and discrimination.

The objective of disaster resilience planning is to support community resilience and increase the District's capacity to prepare for, mitigate, respond to, and recover from emergencies and disasters.

To that end, the following policies were developed to meet the disaster resilience planning objective:

- The District has finalized the CEMP with Hazard Specific (Flood, Wildfire) and Function Support Annexes (Evacuation Plan, Communications) and to update the CEMP annually.
- Update the District's *Community Risk Assessment* every 5 years.
- Designate a network of post-disaster neighbourhood support hubs to focus and coordinate assistance efforts and share resources.
- Plan, coordinate and test emergency and disaster response in coordination with the Squamish Nation and neighbouring communities.

The objectives of emergency preparedness and mitigation are to: strengthen local level emergency response capacity and to build community resiliency; promote individual, business, and community preparedness for disaster response and recovery; and prepare the community to be self-reliant for one-week post-disaster. The District proposes to achieve these objectives through the following policies:

- Strengthen emergency and business continuity planning.

- Implement mitigation measures for vulnerable neighborhoods and infrastructure prior to emergencies.
- Relocate core emergency response facilities from areas threatened by natural hazards at the end of their lifespans.
- Assess impacts of climate change on requirements for emergency response capabilities.

Emergency management and planning seeks to safeguard the public from harm; business continuity planning enables the continual delivery of critical services or products in a crisis or disaster. Effective emergency and business continuity planning will increase community resiliency post-emergency by reducing the time it takes for the community to be functioning again: providing critical services to the residents and minimizing the economic impacts to the community.

RECOMMENDATION #11: Complete business continuity planning for the District.

2017 OCP Section 23: Natural Resources

The forestry industry has been the main economic driver and largest provider of jobs in Squamish. Specific to forested lands, the objectives of the District are to: protect and promote stewardship of the forest land base to manage ecosystem health, recreation and tourism in working forests; and, enhance local economic development in the forest sector through sustainable forest management.

The OCP states the following policies to achieve the aforementioned objectives:

- Work with the Sea to Sky Natural Resource District in the development of a Forestry Land Strategy, which could include the development of local wood waste facilities for wood biomass conversion.
- Explore alternative wood waste disposal methods and provide an interim wood waste disposal site.
- Continue to support the establishment of a Community Forest in partnership with the Squamish Nation and other key stakeholders.
- Work with the BCWS on wildland fire management planning and wildfire prevention through forest management education and enforcement.
- Consider climate change in all aspects of forest management.

The OCP policies for forested land within the District are appropriate to help meet the stated objectives and can also be beneficial for wildfire risk reduction efforts.

Wood waste and debris disposal can be a challenging aspect of fuel management activities. Open burning is often the only cost-effective way to complete debris disposal, but can impact air quality, public health, and visibility. Diversion of woody debris from burn piles can reduce the impacts of open burning, while allowing full utilization of fiber.

Establishment of a community forest may allow forested area within the WUI to be managed for a variety of values important to the community and Squamish First Nation, including wildfire management.

RECOMMENDATION #12: Continue to support the establishment of a community forest in partnership with the SFN and MFLNRORD, as well as other key stakeholders. Apply recommendations and principles found within this update to drive fuel management activities on community forest lands, wherever possible.

RECOMMENDATION #13: Maintain open communications with BCWS regarding fire management planning.

2017 OCP Part 5: DPA

There is not a current wildfire hazard DP established in the OCP, although development of a wildfire hazard DP area is recommended above in the policies of the OCP's Section 11.

District Bylaw No. 2314, 2014: Fire Service Bylaw

This bylaw guides the fire service within the District.

Section 10 identifies regulations specific to prevention of forest fires. These regulations include the authority to: close outdoor trails and recreation areas, to prohibit lighting or maintaining a campfire or other outdoor fire, issue stop or modify work orders for activities within 1 km of a forest and suspend or revoke fireworks discharge permits.

Section 11 guides campfires and open air burning within the District. Permits are required for all open burns; fuels and size limitations are stated, and minimum supervision requirements are in place. Section 13 limits fireworks use within the District.

Section 14 sets out Property Regulations which prohibit the accumulation of combustible materials on a roof; within a carport or shed; or within a yard or other open space on the property. The Fire Chief may issue an order for removal of accumulations, if they are not removed of by the property owner or occupier.

Section 22 allows the Fire Chief to suspend or revoke any permits issued, including permits for open air burning and for fireworks.

District Bylaw No. 1822, 2004: Building Bylaw

Section 16 requires that business and residences have a road and driveway accessible by fire and emergency vehicles. This includes strength, grade, and width to allow for safe passage.

The building bylaw does not address the accumulation of combustible materials during construction. Accumulation of highly flammable construction materials during the fire season and within 10 m of structures can increase the hazard of structures, both in development and nearby.

RECOMMENDATION #14: Consider amendment to Bylaw 1822 to include a requirement to remove combustible construction materials promptly during fire season. The frequency within which combustibles need to be removed may be dependent upon the fire danger rating or at the discretion of a fire official. The District is currently addressing this Building Bylaw Amendment.

District Bylaw No. 2254, 2013: Outdoor Water Use Bylaw

The outdoor water use bylaw outlines water use restrictions within the District. In the event of an extreme fire danger rating in the District for three consecutive days, the Fire Chief may suspend watering restrictions in parts of, or the entire District. The notice would allow owners and occupiers to reduce fire hazard on their properties by watering as prescribed.

District Bylaw No. 2373, 2015: Subdivision and Development Control Bylaw

This bylaw regulates the subdivision and development of land, including requirements to provide, design, and construct works and services for the development.

- Section 4.3 and Schedule B outline the standards for emergency access required for subdivisions.
- Section 4.4 outlines the provision of parkland for developments.
- Section 4.19 defines minimum criteria for trails within the District. Many of the standards overlap with best practices for reducing wildfire threat along trails, such as minimum branch height, trail surface width, and cleared width.
- Section 5.1 and Schedule B and C outline the requirements of water distribution and servicing from municipal water supply.
- Schedule B outlines design criteria, including water systems, hydrant placements, road and emergency access design, trails, and wiring. Power and communications wiring in new subdivisions are to be underground.

RECOMMENDATION #15: Require a minimum of two points of access for new subdivisions.

RECOMMENDATION #16: Review subdivision bylaw and consider amending to comply with NFPA 1141. 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. In interface communities, roads are often narrow and densely vegetated to protect the privacy of homes and the character of the neighbourhood. On-street parking can also contribute to the visibility hazard on these roads, especially under heavy smoke conditions.[14] When the time for evacuation is limited, poor access has contributed to deaths associated with entrapments and vehicle collisions during wildfires.[15] Methodologies for access / egress 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.

[14] Cova, T. J. 2005. Public safety in the wildland-urban interface: Should fire-prone communities have a maximum occupancy? Natural Hazards Review. 6:99-109.

[15] De Ronde, C. 2002. Wildland fire-related fatalities in South Africa – A 1994 case study and looking back at the year 2001. Forest Fire Research & Wildland Fire Safety, Viegas (ed.), http://www.fire.uni-freiburg.de/GlobalNetworks/Africa/Wildland.cdr.pdf

RECOMMENDATION #17: Continue to have subdivision development applications reviewed by fire officials to ensure that hydrant placement and access is acceptable for emergency response and suppression.

District Bylaw No. 2200, 2011: Zoning Bylaw

This bylaw guides land use within zones in the District. There are no setbacks specific to top of slope, fire hazard, or forested area.

District Bylaw No. 1716, 2002: Off-Road Vehicle Bylaw

This bylaw prohibits the use of motorized off-road vehicles in parks, trails, the municipal dike, and other identified areas. There is an exception for vehicles operated by emergency personnel (fire, police, search and rescue, etc.) in the course of duty. This is important, as ATVs and UTVs can be effective modes of access during fire suppression. Additionally, depending on width and substrate, many trails can be used as surface fire breaks and access points for suppression crews.

RECOMMENDATION #18: Include in trail inventory database suppression access and fuel break information, such as grade, substrate, width, and clearance. This information can be used by SFR and BCWS during suppression activities.

Trails Master Plan

The District of Squamish Trails Master Plan provides a comprehensive strategy for the maintenance and development of the trails throughout the community. There is no explicit mention of wildfire in the Trails Master Plan. Trails can have significant impact on the wildfire risk of a community. High-use recreational trails can be beneficial when high-use times provide increased early detection and reporting. Alternatively, trails are potentially locations of increased ignitions in the interface (high–use areas). Furthermore, depending upon width, clearance, and surfacing, can provide points of access for suppression efforts, serve as surface fire fuel breaks, and act as control lines for suppression efforts.

Appendix E of the Trails Master Plan does not mention regulatory requirements or obligations under the Wildfire Act and Wildfire Regulation. Those completing trail work should be knowledgeable of their obligations under the Wildfire Act and Wildfire Regulations, particularly regarding high-risk activities, for example use of spark-producing machinery, such as chainsaws. High risk activities may be limited or restricted during times of high Fire Danger Class ratings; these restrictions apply to activities undertaken by industrial personnel, as well as the general public.

RECOMMENDATION #19: Review and update the Trails Master Plan to ensure that the guidance and direction in the plan consider, and are not in conflict with, wildfire risk reduction strategies. Review and amend Appendix E to include guidance acceptable methods to dispose of residual fuels from maintenance, acceptable levels of surface fuels to retain on site after maintenance and new construction, and trail building crews' obligations under the Wildfire Act and Wildfire Regulation.

Parks and Recreation Master Plan

Appendix F of the *Parks and Recreation Master Plan* is the parkland acquisition guidelines for the District to help guide the District in development and acquisition decisions. Parkland acquisition decisions should incorporate the community's wildfire management and risk reduction objectives, along with the many other factors and values considered in the acquisition process. More details on short and medium-term considerations can be found in the discussion of Section 18: Parks of the OCP.

RECOMMENDATION #20: Review and update the parkland acquisition guidelines and amend to include interface fire management and risk reduction considerations. Consider creating a decision-matrix to help guide parkland acquisition.

2.5.4 Higher Level Plans and Relevant Legislation

Sea-to-Sky Land and Resource Management Plan (LRMP)[16]

The Sea-to-Sky Land and Resource Management Plan (LRMP) is the higher-level planning document for the Sea to Sky Resource District, which includes the District of Squamish. The plan provides general resource management direction for the following categories: 1) Access; 2) Cultural Heritage Values; 3) Forest Health; 4) Recreation; 5) Riparian and Aquatic Habitats; 6) Water; 7) Wildfire Management; 8) Wildlife and Biodiversity; 9) Bald Eagle; 10) Deer; 11) Moose; 12) Mountain Goat; 13) Grizzly Bear; 14) Marbled Murrelet; 15) Spotted Owl; 16) Visual Quality. The plan also identifies Land Use Zones, which are used to delineate areas which require specific management. The objective for wildfire management stated in the LRMP is *'to minimize the wildfire risks to community, recreation, power transmission and transportation infrastructure, and natural resource values, while providing for enhanced ecological function'.* This objective is to be achieved through the implementation of recommended activities outlined in an approved Integrated Fire Management Plan (see "Sea to Sky Natural Resource District/Pemberton Fire Zone Fire Management Plan – 2016" below).

There are fourteen land use objective regulation orders establishing OGMAs and a number of GAR orders establishing wildlife habitat areas for grizzly bears, Marbled Murrelet and Spotted Owls within the AOI. First Nation cultural places were recognized in the Strategic Land Use Plan which was harmonized with the LRMP and established through the LRMP LUOR and Land Act reserves.

Further, non-legal Squamish Nation Wildlife Focus Areas are identified within the AOI for deer, elk, moose, and fur animals. These plans, focus areas, and spatially explicit ministerial orders must be reviewed, considered, and addressed during the prescription-level phase. Fuel management within these areas should aim to enhance these values, whenever possible and the land manager (Sea to Sky Natural Resource District) must be consulted regarding any overlapping values at risk, spatially explicit ministerial orders, or other notable values on the land base, during prescription development.

[16] https://www.for.gov.bc.ca/tasb/slrp/lrmp/surrey/s2s/docs/S2S_LRMP_Final/S2SLRMP_Final_April2008.pdf

Sea to Sky Coordinated Access Management Plan (CAMP)[17]

The Sea to Sky Coordinated Access Management Plan (CAMP) is an assessment of road access issues in the Sea to Sky Natural Resource District. The primary concerns related to road access are impacts to wildlife and wildlife habitat and impacts to sensitive ecosystems, parks or protected areas. The CAMP provides guidance on which roads should be maintained for recreational or industrial use, and which roads should be deactivated or managed for access due to potential impacts on important values. This plan has implications for access routes for fire suppression efforts and egress routes for recreationalists and resource staff (e.g. forestry workers) in the event of an emergency such as a wildfire, as well as the location of proposed treatments.

2.5.5 Ministry or Industry Plans

Reviewing and incorporating other important forest management planning initiatives into the CWPP planning process is a critical step in ensuring a proactive and effective wildfire mitigation approach in the AOI. The Fire Management Plan[18] that encompasses the District of Squamish was reviewed to identify future landscape level fire management planning at the Natural Resource District level.

The Sea to Sky Natural Resource District completed a Fire Management Plan (FMP) in 2016 which went through an update process in 2017. This updated 2017 FMP has since been merged into the South Coast Region's plan. According to the 2016 S2S FMP, fuel breaks should be strategically located in order protect values and to provide safe access for fire suppression activities. Through consultation with the land manager (MFLNRORD Sea to Sky Natural Resource District), it was determined that previously only one landscape level fuel break was identified within the AOI along Garibaldi Park Rd which is managed by the Ministry of Transportation. This landscape level fuel break was proposed and a prescription was developed by BA Blackwell in 2017 with funding from FESBC. It is the hope of the MFLNRORD land manager that the Squamish Community Forest will implement this prescription (Frank DeGagne, personal communication, June 2018). The S2S FMP identifies several potential fuel breaks around the municipalities of Whistler and Pemberton. To address this gap, landscape level fuel break opportunities have been identified as part of this CWPP. These fuel breaks have been recommended in order to protect access and egress routes in the District of Squamish as well as to serve as strategic anchors for fire suppression and to reduce extreme crown fire behaviour.

Due to the fact that the District of Squamish has limited access and egress options, improving access and increasing public safety in the event of an emergency evacuation should be a priority. There may be funding opportunities for fuel breaks on Crown land along Highway 99 and other single-access roads through the Forest Enhancement Society of British Columbia (FESBC). To facilitate this, communication

[17] Sea to Sky Coordinated Access Management Plan. 2009. Rowe Forest Management Ltd. Ministry of Forests, Lands & Natural Resource Operations.
[18] Sea to Sky District Fire Management Plan Update. 2015.

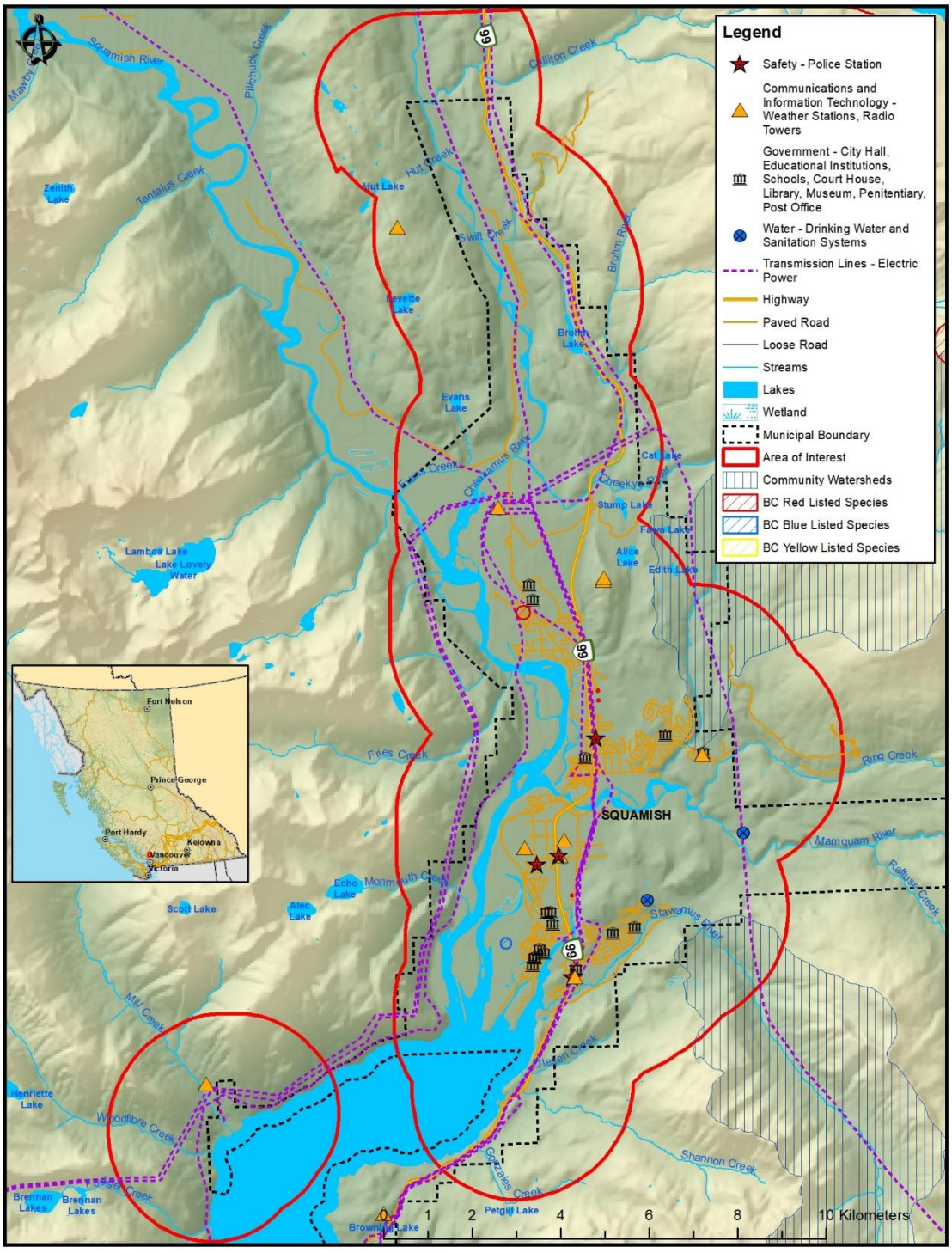
with the Natural Resource District and Ministry of Transportation and Infrastructure should be initiated to explore potential fuel treatments.

Forest health management and associated initiatives within the Sea to Sky Natural Resource District are guided by the Squamish Forest District Forest Health Strategy[19]. These plans must be reviewed, considered, and addressed during the prescription-level phase. Fuel management and prescriptions aimed at reducing wildfire hazard within the AOI should aim to incorporate the guiding principles and best management practices (BMPs) presented within this aforementioned plan.

SECTION 3: VALUES AT RISK

Following is a description of the extent to which wildfire has the potential to impact the values at risk (VAR) within the District of Squamish. VAR or the human and natural resources that may be impacted by wildfire include human life and property, critical infrastructure, high environmental and cultural values, and other resource values. VAR also include hazardous values that pose a safety hazard. Key identified VAR are illustrated below in Map 2.

[19] British Columbia Ministry of Forests and Range. Squamish Forest District Forest Health Strategy. 2010.



Map 2. Values at Risk within the AOI/Study Area.

3.1 HUMAN LIFE AND SAFETY

One of the primary goals of the BCWS is to support emergency response and provide efficient wildfire management on behalf of the BC government. BCWS aims to protect life and values at risk, while ensuring the maintenance and enhancing the sustainability, health and resilience of BC ecosystems.[20]

Human life and safety is the first priority in the event of a wildfire. A key consideration is the evacuation of at-risk areas and safe egress. Evacuation can be complicated by the unpredictable and dynamic nature of wildfire, which can move quickly. Evacuation takes time and safe egress routes can be compromised by wildfire, limited visibility, or by traffic congestion and/or accidents.

The population distribution (both people and structures) within the AOI is important in determining the wildfire risk and identifying mitigation activities. The population of Squamish has increased significantly in recent years. It was last measured at 17,587 persons in 2016, up 13% from 2011.[21] This compares to 5.6% growth in the province of British Columbia during the same years. According to the 2016 Census, there are 6,756 private dwellings in the District, approximately 265 of which are occupied on a part-time basis. The District of Squamish is a major destination for outdoor recreation, including rock climbing, hiking, mountain biking, kayaking and kiteboarding. These activities can occur year-round but are especially popular during the fire season (April – October). Several campgrounds throughout the AOI are also highly used during the summer months, including Shannon Falls Provincial Park, Stawamus Chief Provincial Park, Alice Lake Provincial Park, Mamquam River campground, Klahanie campground, Paradise Valley campground, and Cat Lake Recreation Site. Furthermore, the Sea to Sky highway is heavily used during the fire season as an access corridor to Whistler and Pemberton, which increases the number of people to evacuate in the event of a wildfire and contributes to road congestion.

Knowledge and access to updated structure locations within an area is a critical step in efficient and successful emergency response planning and the development of mitigation strategies and recommendations. Field visits to the District of Squamish AOI and access to recent orthophotography and spatial data from the District has enabled the development of an updated WUI boundary that accounts for the most recent development.

3.2 CRITICAL INFRASTRUCTURE

Protection of critical infrastructure (CI) during a wildfire event is an important consideration for emergency response effectiveness, ensuring that coordinated evacuation can occur if necessary, and that essential services in the AOI can be maintained and/or restored quickly in the case of an emergency. Critical infrastructure includes emergency and medical services, electrical and gas services, transportation, water, social services, and communications infrastructure. A CI dataset was provided by

[20] BC Provincial Coordination Plan for Wildland Urban Interface Fires. 2016. https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/emergency-preparedness-response-recovery/provincial-emergency-planning/bc-provincial-coord-plan-for-wuifire_revised_july_2016.pdf

[21] Statistics Canada. 2016 Census.

the District's GIS staff and these data were included in Map 2. Table 3 details an inventory of CI identified by the District and via field visits.

Protection of CI has shown itself to be an essential wildfire preparedness function. Survival and continued functionality of these facilities not only support the community during an emergency but also determine, to a great degree, the extent and cost of wildfire recovery and economic and public disruption during post wildfire reconstruction. Critical infrastructure provides important services that may be required during a wildfire event or may require additional considerations or protection. As outlined in Section 5.2, FireSmart principles are important when reducing wildfire risk to both critical and non-critical classes of structure and are reflected in the outlined recommendations. During field visits, it was observed that generally the District's CI is compliant with FireSmart principles.

RECOMMENDATION #21: The use of fire resistant construction materials, building design and landscaping should be considered for all CI when completing upgrades or establishing new infrastructure. Additionally, vegetation setbacks around CI should be compliant with FireSmart guidelines. Secondary power sources are important to reduce CI vulnerability in the event of an emergency which cuts power for days, or even weeks.

3.2.1 Electrical Power

Electrical service for most of the District of Squamish is received through a network of wood pole transmission and underground distribution infrastructure supplied by BC Hydro and FortisBC. Neighbourhoods with small, street-side wooden poles to connect homes are particularly vulnerable to fire.

There is an extensive transmission line system present in the Squamish AOI. Two BC Hydro substations are located within the District of Squamish and power is supplied to the District via a radial transmission line of (69kV), which is connected to the 230kV transmission line that follows Highway 99. Two 500kV and one 130 kV transmission line from the Cheekye substation follow the west side of Howe Sound past Woodfibre to the Sunshine Coast. The Woodfibre LNG Limited power generation facility generates 1.6 MW/year and is connected to the BC Hydro transmission grid.

Another 500kV transmission line travels from the Cheekye substation, along Stawamus River and eventually reaches the Meridian substation in Coquitlam, BC. Three 500kv transmission lines travel from Kelly Lake and Bridge River substations (north of Pemberton) to the Cheekye substation. One 130kv exists between the Culliton Creek Independent Power Producer hydroelectric project and the Cheekye substation. This system is well-mapped and BC Hydro staff will work with the SFR and BCWS to mitigate impacts to this infrastructure in the event of a wildfire.[22]

[22] https://www.bchydro.com/safety-outages/emergency-preparation/natural-disasters.html

FortisBC makes available online the maps of its natural gas and electrical distribution and transmission systems. The FortisBC company website states that employees will consult with local authorities and BCWS in the event of a wildfire.

A large fire has the potential to impact electrical service by causing disruption in network distribution through direct or indirect means. For example, heat from flames or fallen trees associated with a fire event may cause power outages. Consideration must be given to protecting this critical service and providing power back up at key facilities to ensure that the emergency response functions are reliable.

Secondary power sources are important to reduce critical infrastructure vulnerability in the event of an emergency which cuts power for days, or even weeks. Secondary power is available for some critical infrastructure (RCMP Detachment, Municipal Hall, Fire Halls 1 & 2, Public Works sewage treatment plant, Public Works Operations Centre, and Brennan Park Recreation Centre) via backup generators[23]. The District has 18 emergency generators for various infrastructure during the event of a power outage, which includes 3 portable trailer generators. These emergency generators are powered by either diesel, natural gas, or propane. Vulnerabilities for secondary power sources include mechanical failure, potentially insufficient power sources should a wide-scale outage occur, and fuel shortage in the event of very long outages. Available diesel fuel in the District Public Works Yard storage (9,000L) may dwindle in the case of extended outages. Further, the portions of the water distribution system that do not have backup generators are at risk of becoming unavailable in the event of a power outage.

RECOMMENDATION #22: It is recommended that utility right-of-way BMPs such as regular brushing and clearing of woody debris and shrubs be developed and employed to help reduce fire risk, utility pole damage and subsequent outages. Utility owners should be responsible for maintaining these areas within the AOI including the development of prescriptions and subsequent maintenance plans.

3.2.2 Communications, Pipelines and Municipal Buildings

The District of Squamish is serviced by one hospital, one airport, one municipal building, and 6 critical communication towers (Table 3). There is a Fortis BC gas line that supplies Squamish, as well as the Sunshine Coast and Vancouver Island. A compressor station and pipeline infrastructure have been proposed for the Squamish area, called the 'Eagle Mountain – Woodfibre Gas Pipeline Project', which would provide gas to the planned Woodfibre LNG Limited power generation plant. A full inventory of critical infrastructure for communications, pipelines and municipal buildings with updated locations is presented in Table 3, below.

[23] District of Squamish Community Risk Assessment Report. 2015.

Table 3. Identified Critical Infrastructure.

Critical Infrastructure Type	Location
Electrical service	Service from regionally integrated transmission network. Distribution is combination of wood poles and underground servicing.
Power grid	BC Hydro Cheekye substation is located on Squamish Valley Rd and the Squamish substation is located at Pemberton Ave and Loggers Lane. Hydroelectric generation creating 1.6 MW/year and is connected to the BC Hydro transmission grid.
Woodfibre LNG Limited Power Generation Plant	A modestly-sized liquefied natural gas (LNG) processing and export facility at the former Woodfibre pulp mill site.
Squamish Search and Rescue Base	Trained in ground search and rescue techniques and emergency first aid, the base is located at the MFLNRORD District Office.
FLNRORD/MOTI/BCTS offices	This office is located at 42000 Loggers Lane.
BCWS Base	The Coastal Fire Centre encompasses Squamish and the nearest BCWS office is located in Pemberton, BC at 2000 Airport Rd. However, BCWS has a field office in Squamish where response equipment are frequently kept on stand-by.
Totem Hall	Squamish Nation Totem Hall functions as a vital nucleus of the community for events and congregations and is located within Squamish on Stawamus Rd.
Well sites	The Powerhouse Springs well field comprises seven municipal well facilities and are the primary source of water for the SLRD.
Squamish Public Works Yard	Responsible for the maintenance of roads, water, sewer and solid waste utilities, as well as infrastructure planning. The Yard is located at 39909 Government Rd.
Mamquam Wastewater Treatment Plant	As the collection facility terminating the network of sewer pipes, the Plant is also located at 39909 Government Rd.
Communication Tower	Quest University (Thunderbird Ridge) – Telus owned. This is the main tower for DOS radio communications (including SFR, the Emergency Operations Centre, Squamish First Nation, and many others).
Communication Tower	The Smoke Bluffs tower (Rogers owned, used by local radio station Mountain FM).
Communication Tower	De Becks Hill tower site near Alice Lake (used by BC Hydro, Rogers, Telus).
Communication Tower	DOS Emergency Operations Centre Radio tower
Communication Tower	Power House Springs site (the primary source of water for the District) – this is a SCADA station used by DOS Public Works.
Communication Tower	Watts Point - An important tower for relaying EComm dispatches at Watts Point in Murrin Park.
Squamish General Hospital	38140 Behrner Dr.
BC Ambulance Service	Station 222 - 38929 Production Way

Critical Infrastructure Type	Location
Squamish RCMP Detachment	1000 Finch Dr.
Squamish Fire Hall 1 & Training Site	37890 Clarke Dr., Garibaldi Highlands
Squamish Fire Hall 2 – Fire Rescue	40439 Tantalus Rd
Municipal Hall	37955 2 Ave
Squamish Airport	46021 Government Rd, Brackendale
Emergency Operations Centre (EOC)	1000 Finch Dr.
Emergency Social Services (ESS)	Approximately 18 volunteers
Royal Canadian Marine Search and Rescue	Station 04 – Squamish Yacht Club – 37778 Loggers Lane
Brennan Park Recreation Centre (Reception Centre)	1009 Centennial Way

3.2.3 Water and Sewage

In the District of Squamish, water is primarily supplied through Powerhouse Springs wells. District staff do not have any concerns related to the quantity of water that can be drawn from this source, as Maximum Day Demand for future projections of population growth (2031) are 299 litres per second (L/s), and Powerhouse Springs well site has a capacity of 760 L/s if more pumps are installed to increase the pump capacity[24]. However, in order to maintain supply from these wells, access from Mamquam FSR is critical for fuel delivery in the event of a power outage. Secondary and tertiary sources of water include two surface sources, Stawamus River and Mashiter Creek, respectively. In recent years, the District has shifted its reliance from these surface water sources, which are now only drawn upon for emergency supply, to the Powerhouse Springs well system[16]. The Stawamus River surface water source is gravity fed, therefore less susceptible to interruption during a power outage, however, supply is not secure during the dry summer months or when demand is at its peak[16]. These riparian systems are both located in Community Watersheds and therefore forest and range activities occurring within these watersheds are subject to requirements and regulations outlined in the Forest and Range Practices Act (FRPA) and the associated Forest Planning and Practices Regulation (FPPR). These requirements are set out to prevent impacts to the quality and quantity of water and the timing of flow.

Seven reservoirs are located across the District of Squamish: Upper University, Lower University, Boulevard, Thunderbird, Plateau, Alice Lake, and Crumpit Woods. The District of Squamish Water Master Plan[16] identifies concerns related to the size of the Plateau and Thunderbird reservoirs, as they cannot be supplied from higher elevations in the event of a major increase in demand, such as when water is required for wildfire suppression activities. The Plan also outlines a number of upgrades to the District water supply and distribution system in order to correct existing shortfalls and to address future population growth.

[24] District of Squamish – Water Master Plan (2015)

Table 4. Critical Infrastructure Identified in 2017 CWPP field visits.

Critical Infrastructure Type	Location
Water supply	Primary infiltrative source of domestic water for the District is taken from Powerhouse Springs wells, seven wells located on Mamquam FSR supplied by the Ring Creek aquifer. The Powerhouse chlorination building is located on Mamquam Forest Service Road (FSR). The District-owned transmission line to Powerhouse Springs is located along Mamquam FSR and provides power to the chlorination building and wells. Emergency backup surface water supply from Stawamus River and Mashiter Creek. Additional infrastructure includes: Judd Rd Pump Station, Dryden Rd Pump Station and Harris Rd Pump Station. Seven reservoirs are located across the District of Squamish: Upper University, Lower University, Boulevard, Thunderbird, Plateau, Alice Lake, Crumpit Woods.
Sanitary sewer system	Sewage is transported through a pipe system and 22 lift stations throughout the District to a central wastewater treatment facility, located at 39909 Government Rd.

3.3 HIGH ENVIRONMENTAL AND CULTURAL VALUES

The following section identifies high environmental and cultural values and where they are located. Environmental, cultural and recreational values are high throughout the study area.

3.3.1 Drinking Water Supply Area and Community Watersheds

According to the Community Risk Assessment Report, the District of Squamish draws its domestic water from Powerhouse Springs wells. The Powerhouse Springs Well Protection Plan[25] outlines the Groundwater Protection Zone (GPZ), potential contaminants, management strategies, contingency plans, and implementation of the protection plan. This plan provides detailed direction on protecting this valuable water source by: requesting that the Squamish-Lillooet Regional District (SLRD) assign the GPZ with Community Watershed Protection Status, creating a Contingency Plan for well protection, educating the public on the GPZ, septic tank maintenance, and disposal of hazardous liquids through signage and campaigns (specifically for residents of the Ring Creek community), and set up a monitoring system for water levels and contaminants.

3.3.2 Cultural Values

The District of Squamish is within the Squamish First Nations traditional territory. The Tseil-Waututh and Musqueam First Nations traditional territories also coincide with Squamish First Nation territory, to the east and south of the AOI.

Within the Sea to Sky LRMP there are four legal orders that guide forest management with regards to First Nations Cultural Places in the District of Squamish AOI:

[25] https://squamish.ca/assets/water/2841-WPP-FINAL-May.pdf

1. Mid Cheakamus River Síiyamín ta Skwxwú7mesh (cultural) site
2. Fries Creek Síiyamín ta Skwxwú7mesh (cultural) site
3. Stawamus Creek Síiyamín ta Skwxwú7mesh (cultural) site
4. Monmouth Creek Síiyamín ta Skwxwú7mesh (cultural) site

The Sea to Sky LRMP defines specific management intent, objectives and implementation direction for the above listed Cultural Places. In order to preserve the integrity and natural and cultural resources present on these sites, the following uses are not permitted:

- commercial logging (with the exception of harvesting for forest health reasons),
- new road construction is not permitted for forestry or resource development (with potential exceptions for subsurface resource exploration),

Special management zones within protected areas should encompass these cultural sites where present, and new Crown land tenures cannot be granted within these sites. Furthermore, pre-existing tenures, roads and infrastructure and new tenures adjacent to cultural sites should mitigate impacts to Síiyamín ta Skwxwú7mesh (cultural) sites and include consultation with the Squamish First Nation, where appropriate.

Archaeological sites in BC that pre-date 1846 are protected by the *Heritage Conservation Act* (HCA), which applies on both private and public lands. Archaeological remains in BC are protected from disturbance, intentional and inadvertent, by the HCA. 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 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.

Due to site sensitivity, the locations of archaeological sites may not be made publicly available, however, an Archaeological Overview Assessment of the AOI by the MFLNRORD Archaeology Branch confirms that multiple sites do exist. The District should ensure that they have direct access to Remote Access to Archaeological Data (RAAD), which allows the District to look up or track any archeological sites in the area.[26]

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 archaeological resources may include features such as CMTs, which could be damaged or accidentally harvested during fire hazard reduction activities. Fuel treatment activities should include consultation with the all identified First

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

Nations at the site level and with sufficient time for review and input regarding their rights and interests prior to prescription finalization or implementation.

3.3.3 High Environmental Values

The AOI overlaps with 60 legal OGMAs. Any proposed fuel treatment that may overlap these areas requires MFLNRORD oversight at the prescription development phase, and works can only occur following MFLNRORD approval (OGMA amendment policy replacement application and/or detailed rationale must be provided to the District Manager for review).

Ten Ungulate Winter Range (UWR) polygons intersect the Squamish AOI. Three of these polygons are "No Harvest Zones" as per Government Actions Regulation (GAR) Order U-2-002 [2] and U-2-005 [1]. Seven are "Conditional Harvest Zones" under GAR Order U-2-005. These GAR Orders are intended to protect critical winter foraging habitats for black-tailed deer and moose populations and have specific management requirements associated with them. There are also established legal objectives and orders for Wildlife Habitat Areas (WHAs) for Spotted Owl within the Squamish AOI. This includes a Long-term Owl Habitat Area ("No Harvest Zone") and two Managed Forest Habitat Areas ("Conditional No Harvest Zones". These GAR Orders should be reviewed and adhered to should a fuel treatment be proposed within any of these areas. The grizzly bear, bald eagle, deer, moose, mountain goat, marbled murrelet, and spotted owl are additional important wildlife species that the Sea to Sky Natural Resource District is actively managing and defines best management guidelines for.

The Conservation Data Centre (CDC), which is part of the Environmental Stewardship Division of the Ministry of Environment and Climate Change Strategy, 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. Two classes of data are kept by the CDC: non-sensitive occurrences for which all information is available (species or ecosystems at risk and location); and masked, or sensitive, occurrences where only generalized location information is available.

There are two occurrences of Red-listed species and two occurrences of Blue-listed species within the AOI (Table 5). There are is one overlap with a masked occurrence. Through consultation with the CDC and a biologist or qualified professional, all site level operational plans must determine if these occurrences 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 on species at risk.

Table 5. Publicly available occurrences of Red and Blue-listed species recorded within the AOI.

Common Name	Scientific Name	Category	BC List	Habitat Type
Pacific water shrew	*Sorex bendirii*	Vertebrate animal	Red	Creek
Vancouver Island beggarticks	*Bidens amplissima*	Vascular plant	Blue	Estuarine meadow
Henderson's checker-mallow	*Sidalcea hendersonii*	Vascular plant	Blue	Herbaceous wetland
Roell's brotherella	*Brotherella roellii*	Nonvascular plant	Red	Forest-mixed; coarse woody debris

3.4 OTHER RESOURCE VALUES

The District of Squamish is located in the Soo Timber Supply Area, which encompasses approximately 900,000 hectares of land within the South Coast Natural Resource Region and is administered by the Sea to Sky Natural Resource District. The current Allowable Annual Cut (AAC) is 480,000 cubic meters per year (the AAC is not applicable to private managed forest land). The last Timber Supply Review (TSR) was completed in 2011. The TSR determined that the timber harvesting land base (THLB) is 93,152 hectares or 35% of the Crown forest managed land base (CFMLB).[27]

There are multiple values associated with the land base, including recreation and tourism, wildlife habitat, drinking water supplies, and many others.

There are multiple forest licensees operating within the Squamish AOI, under both area and volume-based agreements, including Woodlot Licenses, Forest Licenses, Timber Sale Licenses, Occupant License to Cut, Christmas Tree Permits, and Forestry License to Cut.

In February of 2016, a District of Squamish Special Council Meeting was held in which it was decided that the "Squamish Community Forest Corporation", a partnership between the Squamish First Nation and the District of Squamish, would be established.[28] The application and planning associated with obtaining a Community Forest Agreement in Squamish is still underway (Tom Cole, personal communication, May 2018).

[27] AAC Rationale for Soo TSA. May 2011.

[28] https://squamish.civicweb.net/document/124218

Fuel reduction treatments are not anticipated to have a measurable effect on the timber harvesting land base. Typically, forest stands identified for fuels treatments are highly constrained for conventional logging and are often in undesirable or uneconomic stand types. The opportunity exists to work with local licensees on commercial thinning projects that meet fuels management objectives. See Section 7.0 (Recommendations) for opportunities to build relationships with forest industry licensees.

3.5 HAZARDOUS VALUES

Hazardous values are defined as values that pose a safety hazard to emergency responders. The District has identified four hazardous values, located primarily in the industrial zone of the AOI immediately to the west of Highway 99 (Table 6). Additionally, the District Landfill is located on the western side of Highway 99, north of Squamish Valley Rd. The management and treatment of fuels in proximity to hazardous infrastructure is critical in order to reduce the risks associated with both structural fire and wildfire. Specifically, best management practices recommended for management of hazardous values include: 1) incorporating FireSmart planning and setback requirements for all infrastructure in this category; 2) maintain emergency fuel/propane emergency shut off procedures to be enacted immediately and efficiently in the event of an approaching wildfire or ember shower; and 3) in relation to landfills, during periods of high or extreme fire danger, ensure that landfill contents are covered with soil or disposed of appropriately to avoid increased risk of a fire occurring due to incoming ember showers.

RECOMMENDATION #23: It is recommended that the SFR review or establish a mock emergency shut-down procedure for hazardous values within the AOI, as well as conduct a thorough FireSmart assessment of these hazardous values.

RECOMMENDATION #24: Conduct a more thorough inventory and review of hazardous infrastructure within the District.

Table 6. Hazardous Infrastructure Identified in 2017 CWPP field visits.

Hazardous Infrastructure Name	Location
Chevron Commercial Cardlock	38926 Progress Way
Fuel stations	• Petro Canada (1901 Garibaldi Way) • Chevron (1902 Garibaldi Way) • Husky (1814 Garibaldi Way) • Petro Canada (41409 Government Road) • Petro Canada (38471 Cleveland Ave) • Squamish Valley Gas Bar (9001 Valley Dr) • Shell (1580 Hwy 99) • Husky (38183 Cleveland Ave)
CN Railway	Follows Highway 99 from the south, re-directs to the east through Dentville and south to Squamish Terminals. The tracks then continue north along the Squamish River to the railyard between Queens Way and Government Rd.
Squamish Mills Dryland Sort	1555 Pemberton Ave

Hazardous Infrastructure Name	Location
Squamish Public Works Yard (diesel fuel storage)	39909 Government Rd
Squamish Landfill	Located west of Highway 99 on Landfill Rd off of Squamish Valley Rd in Brackendale.

SECTION 4: WILDFIRE THREAT AND RISK

This section summarizes the factors that contribute to and were assessed in the determination of wildfire threat around the community. These factors include the natural fire regime and ecology, the Provincial Strategic Threat Analysis, and the local wildfire risk analysis completed for the AOI.

4.1 FIRE REGIME, FIRE DANGER DAYS AND CLIMATE CHANGE

The ecological context of wildfire and the role of fire in the local ecosystem under historical conditions is an important basis for understanding the current conditions and the potential implications of future conditions on wildfire threat to the community. Historical conditions may be altered by the interruption of the natural fire cycle (i.e., due to fire exclusion, forest health issues, human development) and/or climate change.

4.1.1 Fire Regime

Ecological Context and Forest Structure

The Biogeoclimatic Ecosystem Classification (BEC) system describes zones by vegetation, soils, and climate. Map 3 outlines the BEC zones found within the AOI. Regional subzones are derived from relative precipitation and temperature. Subzones may be further divided into variants based upon climatic variation and the resulting changes in the vegetative communities; variants are generally slightly drier, wetter, snowier, warmer, or colder than the climate of the regional subzone.[29] The following section is synthesized from information found on MFLRNORD's Research Branch BECWeb.[30]

BEC zones have been used to classify the Province into five Natural Disturbance Types (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[31].

The AOI is characterized by the following BEC subzones in order of highest to lowest occurrence within the AOI:

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

[31] Province of British Columbia, 1995. Biodiversity Guidebook, s.l.: s.n.

1. Coastal Western Hemlock Dry Maritime (CWHdm) BEC Zone – NDT 2

The CWHdm makes up 80% of the Squamish AOI (Table 7) at lower to mid elevations (0-600m). The CWHdm is characterized by relatively mild winters and warm, dry summers. Moisture deficiencies occur uncommonly on zonal sites. These ecosystems support Douglas-fir, western redcedar, and western hemlock forest stands. The CWHdm is classified as a Natural Disturbance Type 2 – ecosystems with infrequent stand-initiating events. Historically, these ecosystems were generally represented by even-aged stands with patches of uneven-aged stand structure due to infrequent wildfire regime. Wildfires occurring in these areas ranged in size from 20 to 1,000 ha and resulted in a patchwork of primarily mature forests with intermixed patches of younger forests. The CWH ecosystems in this NDT experience a mean disturbance interval of 200 years.[31] Although the fire frequency is not high and fires are generally not large, pre-planning and preparation are essential to reduce the negative impacts of a wildfire.

2. Coastal Western Hemlock Montane Very Wet Maritime Variant (CWHvm2) – NDT 1

The CWHvm2 is the second-most common BEC unit occurring within the Squamish AOI (Table 7). These ecosystems are generally present above CWHvm1 BEC zones (see description below) and tend to have shorter growing seasons and greater snowpack than the CWHvm1. Within the AOI, the CWHvm2 occurs between elevation bands of approximately 700-1000m. The major tree species that characterize these sites are western hemlock, amabilis fir, yellow cedar, and mountain hemlock. The climate tends to be wet and cool, with relatively short summers.

The CWHvm2 is characterized as a Natural Disturbance Type 1 – ecosystems with rare stand-initiating events. These are forest ecosystems that experience relatively small disturbances in terms of spatial extent. They have historically resulted in uneven-aged, heterogeneous stand structures from rare and small disturbances caused by fire, wind and/or landslides. The CWH ecosystems in this NDT experience a mean disturbance interval of 250 years.[31] Mitigation efforts should not be focused in this subzone.

3. Coastal Western Hemlock, Southern Dry Submaritime Variant (CWHds1) – NDT 2

The CWHds1 encompasses a small proportion of the AOI (approximately 6%), primarily the northern extent, at low to mid elevations (200-700m). This BEC subzone and variant represents a transition between coastal and interior ecosystems. Moisture deficiencies can be common on zonal sites during the dry summers. The winters tend to be cool and moist with moderate snowfall. Compared to the CWHdm, which is present at similar elevations, the CWHds1 is drier and cooler. This BEC zone is dominated by forests of Douglas-fir and western hemlock, with a smaller component of western redcedar. The historical wildfire regime characteristic of CWHds1 is similar to that of CWHdm.[31]

4. Coastal Western Hemlock Submontane Very Wet Maritime Variant (CWHvm1) – NDT 1

The CWHvm1 occurs below the CWHvm2 and above the CWHds at elevations of approximately 200-700m within the AOI. Although this is the most common BEC unit in the Vancouver Forest Region, it only covers approximately 5% of the Squamish AOI. The climate of the CWHvm1 is wet and mild, with lengthy growing seasons and considerable variability in amount of precipitation due to topography. Western hemlock, amabilis fir, and some western redcedar are common tree species in these ecosystems. The

historical wildfire regime characteristic of CWHvm1 is similar to that of CWHvm2.[31] Mitigation efforts should not be focused in this subzone.

5. Mountain Hemlock Windward Moist Maritime Variant (MHmm1) – NDT 1

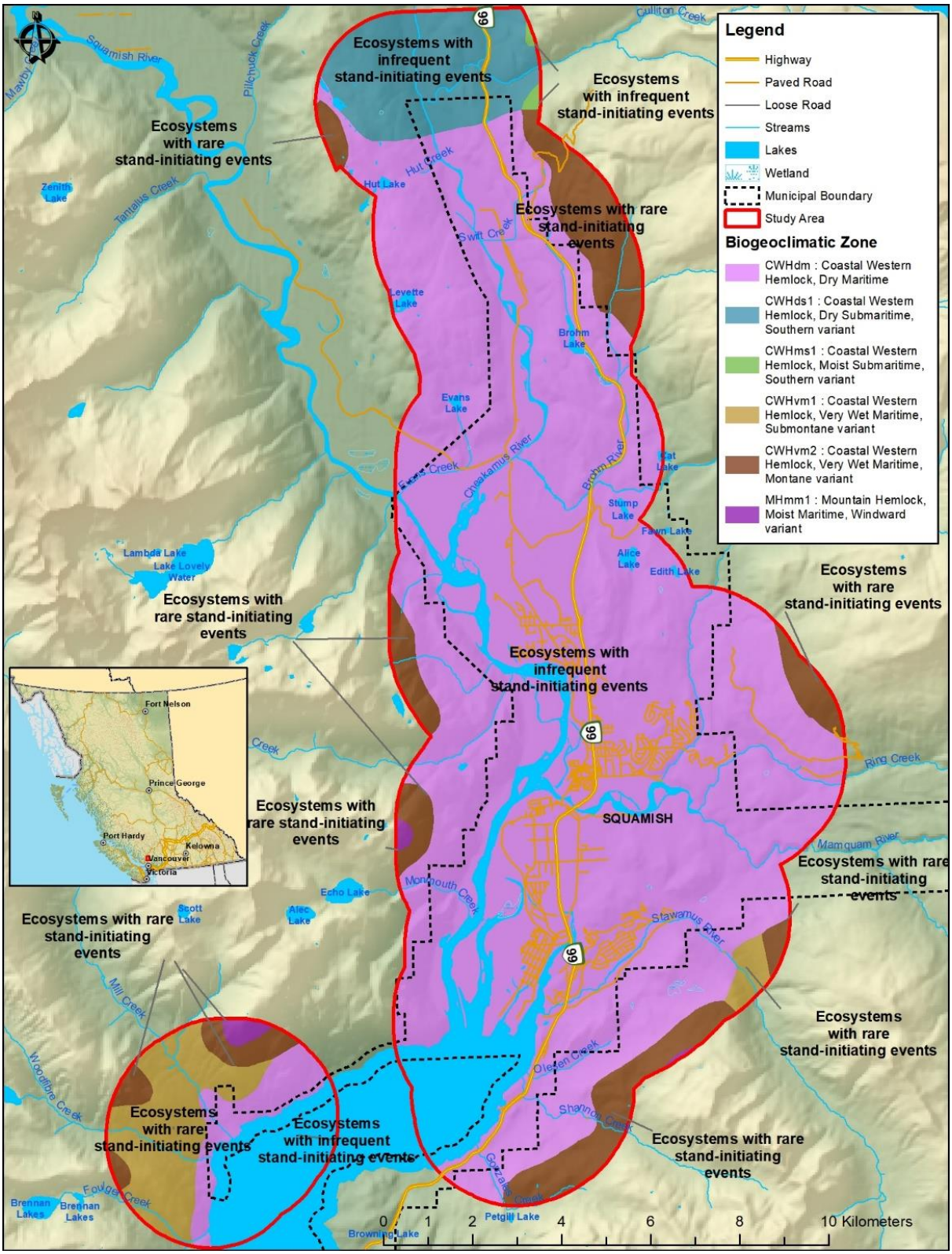
The MHmm1 exists at the highest elevations of all BEC zones present within the Squamish AOI, at approximately 1000-1300m. Forest stands are dominated by amabilis fir, mountain hemlock, and some yellow cedar. The climate of this BEC unit is characterized by cool, moist summers where the snowpack may be present well into the summer and long, wet winters. The historical wildfire regime characteristic of MHmm1 is similar to that of CWHvm2, however the MH ecosystems in this NDT experience a mean disturbance interval of 350 years.[31] Mitigation efforts should not be focused in this subzone.

6. Coastal Western Hemlock, Southern Moist Submaritime Variant (CWHms1) – NDT 2

The CWHms1 is present in a very small proportion of the Squamish AOI, from approximately 600-800m elevation bands at the northern extent of the AOI. This BEC subzone and variant represents a transition between coastal and interior ecosystems. Winters in this BEC unit are typically moist and cool, whereas the summers are dry, which has in the past created conditions that allowed for stand-replacing wildfires. The overstorey is typically dominated by western hemlock, Douglas-fir, western redcedar, and amabilis fir. The historical wildfire regime characteristic of CWHms1 is similar to that of CWHdm.[31] Overall, the majority of the AOI (~86%) falls into the NDT 2 – ecosystems with infrequent stand-initiating events. The remaining 14% of the AOI falls into the NDT 1 – ecosystems with rare stand-initiating events.[31]

Table 7. BEC zones and natural disturbance types found within the AOI.

Biogeoclimatic Zone	Natural Disturbance Type	Area (ha)	Percent (%)
CWHdm: Coastal Western Hemlock, Dry Maritime Subzone	NDT2	15,984	80%
CWHvm2: Coastal Western Hemlock *Montane* Very Wet Maritime Variant	NDT1	1,738	9%
CWHds1: Coastal Western Hemlock, *Southern* Dry Submaritime Variant	NDT2	1,150	6%
CWHvm1: Coastal Western Hemlock *Submontane* Very Wet Maritime Variant	NDT1	916	5%
MHmm1: Mountain Hemlock *Windward* Moist Maritime Variant	NDT1	78	<1%
CWHms1: Coastal Western Hemlock, *Southern* Moist Submaritime Variant	NDT2	26	<1%
TOTAL		**19,892**	100%



Map 3. Biogeoclimatic Zones within the AOI.

Forest Health Issues

The Squamish Forest District (DSQ) Forest Health Strategy[32] ranks the priority pests in the DSQ based on the range and degree of impacts on the forest resource, and the incidence and permanency within these ecosystems. The pests identified as being very high priority for mature forests are laminated root rot, armillaria root rot, mountain pine beetle (MPB), western spruce budworm, and white pine blister rust. The severity of attack by MPB and western spruce budworm within the AOI are considered very low. Both laminated and armillaria root rot can result in high levels of windthrow due to the destabilization of infected trees' root systems. Furthermore, white pine blister rust has resulted in widespread mortality of 5-needle pines (western white and whitebark pine). These three forest health factors have implications for the level of surface fuel accumulation in affected stands, as well as access and working conditions for fire fighters in the event of wildfire. Forest health agents identified as high priority within the AOI are Douglas-fir beetle, spruce beetle, annosus root rot, and hemlock dwarf mistletoe.

The Coast Forest Health Strategy outlines forest health issues present within the Soo TSA.[33] This strategy outlines seven forest health issues that are most prevalent within this timber supply area: balsam woolly adelgid, Douglas-fir beetle, mountain pine beetle, root diseases (primarily laminated root disease and armillaria spp.), spruce beetle, western balsam bark beetle, and western spruce budworm. Spatial data available through iMapBC is minimal and provided only minor coverages for Douglas-fir beetle and mountain pine beetle.[34]

Human Development and Natural Events

Most land cover change in the AOI can be described as residential and commercial development. This process entails land clearing and road building. Forest harvesting is also common on Provincial Crown land within the AOI.

Generally speaking, the overall implication of human development is an increase in human ignition potential with a decrease in hazardous fuels cover as land clearing for human development in the DOS appears to increase non-fuel, O1a/b and D-1/2 fuel types. To a lesser extent, those areas located right at the juxtaposition of the interface of wildland and the urban environment are at higher risk due to the presence of more hazardous conifer forest fuel types. At these locations, both the urban environment and the surrounding forests area at risk should a fire originate from either within or outside developed areas.

4.1.2 Fire Weather Rating

The Canadian Forestry Service developed the Canadian Forest Fire Danger Rating System (CFFDRS) to assess fire danger and potential fire behaviour. Fire Danger Classes provide a relative index of the ease of ignition and the difficulty of suppression. A network of fire weather stations is maintained during the fire season by MFLNRORD and the recorded data are used to determine fire danger, represented by Fire

[32] Squamish Forest District Forest Health Strategy. 2010.

[33] 2015-17 Coastal Timber Supply Areas Forest Health Overview. 2015.

[34] iMapBC. 2018.

Danger Classes, on forestlands within a community. The information can be obtained from BCWS and is most commonly utilized by municipalities and regional districts to monitor fire weather, restrict high risk activities when appropriate, and to determine hazard ratings associated with bans and closures.

The BC *Wildfire Act* [BC 2004] and *Wildfire Regulation* [BC Reg. 38/2005] specifies responsibilities and obligations with respect to fire use, prevention, control and rehabilitation, and restrict high risk activities based on these classes. 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. Ground crews easily contain fires 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.

It is important for the development of appropriate prevention programs that the average exposure to periods of high fire danger is determined. 'High fire danger' is considered as Danger Class ratings of 4 (High) and 5 (Extreme). Danger class days were summarized to provide an indication of the fire weather in the AOI. Considering fire danger varies from year to year, historical weather data can provide information on the number and distribution of days when the AOI is typically subject to high fire danger conditions, which is useful information in assessing fire risk.

Figure 1 displays the average frequency of Fire Danger Class days between the months of April and October. The data summarized comes from the Squamish Airport weather station (years 1998 – 2017). According to Figure 1, the months with the highest average number of 'high' and 'extreme' fire danger class days are June, July and August. August historically has the highest number of these two classes when compared to June and July. Although highest fire danger is within these three months, it should be noted that there are 'high' danger class days which extend into October (Figure 1).

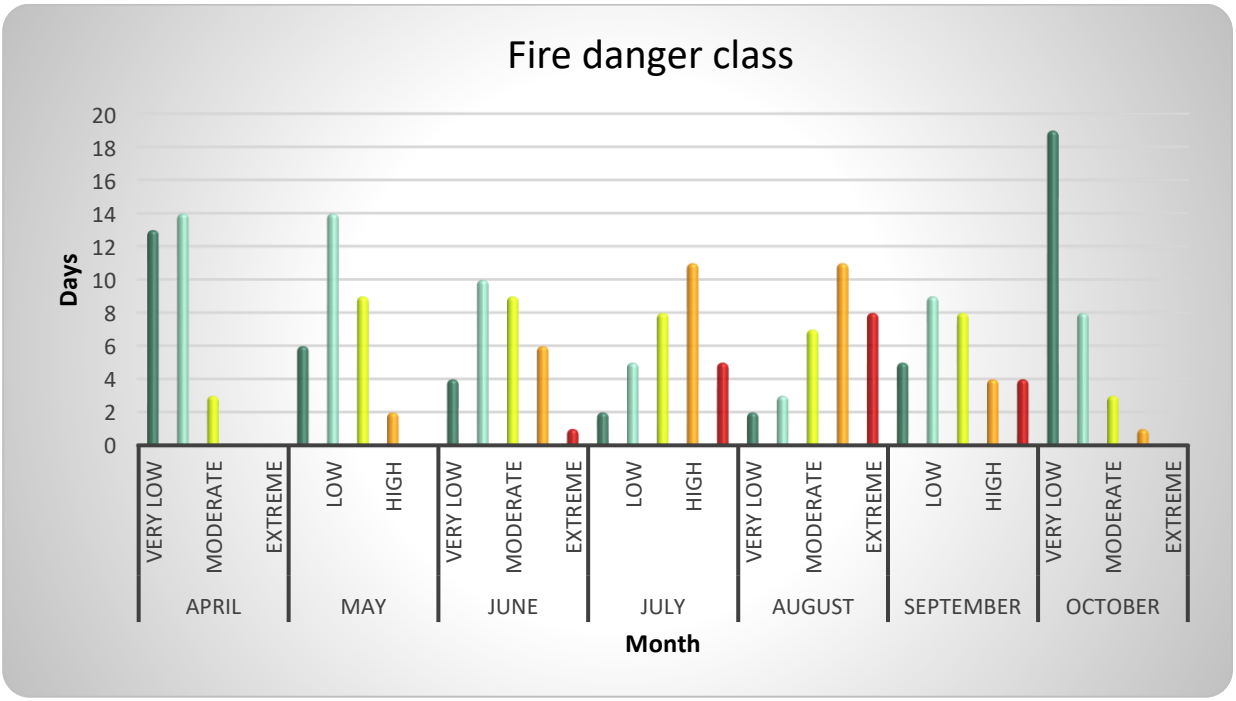


Figure 1. Average number of danger class days for the Squamish Airport weather station. Summary of fire weather data for the years 1998 - 2017.

4.1.3 Climate Change

Climate change is a serious and complex aspect to consider in wildfire management planning. Warming of the climate system is unequivocal, and since the 1950s, each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. The period from 1983 to 2012 was likely the warmest 30-year period of the last 1400 years in the Northern Hemisphere.[35]

Anticipated changes in mean climatic conditions in the South Coast Forest Region (which encompasses the District of Squamish) are linked to overall warming and precipitation trends. Averaged over the coast, over 1°C of warming has occurred during the 20th century and projections suggest the South Coast may continue to warm, on average 1.9 to 5°C. Precipitation trends are more complex, varying across the South Coast Forest Region from year to year. Annual precipitation has increased over the past century. Projected changes in precipitation are relatively modest compared to historical variability, with about 10% decrease in summer and a 10% increase in winter by the end of this century. However, snowfall is projected to decrease considerably in both winter and spring.

An increased frequency of natural disturbance events is expected to occur as a result of climate change with coincident impacts to ecosystems. These include:

- Storm events, especially catastrophic blowdown and damage to trees from snow and ice;

[35] International Panel on Climate Change. (2014) Climate change 2014: Synthesis report, summary for policymakers. 32p.

- Wildfire events and drought;
- Increased winter precipitation may result in slope instability, mass wasting, increased peak flows (loss of forest cover from fire or other disturbance may increase the chance of mass wasting);
- Insects and disease outbreaks of spruce beetle, Swiss needle cast, and western hemlock looper. [36]

Although there are uncertainties regarding the extent of the impacts of climate change on wildfire, it is clear that the frequency, intensity, severity, duration and timing of wildfire and other natural disturbances is expected to be altered significantly with the changing climate.[37] Despite the uncertainties, trends are apparent.

Other research regarding the intricacies of climate change and potential impacts on wildfire threats to Canadian forests has found that:

- Fuel moisture is highly sensitive to temperature change and projected precipitation increases will be insufficient to counteract the impacts of the projected increase in temperature. Results conclude that future conditions will include drier fuels and a higher frequency of extreme fire weather days.[38]

- The future daily fire severity rating (a seasonally cumulative value) is expected to have higher peak levels and head fire intensity is expected to increase significantly in Western Canada. A bi-modal (spring-late summer) pattern of peak values may evolve to replace the historical late summer peak which is the current norm.[39]

- The length of fire seasons is expected to increase and the increase will be most pronounced in the northern hemisphere, specifically at higher latitude northern regions. Fire season severity seems to be sensitive to increasing global temperatures; larger and more intense fires are expected and fire management will become more challenging.[40, 41]

[36] MFLNRO, BC Provincial Government extension note '*Adapting natural resource management to climate change in the West and South Coast Regions*' can be found at https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nrs-climate-change/regional-extension-notes/coasten160222.pdf , February 22, 2016.

[37] Dale, V., L. Joyce. S. McNulty, R. Neilson, M. Ayres, M. Flannigan, P. Hanson, L. Irland, A. Lugo. C. Peterson, D. Simberloff, F. Swanson, B. Stocks, B. Wotton. *Climate Change and Forest Disturbances*. BioScience 2001 51 (9), 723-734.

[38] Flannigan, M.D., B.M. Wotton, G.A. Marshall, W.J. deGroot, J. Johnston, N. Jurko, A.S. Cantin. 2016. *Fuel moisture sensitivity to temperature and precipitation: climate change implications*. Climatic Change (2016) 134: 59 -71. Accessed online at https://link.springer.com/content/pdf/10.1007%2Fs10584-015-1521-0.pdf.

[39] deGroot, W. J., M. D. Flannigan, A.S. Cantin. 2013. *Climate change impacts on future boreal fire regimes*. Forest Ecology and Management. 294: 35 -44.

[40] Flannigan, M.D., A.S. Cantin, W.J. de Groot, M. Wotton, A. Newbery, L.M. Gowman. 2013. *Global wildland fire season severity in the 21st century*. Forest Ecology and Management (2013) 294: 54 - 61.

[41] Jandt, R. 2013. Alaska Fire Science Consortium Research Brief 2013-3.

- More extreme precipitation events (increased intensity and magnitude of extreme rainfall) are expected, along with longer dry periods between major events (increased summer drought periods).[42,43] During large volume, extreme precipitation events in which much of the precipitation is expected to fall, there is higher likelihood of less infiltration of surface water into soils and therefore more runoff and drier soils.[44]

- Future climatic conditions may be more suitable for, or give competitive advantage to, new species of plants, including invasive species.[45]

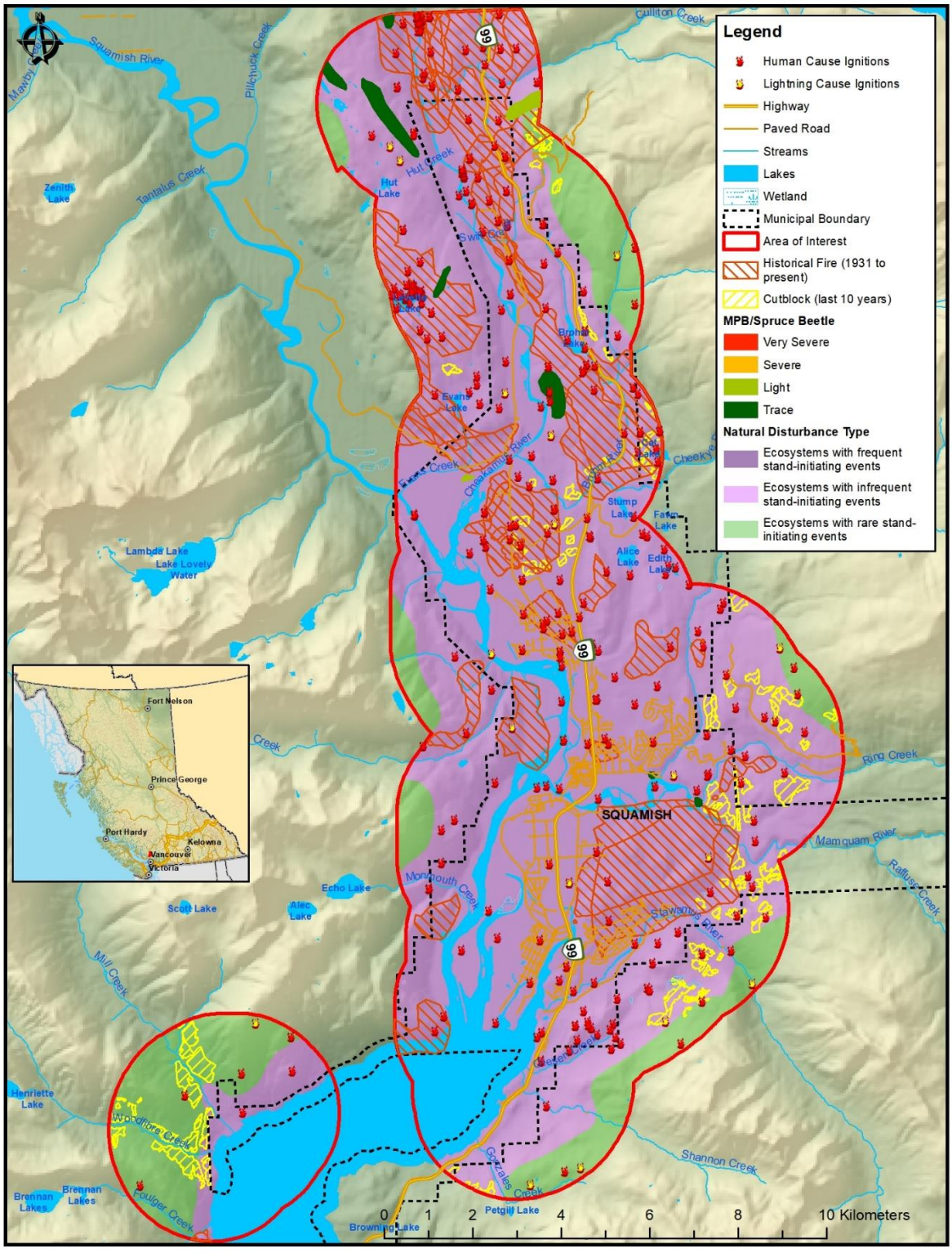
In summary, climate scientists expect that the warming global climate will trend towards wildfires that are increasingly larger, more intense and difficult to control. Furthermore, it is likely that these fires will be more threatening to WUI communities due to increased potential fire behaviour, fire season length, and fire severity.

[42] Picketts, I., A. Werner, and T. Murdock for Pacific Climate Impacts Consortium. 2009. Climate Change in Prince George Summary of Past Trends and Future Projections.

[43] British Columbia Agriculture & Food Climate Action Initiative. 2008.. Peace Region BC Agriculture and Climate Change Regional Adaptation Strategy Series.

[44] British Columbia Agriculture & Food Climate Action Initiative. 2008.. Peace Region BC Agriculture and Climate Change Regional Adaptation Strategy Series.

[45] Picketts, I., A. Werner, and T. Murdock for Pacific Climate Impacts Consortium. 2009. Climate Change in Prince George Summary of Past Trends and Future Projections.



Map 4. Fire Regime, Ecology and Climate Change.

4.2 PROVINCIAL STRATEGIC THREAT ANALYSIS

The Provincial Strategic Threat Analysis (PSTA) evaluates multiple data sets to provide a coarse (high-level) spatial representation of wildfire threats across BC. The information in this section is a synthesis of the BCWS' Provincial Strategic Threat Analysis 2017 Wildfire Threat Analysis Component.[46] Three inputs are combined to create the PSTA Wildfire Threat Analysis (WTA) Component:

1) **Historic fire density**: represents the ignition and fire spread potential based upon historic patterns and fire density weighted by fire size (larger fire perimeters were given a higher weight in order to reflect the greater cost and damage usually associated with larger fires). (see Map 5 below).
2) **Head fire intensity (HFI)**: represents the intensity (kW/m) of the fire front, a measure of the energy output of the flaming front. HFI is directly related to flame length, fire spread rate and fuel consumption and a fire's leading edge. There is a strong correlation between HFI, suppression effort required and danger posed to suppression personnel. The HFI used in the WTA was developed using the 90th percentile fire weather index value.
3) **Spotting impact**: represents the ability of embers or firebrands from a burning fire to be sent aloft and start new fires in advance of the firefront, or outside of the fire perimeter. Spotting is most associated with high intensity crown fires in coniferous fuels and structure losses. For the WTA, the spotting analysis is based on estimating the threat to a given point on the landscape from the fuels surrounding it, up to a distance of 2 km. Spotting distances greater than 2 km are rare and unpredictable.

The final wildfire threat analysis value was developed through an average weighting process of the aforementioned three layers: fire density 30%; HFI 60%; and spotting impact 10%. Water bodies were automatically given a value of 'no threat' (-1). The values were then separated into 10 classes (1 – 10) which represent increasing levels of overall fire threat (the higher the number, the greater the fire threat); threat class 7 is considered the threshold. Threat classes of 7 and higher represent locations where the threat is severe enough to potentially cause catastrophic losses in any given fire season, when overlapping with values at risk. Classes were grouped into the following general threat class descriptions: low (1 – 3); moderate (4 – 6); high (7 – 8); and, extreme (9 – 10).

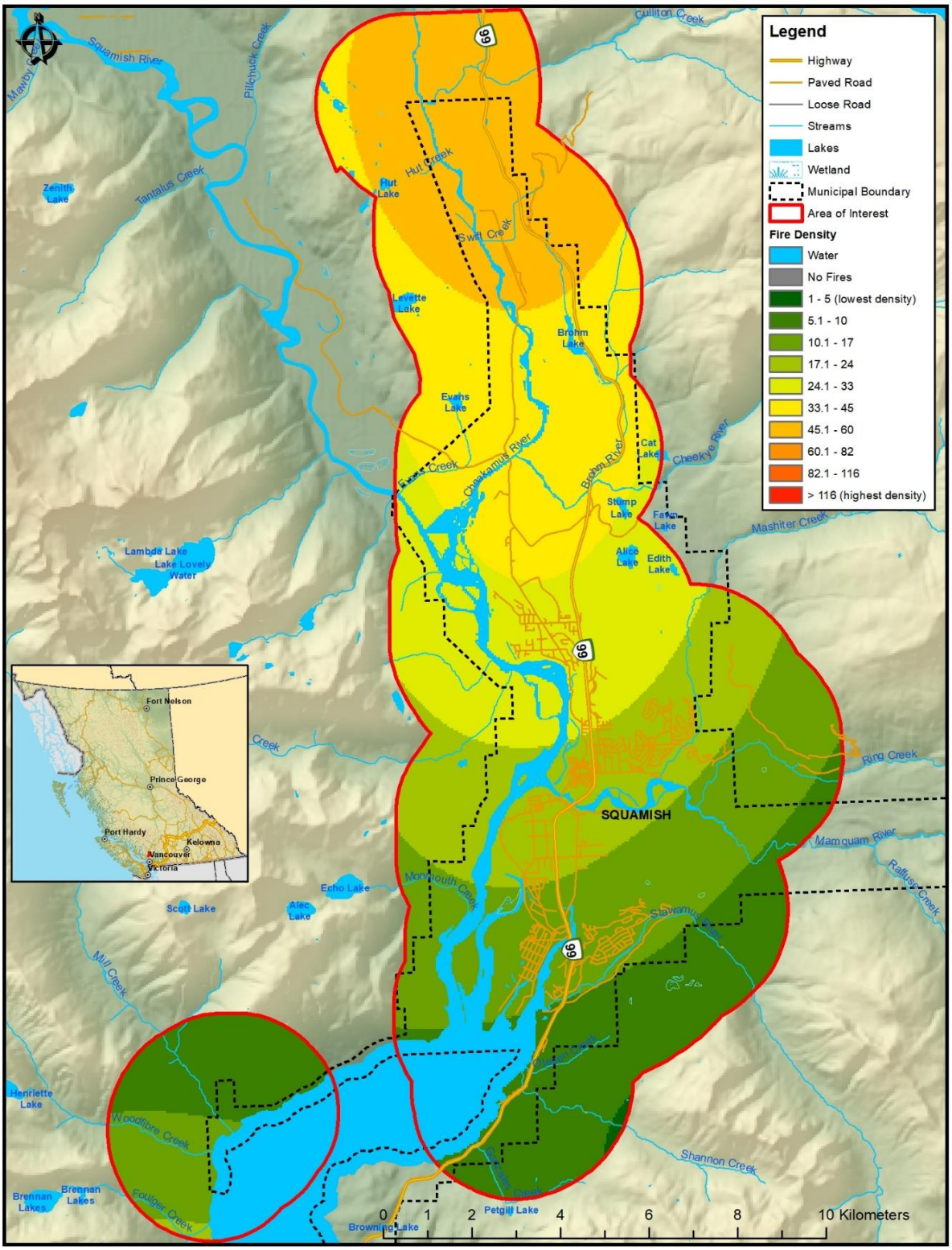
There are considerable limitations associated with the WTA Component based upon the accuracy of the source data and the modeling tools, the most notable being:

- Limited accuracy and variability of the fire history point data;
- Sensitivity to fuel type and the associated limitations of using fuel type approximations for fire behaviour modelling; and,

[46] BC Wildfire Service. 2015. *Provincial Strategic Threat Analysis 2015 Wildfire Threat Analysis Component*. Retrieved from: https://www.for.gov.bc.ca/ftp/!Project/WildfireNews/PSTA/Provincial_Strategic_Threat_Analysis_PSTA_2015_REPORT.pdf. Accessed January 9, 2018.

- 90th percentile rating for HFI, which represents a near worst-case scenario and may be artificial in some circumstances.

The WTA serves to provide a provincial-level threat assessment for resource and land managers and local governments in order to complete landscape fire management planning and strategically plan efficient and effective wildfire risk reduction initiatives (e.g. placement or prioritization of fuel treatment areas, identification of values at risk, FireSmart planning, etc.). The WTA is then validated at the stand level in order to produce a finer, more accurate assessment of local threat.



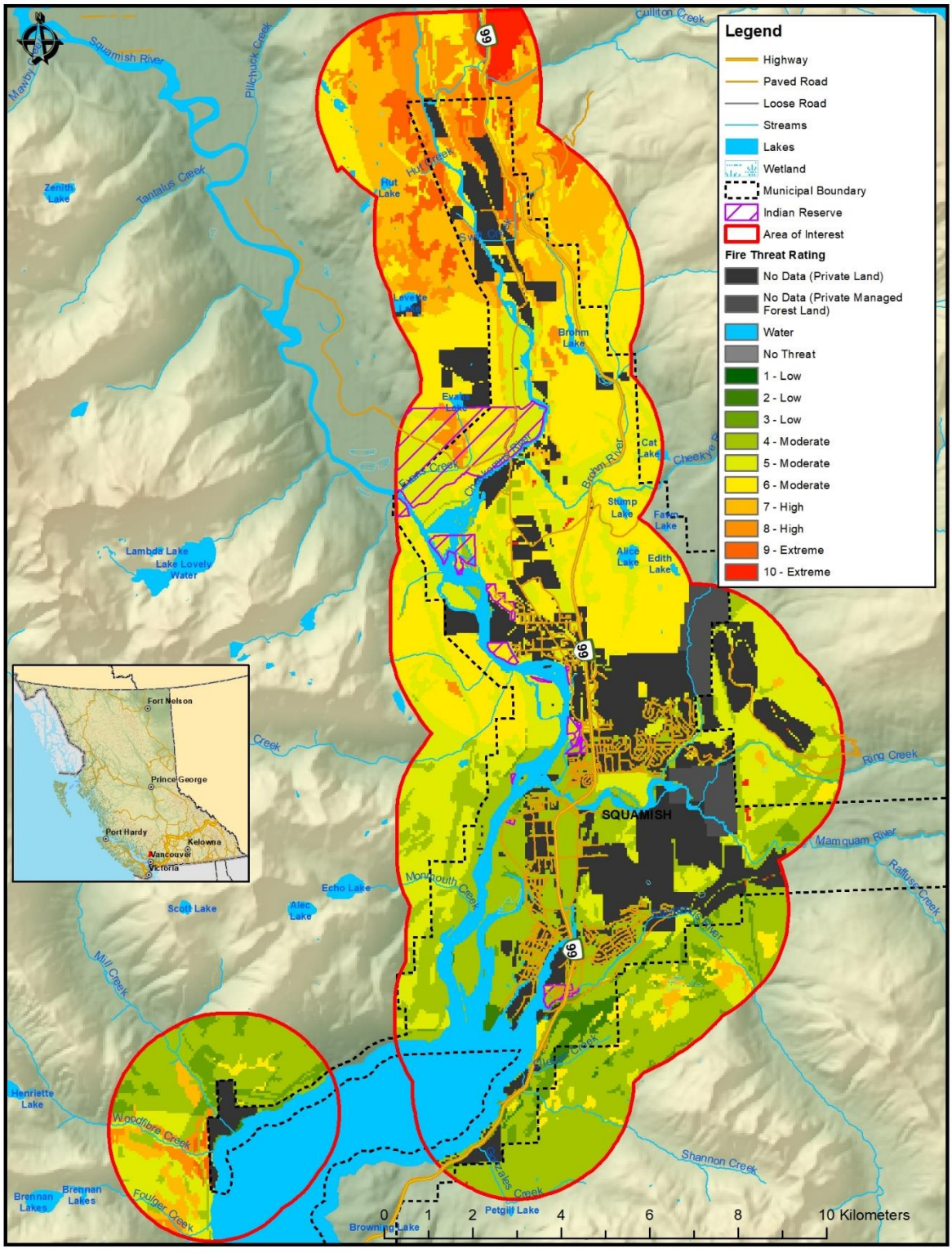
Map 5. Historical Fire Density.

4.2.1 PSTA Final Wildfire Threat Rating

71% of the AOI is categorized as having a moderate, high, or extreme wildfire threat rating in the provincial Wildfire Threat Analysis (Table 8). Low threat areas cover 3% of the AOI, water covers 10%, and private land and private managed forest land together cover 16%. High and extreme threat ratings cover 14% of the study area, with the most notable high-threat area being concentrated north of Brohm Lake to the northern limit of the AOI; these high and extreme areas also envelope private land and privately managed forest land (Map 6). High and extreme fire threat also is identified by the PSTA in the area to the southwest of Mill Creek.

Table 8. Overall PSTA Wildfire Threat Analysis for the AOI (rounded to the nearest hectare).

Threat Class	Area (ha)	Threat Class Description	Percent of AOI
-3	2,852	No Data (Private Land)	14%
-2	343	No Data (Private Managed Forest Land)	2%
-1	1,927	Water	10%
0	0	No Threat	0%
1	0	Low	3%
2	152		
3	424		
4	4,276	Moderate	57%
5	3,629		
6	3,483		
7	1,506	High	11%
8	702		
9	459	Extreme	3%
10	139		
Total	**19,892**	**-**	**100%**



Map 6. Provincial Strategic Threat Rating.

4.2.2 Spotting Impact

Spotting impact is modeled by fuel type and distance class from a given fuel type. The layer estimates the threat of embers impacting a given point on the landscape from the fuel types surrounding it.

It has been found that, during extreme wildfire events, most home destruction has been a result of low-intensity surface fire flame exposures, usually ignited by embers in advance of the fire front. Firebrands can be transported long distances ahead of the wildfire, across fire guards and fuel breaks, and accumulate in densities that can exceed 600 embers per square meter. Combustible materials found adjacent or near to values at risk can provide fire pathways allowing spot surface fires ignited by embers to spread and carry flames or smoldering fire into contact with structures.

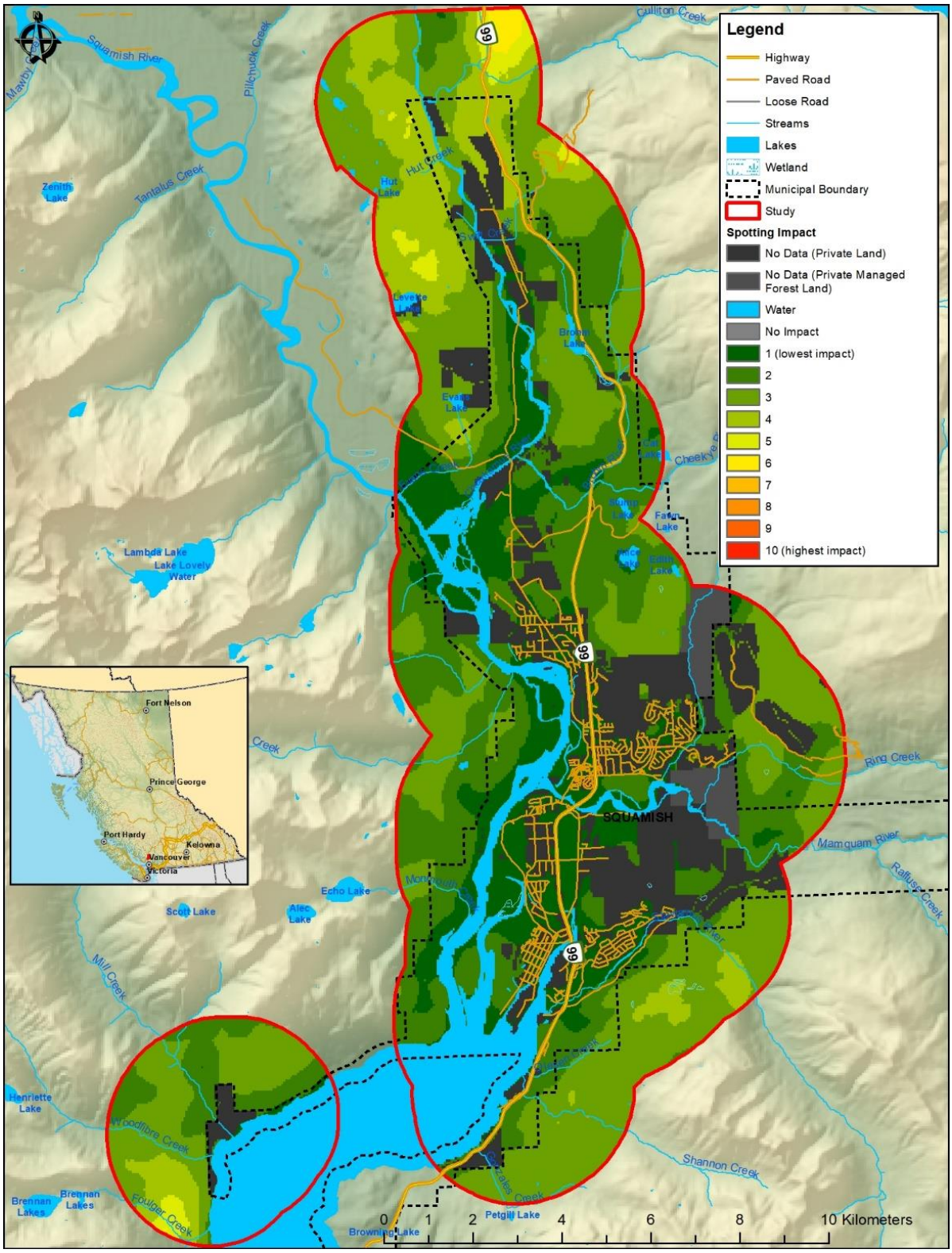
For example, an investigation of home destruction from the 2016 Fort McMurray, Alberta fire found that the vast majority of home ignitions in the interface (outer edges of urban neighbourhoods) were attributable to embers alighting on combustible material (home or adjacent areas).[47] Similarly, reports from the 2010 Fourmile Canyon fire outside Boulder, Colorado, found that only 17% of the 162 homes destroyed were attributed to crown fire.[48,49] Instead of high intensity flames or radiant heat, 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.[49] Post-fire studies have shown that it is uncommon for homes to be partially damaged by wildfire; survivability is based upon whether or not the structure, or area adjacent to the structure, ignites.

The AOI appears to generally be low in terms of spotting impact with small isolated areas of moderate potential impact (Map 7).

[47] Westhaver, A. 2017. *Why some homes survived. Learning from the Fort MacMurray wildland/urban interface fire disaster*. A report published by the Institute for Catastrophic Loss Reduction – ICLR research paper series – number 56. https://www.iclr.org/images/Westhaver_Fort_McMurray_Final_2017.pdf

[48] Calkin, D., J. Cohen, M. Finney, M. Thompson. 2014. *How risk management can prevent future wildfire disasters in the wildland-urban interface*. 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/.

[49] Graham, R., M. Finney, C. McHugh, J. Cohen. D. Calkin, R. Stratton, L. Bradshaw, N. 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.



Map 7. Spotting Impact within the AOI/Study Area.

4.2.3 Head Fire Intensity

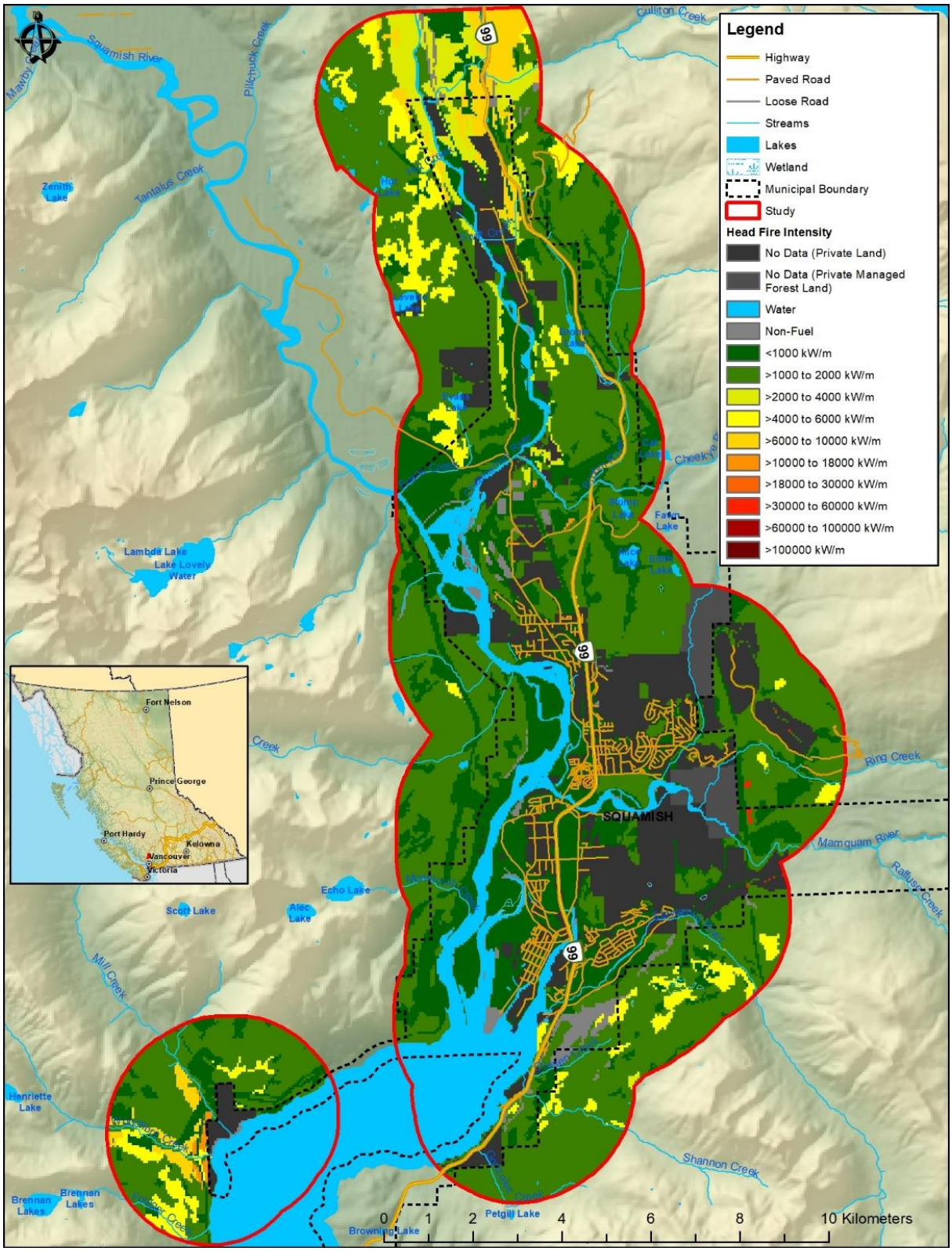
HFI is correlated with flame length and fire behaviour. The greater the fire intensity (kW/m), or HFI and fire intensity class, the more extreme the fire behaviour, and the more difficult suppression efforts will likely be (Table 9 and Map 8).

In the AOI, generally speaking, the highest fire intensity class is 5, which represents a vigorous surface fire with intermittent crowning (Table 9). Class 5 is quite uncommon in the AOI while classes 2 and 1 dominate throughout (Map 8). Classes 2 and 1 are described as moderate vigour surface fire and smouldering surface fire, respectively.

Table 9. Head Fire Intensity Classes and Associated Fire Behaviour.

PSTA - HFI Class	Fire Intensity kW/m	Fire Intensity Class[50]	Flame Length (meters)[51]	Likely Fire Behaviour[52]
1	0.01 – 1,000	2	< 1.8	Smouldering surface fire
2	1,000.01 – 2,000	3	1.8 to 2.5	Moderate vigour surface fire
3	2,000.01 – 4.000	4	2.5-3.5	Vigorous surface fire
4	4,000.01 – 6,000	5	3.5 to 4.2	Vigorous surface fire with occasional torching
5	6,000.01 – 10,000	5	4.2 to 5.3	Vigorous surface fire with intermittent crowning
6	10,000.01 – 18,000	6	12.3 to 18.2	Highly vigorous surface fire with torching and/or continuous crown fire
7	18,000.01 – 30,000	6	18.2 to 25.6	Extremely vigorous surface fire and continuous crown fire
8	30,000.01 – 60,000	6	>25.6[53]	Extremely vigorous surface fire and continuous crown fire, and aggressive fire behaviour
9	60,000.01 – 100,000	6	>25.6	Blowup or conflagration, extreme and aggressive fire behaviour
10	≥ 100,000	6	>25.6	Blowup or conflagration, extreme and aggressive fire behaviour

[50] Head fire intensity should be classified by intensity class not fire rank. Fire rank is a visual description of conifer fires for air operations.
[51] For calculating Flame Length, Bryam (1959) was used for surface fire (<10 000 kW/m) and Thomas (1963) was used for crown fire situations (>10 000 kW/m).
[52] These characteristics will be different in open and closed forest fuel.
[53] With HFI over 30 000 kW/m the function of the equation are stretched beyond the expectation of the equation, fire is under the influence too many other factors.



Map 8. Head Fire Intensity within the AOI.

4.2.4 Fire History

Fire ignition and perimeter data are depicted in Map 4. It was reported from BCWS (Justin Penney, personal communication, April 2018) that within the last 15 years there have been approximately 30 ha burned by wildfire within the AOI.

Historically, wildfires have burned within the AOI. The top ten fires burning the greatest number of hectares occurred in the 44 year-period between 1919 and 1963, with the largest covering 2,150 ha and the smallest of the ten covering 380 ha (mean of 799 ha). More than half (52%) of these wildfire events occurred in the two decades between 1919 and 1939.

Although the wildfire data for these areas is limited, it is well known that the majority of these wildfire events usually occurred in slash fuels after harvest (Frank DeGagne, personal communication, June 2018). Of these, the majority were defined as human-caused (approximately 74%). Other causes included railroad, equipment, and miscellaneous causes.

The 2015 Boulder Creek Complex wildfire (which occurred to the north of the AOI) burned over 15,000 ha and caused the evacuation of the Innergex IPP facility as well as heavy smoke to the SLRD area and Metro Vancouver. A 2017 small (<5 ha) wildfire occurred near Mamquam FSR and within a few hundred meters of residences; which however, was suppressed within a few days.

On May 21, 2016 a wildfire within the Rockridge community interface exhibited Rank 3 fire behavior. In 2017, six fire ignitions within the AOI were responded to and extinguished by the BCWS. Five of these fires were abandoned campfires, and one was ignited by barbeque briquettes. In 2017 a small also human-caused wildfire (<5 ha) ignited off the Mamquam FSR in a forest cutblock close to the Skookum clean energy project. It began outside of the AOI boundary to the east, near Mamquam Forest Service Road and occurred in August which is historically the hottest and driest time of the year[54].

4.3 LOCAL WILDFIRE THREAT ASSESSMENT

WUI Threat Assessments were completed over four field days in February of 2018, in conjunction with verification of fuel types. WUI Threat Assessments were completed in interface (*i.e*. abrupt change from forest to urban development) and intermix (*i.e*. where forest and structures are intermingled) areas of the AOI to support development of priority treatment areas, and in order to confidently ascribe threat to polygons which may not have been visited or plotted, but which have similar fuel, topographic, and proximity to structure characteristics to those that were.

Field assessment locations were prioritized based upon:

- PSTA WTA class - Field assessments were clustered in those areas with WTA classes of 6 or higher.

[54] https://en.climate-data.org/location/965/

- Proximity to values at risk – Field assessments were clustered in the intermix and interface, as well as around critical infrastructure.
- Prevailing fire season winds – More field time was spent assessing areas upwind (south, southeast) of values at risk.
- Slope position of value – More field time was spent assessing areas downslope of values at risk. Similarly, values at top of slope or upper third of the slope were identified as particularly vulnerable.
- Land ownership – Crown and municipal land was the main focus of field assessments.
- Previous mitigation efforts – Those areas which had previously had fuel reduction or modification were field assessed.
- Local knowledge – Areas identified as hazardous, potentially hazardous, with limited access / egress, or otherwise of particular concern as vulnerable to wildfire, as communicated by fire officials and BCWS zone staff.
- Observations – Additional areas potentially not recognized prior to field work were visually identified as hazardous and were subsequently field assessed.

A total of 20 WUI threat plots were completed and over 136 other field stops (e.g., qualitative notes, fuel type verification, and/or photograph documentation) were made across the AOI (see Appendix D for a summary of WUI threat plots and locations).

4.3.1 Fuel Type Verification

The Canadian Forest Fire Behaviour Prediction (FBP) System outlines five major fuel groups and sixteen fuel types based on characteristic fire behaviour under defined conditions.[55] Fuel typing is 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 used within BC, with continual improvement and refinement, for 20 years.[56] It should be noted that there are significant limitations with the fuel typing system which should be recognized. Major limitations include: a fuel typing system designed to describe fuels which do not occur within the study area, fuel types which cannot accurately capture the natural variability within a polygon, and limitations in the data used to create initial fuel types.[56]. Details regarding fuel typing methodology and limitations are found in Appendix E. There are several implications of the aforementioned limitations, which include: fuel typing further from the developed areas of the study has a lower confidence, generally; and, fuel typing should be used as a starting point for more detailed assessments and as an indicator of overall wildfire threat, not as an operational, or site-level, assessment.

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

[56] 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.

Table 10 summarizes the fuel types by general fire behaviour (crown fire and spotting potential). In general, the fuel types considered hazardous in terms of fire behaviour and spotting potential are C-2 and C-4. C-3 and C-7 can sometimes represent hazardous fuels, particularly if there are large amounts of woody fuel accumulations or denser understory ingrowth. C-5 fuel types have a moderate potential for active crown fire when wind-driven.[56] An M-1/2 fuel type can sometimes be considered hazardous, depending on the proportion of conifers within the forest stand; conifer fuels include those in the overstory, as well as those in the understory. An O-1b fuel type often can support a rapidly spreading grass or surface fire capable of damage or destruction of property, and jeopardizing human life, although it is recognized as a highly variable fuel type dependent upon level of curing.[57] These fuel types were used to guide the threat assessment.

Table 10. Fuel Type Categories and Crown Fire Spot Potential.

Fuel Type	FBP / CFDDRS Description	AOI Description	Wildfire Behaviour Under High Wildfire Danger Level	Fuel Type – Crown Fire / Spotting Potential
C-1	Spruce-lichen woodland	Very open black spruce with *cladonia* lichen as a defining component of the fuel type structure.	Low to very high fire intensity and rate of spread.	High
C-2	Boreal spruce	As identified by PSTA data. Pure spruce stands.	Almost always crown fire, high to very high fire intensity and rate of spread	High
C-3	Mature jack or lodgepole pine	Fully stocked, late young forest, crowns separated from the ground	Surface and crown fire, low to very high fire intensity and rate of spread	High*
C-4	Immature jack or lodgepole pine	Dense/ overstocked pole-sapling forest and young plantations (>8000 stems per hectare and 4- 12 m in height), 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	High
C-5	Red and white pine	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 woody fuels	Low

[57] Ibid.

Fuel Type	FBP / CFDDRS Description	AOI Description	Wildfire Behaviour Under High Wildfire Danger Level	Fuel Type – Crown Fire / Spotting Potential
C-7	Ponderosa pine and Douglas-fir	Open, uneven-aged forest, crowns separated from the ground except in conifer thickets, understory of discontinuous grasses, herbs. Areas harvested 25+ years ago (and not achieving M-1/2 or C-3 fuel type characteristics), open stand type (>40% crown closure).	Surface fire spread, torching of individual trees, rarely crowning (usually limited to slopes > 30%), moderate to high intensity and rate of spread	Low
O-1a/b	Grass	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. Hay fields. Areas harvested 7 – 24 years ago (dense or open and >4 m in height).	Rapidly spreading, high- intensity surface fire when cured	Low
M-1/2	Boreal mixedwood (leafless and green)	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)	<26% conifer (Very Low); 26-49% Conifer (Low); >50% Conifer (Moderate)
D-1/2	Aspen (leafless and green)	Deciduous stands	Always a surface fire, low to moderate rate of spread and fire intensity	Low
S-1/2/3	Slash (jack / lodgepole pine, white spruce / balsam, and coastal cedar / hemlock/ Douglas-fir, respectively)	Jack or lodgepole pine slash, white pine/ balsam slash, coastal cedar/ hemlock/ Douglas-fir slash	Moderate to high rate of spread and high to very high intensity surface fire	Low
W	N/A	Water	N/A	N/A

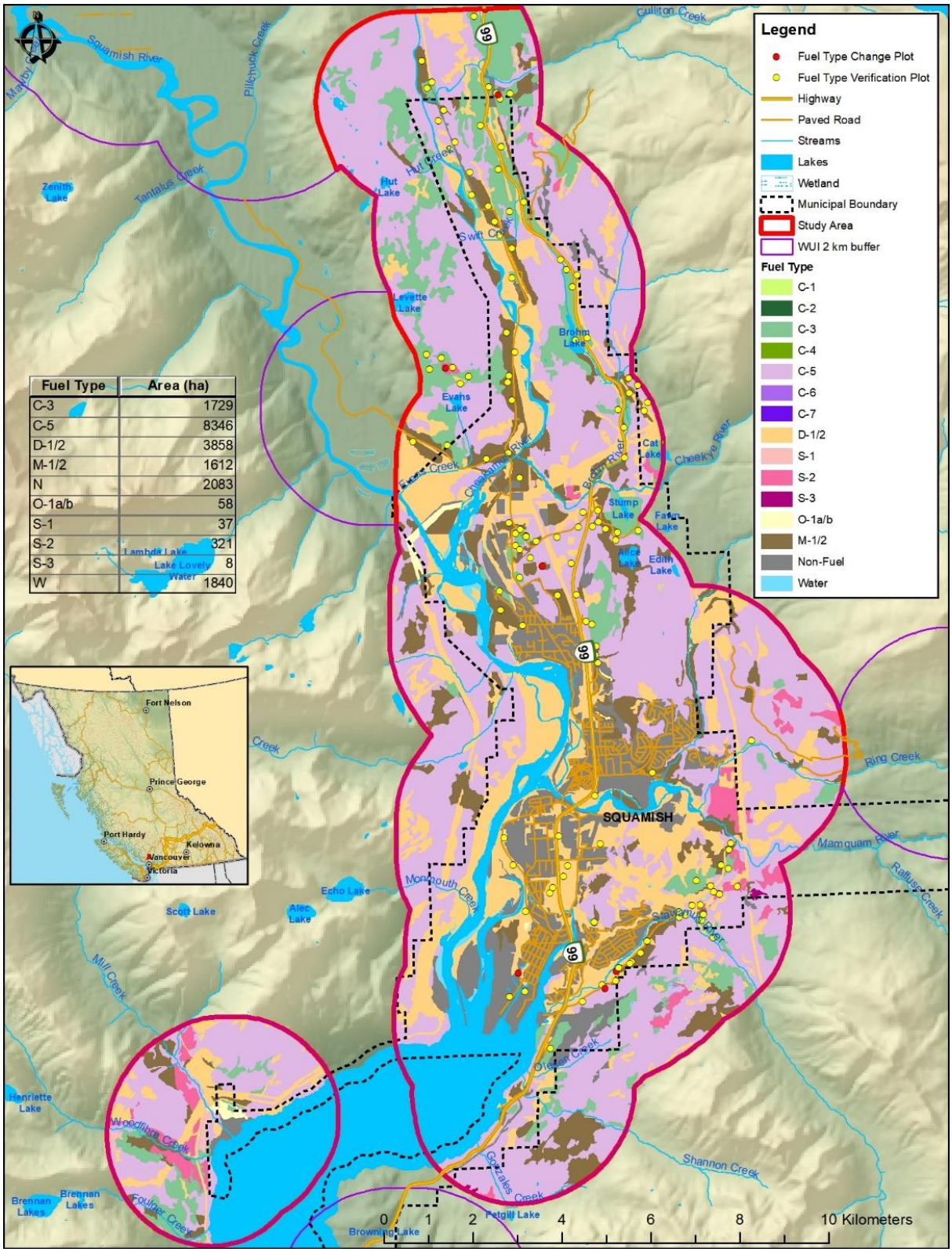
Fuel Type	FBP / CFDDRS Description	AOI Description	Wildfire Behaviour Under High Wildfire Danger Level	Fuel Type – Crown Fire / Spotting Potential
N	N/A	Non-fuel: irrigated agricultural fields, golf courses, alpine areas void or nearly void of vegetation, urban or developed areas void or nearly void of forested vegetation.	N/A	N/A

**C-3 fuel type is considered to have a high crown fire and spotting potential within the AOI due to the presence of moderate to high fuel loading (dead standing and partially or fully down woody material), and continuous conifer ladder fuels.*

During field visits, five recurring patterns of fuel type errors were found in the provincial dataset. They were:

- C-3 fuel types being incorrectly identified by the PSTA as C-5,
- S-2 fuel types identified as C-5,
- M-1/2 fuel types identified D-1/2,
- C-3 fuel types identified M-1/2, and
- N fuel types identified as O-1a/b.

All fuel type updates were approved by BCWS, using stand and fuel descriptions and photo documentation for the review process (see Appendix A for submitted fuel type change rationales).



Map 9. Updated Fuel Type.

4.3.2 Proximity of Fuel to the Community

Fire hazard classification in the WUI is partly dictated by the proximity of the fuel to developed areas within a community. More specifically, fuels closest to the community are considered to pose a higher hazard in comparison to fuels that are located at greater distances from values at risk. As a result, it is recommended that the implementation of fuel treatments prioritizes fuels closest to structures and / or developed areas, in order to reduce hazard level adjacent to the community. Continuity of fuel treatment is an important consideration, which can be ensured by reducing fuels from the edge of the community outward. Special consideration must be allocated to treatment locations to ensure continuity, as discontinuous fuel treatments in the WUI can allow wildfire to intensify, resulting in a heightened risk to values. In order to classify fuel threat levels and prioritize fuel treatments, fuels immediately adjacent to the community are rated higher than those located further from developed areas. Table 11 describes the classes associated with proximity of fuels to the interface.

Table 11. Proximity to the Interface.

Proximity to the Interface	Descriptor*	Explanation
WUI 100	(0-100 m)	This Zone is always located adjacent to the value at risk. Treatment would modify the wildfire behaviour near or adjacent to values; often characterized as FireSmart principles and activities.
WUI 500	(101-500m)	Treatment would affect wildfire behaviour approaching a value, as well as the wildfire's ability to impact the value with short- to medium- range spotting; should also provide suppression opportunities near a value.
WUI 2000	(501-2000 m)	Treatment would be effective in limiting long - range spotting but short- range spotting may fall short of the value and cause a new ignition that could affect a value.
	>2 000 m	This should form part of a landscape assessment and is generally not part of the zoning process. Treatment is relatively ineffective for threat mitigation to a value, unless used to form a part of a larger fuel break / treatment.

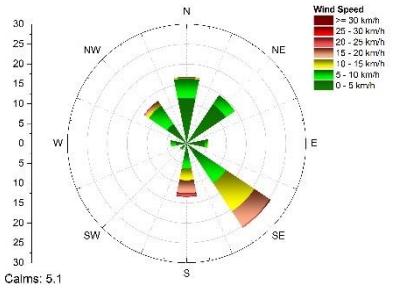
**Distances are based on spotting distances of high and moderate fuel type spotting potential and threshold to break crown fire potential (100m). These distances can be varied with appropriate rationale, to address areas with low or extreme fuel hazards.*

4.3.3 Fire Spread Patterns

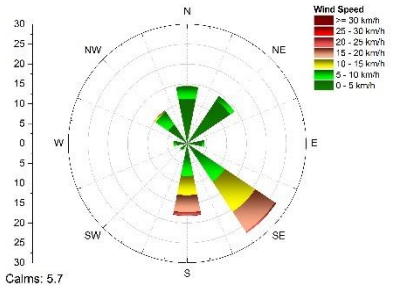
Wind speed, wind direction, and fine fuel moisture condition influence wildfire trajectory and rate of spread. Wind plays a significant role in fire behaviour and direction of fire spread. The wind rose data is compiled hourly and provides an estimate of prevailing wind directions and wind speed in the area of the weather station. It is worth pointing out that erratic and unexpected winds (outside of those prevailing and described below) are known to occur within the AOI. For instance, in 2015, uncharacteristic hot and strong outflow winds from the interior were a key influence to spread and maintain the Boulder and Elaho fires.

During most of the fire season (April – August) predominant winds originate from the southeast and south, with average wind speeds at the highest in June and July (Figure 2). Predominant winds appear

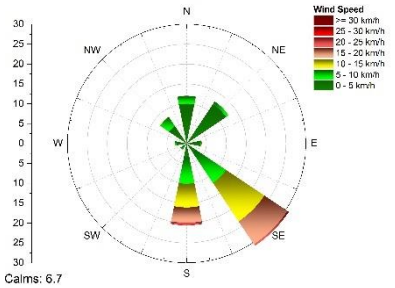
to shift in September and October to the northeast and north; however, the data indicate these are frequent but are not very high speed (Figure 2). An average of hourly wind readings for the fire season shows that winds are predominantly from the southeast and south and gusting upwards of 20 km/hr (Figure 3). Potential treatment areas were identified and prioritized with the predominant wind direction in mind; wildfire that occurs upwind of a value poses a more significant threat to that value than one which occurs downwind.



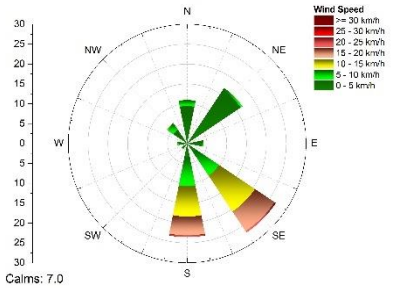
April



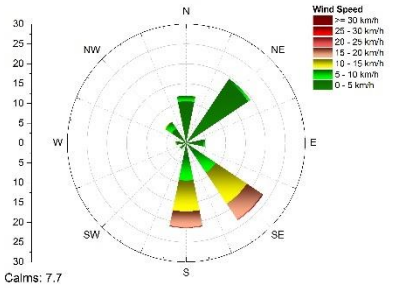
May



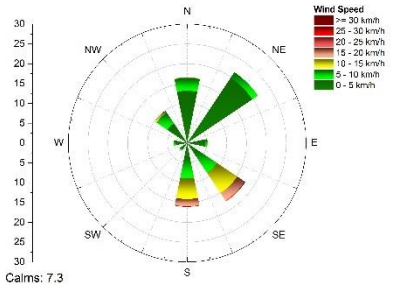
June



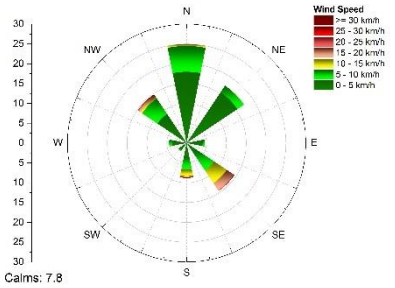
July



August



September



October

Figure 2. Wind roses depicting average hourly wind speed for the fire season April – October.

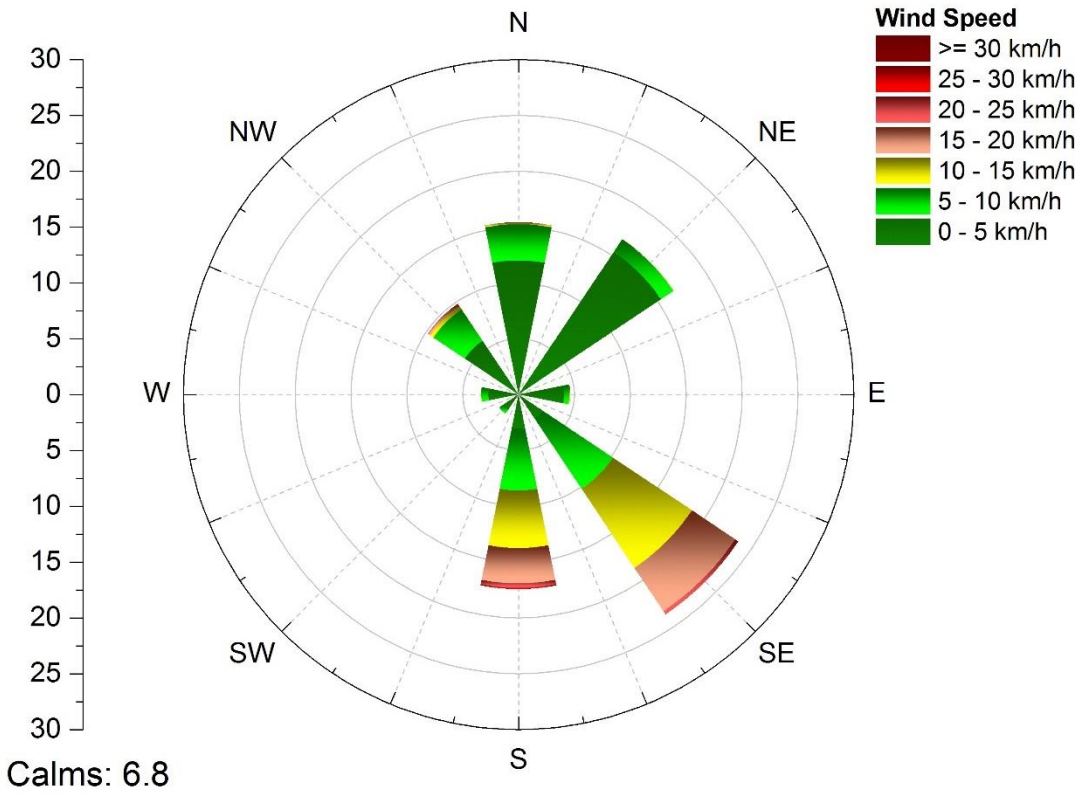


Figure 3. Windrose showing average hourly wind readings during the fire season (April 1 – October 31) 1998 – 2017. Data taken from the Squamish Airport weather station.

4.3.4 Topography

Topography is an important environmental component that influences fire behaviour. Considerations include slope percentage (steepness) and slope position of the value where slope percentage influences the fire's trajectory and rate of spread. Slope position relates to the ability of a fire to gain momentum uphill. Other factors of topography that influence fire behaviour include aspect, elevation and land configuration.

Slope Class and Position

Slope steepness affects solar radiation intensity, fuel moisture (influenced by radiation intensity) and influences flame length and rate of spread of surface fires. Table 12 summarizes the fire behaviour implications for slope percentage (the steeper the slope the faster the spread). In addition, Slope position affects temperature and relative humidity as summarized in Table 13.

Table 12. Slope Percentage and Fire Behaviour Implications.

Slope	Percent of AOI	Fire Behaviour Implications
<20%	44%	Very little flame and fuel interaction caused by slope, normal rate of spread.
21-30%	12%	Flame tilt begins to preheat fuel, increase rate of spread.
31-45%	16%	Flame tilt preheats fuel and begins to bathe flames into fuel, high rate of spread.
46-60%	12%	Flame tilt preheats fuel and bathes flames into fuel, very high rate of spread.
>60%	16%	Flame tilt preheats fuel and bathes flames into fuel well upslope, extreme rate of spread.

Table 13. Slope Position of Value and Fire Behaviour Implications.

Slope Position of Value	Fire Behaviour Implications
Bottom of Slope/ Valley Bottom	Impacted by normal rates of spread.
Mid Slope - Bench	Impacted by increase rates of spread. Position on a bench may reduce the preheating near the value. (Value is offset from the slope).
Mid slope – continuous	Impacted by fast rates of spread. No break in terrain features affected by preheating and flames bathing into the fuel ahead of the fire.
Upper 1/3 of slope	Impacted by extreme rates of spread. At risk to large continuous fire run, preheating and flames bathing into the fuel.

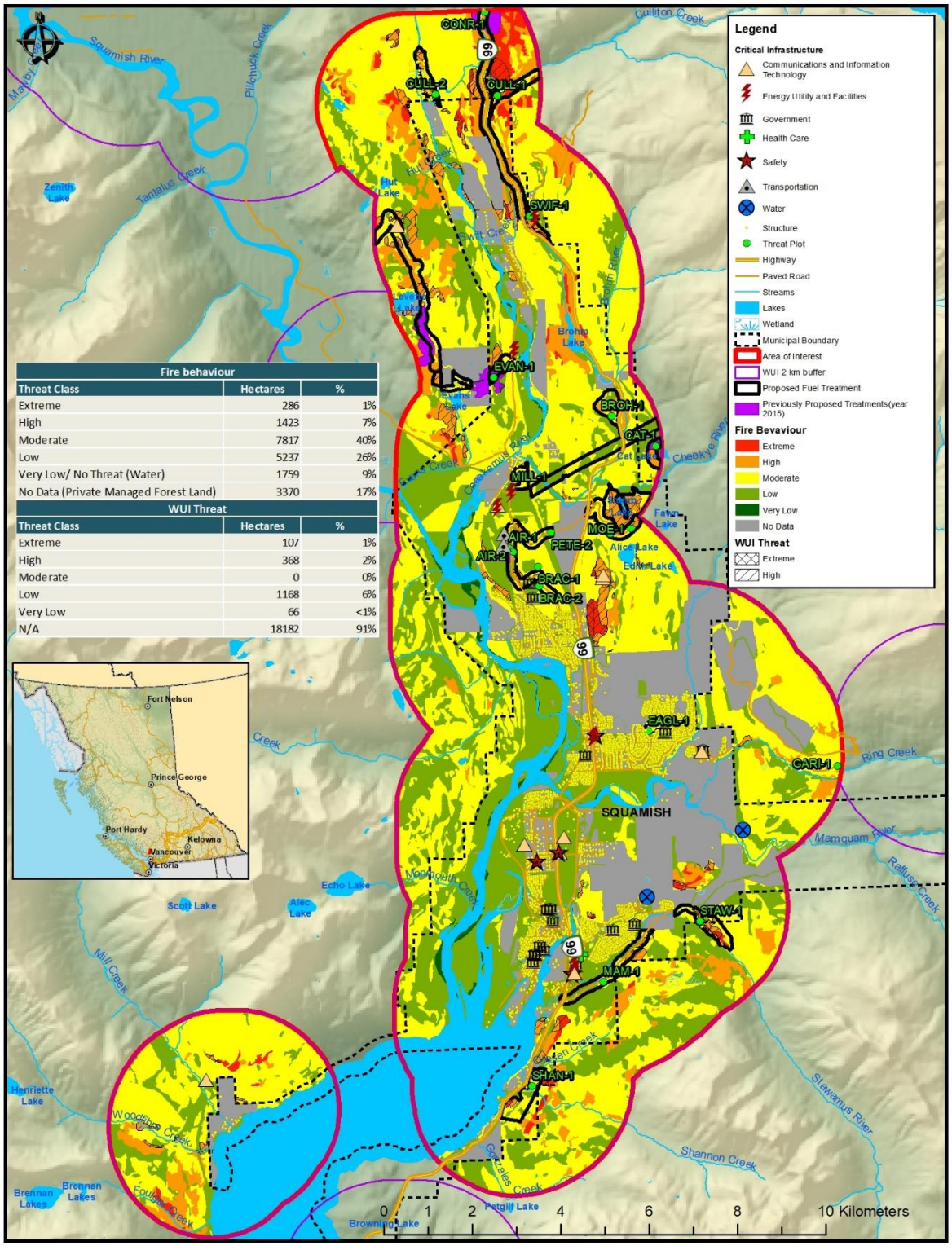
4.3.5 Local Wildfire Threat Classification

Using the verified and updated fuel types combined with field wildfire threat assessments, local wildfire threat for the AOI was updated. Using the 2016 methodology, 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). Full details of the methodology used can be found in Appendix F.

The result of the analysis shows that the AOI is composed of a mosaic of low, moderate and high threat class stands; the variability in wildfire threat is dictated primarily by the level of natural and anthropogenic disturbances that have historically occurred and persist on the landbase. The AOI is roughly 1% extreme threat class rating, 7% high, 40% moderate, and 26% low and 9% very low/water (Table 14). Table 14 also indicates the differences between the original PSTA threat rating and this Update's corrected fire behaviour threat.

Table 14. Fire behaviour threat summary for the study area.

Wildfire Behaviour Threat Class	2015 PSTA Data	2017 CWPP
	Percent of AOI	Percent of AOI
Extreme	3%	1%
High	11%	7%
Moderate	58%	40%
Low	3%	26%
Very Low/ No Threat (Water)	10%	9%
No Data (Private Land and Private Managed Forest Land)	15%	17%



Map 10. Local Fire Behaviour Threat Rating and WUI Threat Rating.

SECTION 5: RISK MANAGEMENT AND MITIGATION FACTORS

This section outlines a wildfire risk management and mitigation strategy that accounts for fuel types present within the community, local ecology, hazard, terrain factors, land ownership, and capacity of Local Government and First Nations. Wildfire risk mitigation is a complex approach that requires cooperation from applicable land managers/owners, which includes all level of governments (local, provincial and federal), First Nations and private landowners. The cooperative effort of the aforementioned parties is crucial in order to develop and proactively implement a wildfire risk mitigation program. Development of a successful wildfire risk mitigation strategy is dependent on hazard identification within the community, which accounts for forest fuels, high risk activities, frequency and type of human use, and other important environmental factors. The resulting wildfire risk management and mitigation strategy aims to build more resilient communities and produces strategic recommendations or actionable items that can be categorized as follows:

1. Fuel management opportunities to reduce fire behaviour potential in the WUI;
2. Applications of FireSmart approaches to reduce fire risk and impacts within the community; and,
3. Implementation of communication and education programs to inform and remind the public of the important role it plays in reducing fire occurrence and impacts within its community.

5.1 FUEL MANAGEMENT

Fuel management, also referred to as vegetation management or fuel treatment, is a key element of wildfire risk reduction. No known fuel treatments have been completed within the AOI to date.

The objectives for fuel management are to:

- Reduce wildfire threat on private and public lands nearest to values at risk; and,
- Reduce fire intensity, rate of spread, and ember/spot fire activity such that the probability of fire containment increases and the impacts on the forested landscape and the watershed are reduced (create more fire resilient landscapes).

Historically, funds from public sources, such as Union of British Columbia Municipalities (UBCM), First Nation Emergency Services Society (FNESS), the Forest Enhancement Society of BC (FESBC), were only eligible to be used on either First Nation federal reserves or Crown lands and could not be used to treat private land. The new Community Resiliency Investment (CRI) Program (formerly SWPI) provides funding for selected FireSmart activities and planning on private land (subject to program requirements and limits)[58]. The best approach to mitigate fuels on private lands is to urge private landowners to comply with FireSmart guidelines (as described below in Section 5.2) and to conduct appropriate fuel modifications using their own resources (CRI program funding may be available).

[58] 2019 CRI FireSmart Community Funding & Supports – Program & Application Guide: https://www.ubcm.ca/assets/Funding~Programs/LGPS/CRI/cri-2019-program-guide.pdf

In general, when considering fuel management to reduce fire risk, the following steps should be followed:

- Carefully anticipate the likely wildfire scenarios to properly locate fuel modification areas;
- Acquire an understanding of local ecological, archaeological, and societal values of the site;
- Prescriptions should be developed by a qualified professional forester working within their field of competence;
- Public consultation should be conducted during the process to ensure community support;
- Potential treatment areas and draft prescriptions should be referred to First Nations with sufficient time for meaningful review and input;
- Treatment implementation should 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.

RECOMMENDATION #25: To account for future timber harvesting within the AOI, include fire management considerations (i.e., modified stocking standards in the wildland urban interface) during harvesting and incorporate into any FSP (Forest Stewardship Plan) updates.

The focus for fuel management in the interface is not necessarily to stop fire but decrease fire behaviour and to ensure that fire intensity is low enough that fire damage is limited. Fuel treatment approaches may include fuel removal, thinning and stand conversion. The latter has been shown to be effective at reducing wildfire potential in mixed-wood or conifer dominated stands and is recommended as a BMP to encourage a higher deciduous component. This approach generally involves a thin-from-below to reduce ladder fuels and crown fuels continuity, targeting the removal of conifer species and the retention of broadleaf species. Stand conversion fuel treatments are intricately linked to the establishment and enactment of fire management stocking standards within the WUI 2km buffer. The implementation of modified stocking standards plays a pivotal role in ensuring the success and effectiveness of stand conversion fuel treatments and associated reduction of fire hazard.[59] Deciduous trees have higher foliar moisture content (>140%)[60] and higher crown base height than coniferous species and are associated with higher moisture fuelbeds.[61] Additionally, deciduous species such as aspen (*Populus tremuloides*) have lower concentrations of resins or essential oil contents than conifer species, which impacts the stand fire hazard by reducing the flammability and potential for sustained

[59]Forest Practices Board. (2006). Managing Forest Fuels. Special Report. Available online at: https://www.bcfpb.ca/wp-content/uploads/2016/04/SR29-Managing-Forest-Fuels.pdf

[60] Johnson, E. A. (1996). *Fire and vegetation dynamics: studies from the North American boreal forest*. Cambridge University Press.

[61] Rothwell, R. L.; Woodard, P. M.; Samran, S. (1991). The effect of soil water on aspen litter moisture content. In: Andrews, Patricia L.; Potts,Donald F., eds. Proceedings, 11th conference on fire and forest meteorology; 1991 April 16-19; Missoula, MT. Bethesda, MD: Society of American Foresters: 117-123.

combustion.[62] An important caveat to note with regards to fire hazard in aspen or hardwood dominated stands is the seasonal flammability aspect, dictated by the foliar moisture content of the hardwoods, the presence or absence of understory vegetation and the moisture level of the litter and duff layers.[63] In the boreal forest region of Canada, the absence of hardwood foliage during the month of May, in particular, has been linked to microclimatic conditions which are conducive to increased fire behaviour.[84] More specifically, the fire behaviour potential is higher during this short, but critical transition period to full leaf-out conditions, due in part to the factors: 1) unrestricted penetration of solar radiation causing drying of surface litter and duff layers; 2) absence of high moisture content understorey vegetation which could otherwise dampen surface fire spread; and 3) unrestricted, ground-level effects of wind speed, which impact fine fuels moisture levels and potential propagation at the flame front.[84]

Wildfire research studies have shown that leafed-out deciduous leading stands will support lower intensity fires,[64] resulting in a lower amount of area burned, and act as natural fuel breaks during wildfires.[65,66] The conifer component within a stand and at the landscape level has direct implications on fire behaviour and area burned, where a higher conifer component is linked to increased head fire intensity and more intense fire behaviour potential in comparison to mixed-wood or deciduous stands.[83]

5.1.1 Proposed Treatment Units

Funding opportunities from UBCM under the SWPI Program have historically been limited to Crown Provincial, Regional District, or Municipal land. The UBCM SWPI funding stream (in place at the time this CWPP Update was developed) has transitioned, as of September 2018, into a new provincial program, the Community Resiliency Investment (CRI) Program, that will consider fire prevention activities on provincial Crown land and private land, in addition to local government and reserve land[67]. Fire prevention activities on private land that may be funded under this program are related to FireSmart activities (including FireSmart planning and assessments, local rebate programs for completion of

[62] Hély, C., Bergeron, Y., & Flannigan, M. D. (2000). Effects of stand composition on fire hazard in mixed-wood Canadian boreal forest. *Journal of Vegetation Science*, *11*(6), 813-824.

[63] Alexander, M. E. (2010). Surface fire spread potential in trembling aspen during summer in the Boreal Forest Region of Canada. *The Forestry Chronicle*, *86*(2), 200-212.

[64] Hély, C., Flannigan, M., Bergeron, Y., & McRae, D. (2001). Role of vegetation and weather on fire behavior in the Canadian mixedwood boreal forest using two fire behavior prediction systems. *Canadian journal of forest research*, *31*(3), 430-441.

[65] Bevins, Collin D. (1984). Historical fire occurrence in aspen stands of the Intermountain West. Missoula, MT: Systems for Environmental Management. Cooperative Agreement 22-C-4-INT-31. 23 p.

[66] Fechner, Gilbert H.; Barrows, Jack S. (1976). Aspen stands as wildfire fuel breaks. Eisenhower Consortium Bulletin 4. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 26 p. In cooperation with: Eisenhower Consortium for Western Environmental Forestry Research.

[67] This new funding program (up to $50 million over three years) was initiated as per recommendations from the 2017 BC Flood and Wildfire Review Report by Abbott and Chapman (https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/emergency-preparedness-response-recovery/embc/bc-flood-and-wildfire-review-addressing-the-new-normal-21st-century-disaster-management-in-bc-web.pdf). Program details are available on the UBCM's website: https://www.ubcm.ca/EN/main/funding/lgps/community-resiliency-investment.html.

eligible FireSmart activities, and provision of off-site disposal of vegetation management debris), subject to program requirements. This does not preclude other current and future funding opportunities or potential industrial partnerships.

The potential treatment areas represent moderate, high or extreme fire hazard areas which are close to values at risk (structures or infrastructure) and are located on Crown Provincial, Regional District, or Municipal land. Recommendation for treatment in areas of moderate fire hazard areas were limited to areas which would increase efficacy of, and / or create continuity between previously proposed treatment areas, and / or link treatment areas to low / no-fuel areas such as water and rock. All polygons identified for potential treatment have been prioritized based on fire hazard, operational feasibility, estimated project cost, type and number of values at risk, common fire weather (wind direction), and expected efficacy of treatment. Although potential treatment areas have been ground-truthed during field work, additional refinement of the polygons will be required at the time of prescription development.

Proposed treatment areas within the AOI are outlined in Table 15 and depicted in Map 11.

RECOMMENDATION #26: The District should apply for fuel treatment prescription development following prioritization within this document.

Fuel Treatment Types

The intent of establishing a fuel break is to create a fire suppression option that is part of a multi-barrier approach to reduce the risk to values (*e.g.*, structures). A fuel break in and of itself, is unlikely to stop a fire under most conditions. The application of appropriate suppression tactics in a timely manner with sufficient resources, is essential for a fuel break to be effective. Lofting of embers (*i.e.*, "spotting") over and across a fuel break is a possibility (increasing with more volatile fuel types and fire weather) and has the potential to create spot fires beyond the fuel break that can expand in size and threaten values at risk, or land directly on or near structures and ignite them. To address spotting, fuels between the fuel break and the values at risk should be evaluated and treated to create conditions where extinguishment of spot fires is possible and FireSmart Standards should be applied to structures and associated vegetation and other fuel to reduce the risk of structures igniting. A multi-barrier approach that reduces the risk to values can include: establishing multiple fuel breaks (Interface Fuel Break and Primary Fuel Break), addressing fuels between the fuel break and structures (Interface Fuel Treatments), and applying FireSmart Standards to structures and the surrounding vegetation. Fuel breaks require periodic maintenance to retain their effectiveness.

Interface Fuel Treatments

Treatments on Crown Land immediately adjacent to private land and in close proximity to the wildland urban interface and/or intermix areas, are termed 'interface fuel treatments'. These are designed to modify fire behaviour, create fire suppression options, and improve suppression outcomes. Interface fuel treatments are relatively small (approximately 100 meters wide) and when treated with appropriate fuel reduction measures, can break the crown fire threshold and reduce the risk of a crown fire reaching

values at risk. Treatment widths can be varied to allow for alignment and to take advantage of natural and man-made fire resilient features that enhance effectiveness. Surface fire spread and spotting across the fuel treatment are both concerns and rely on suppression actions to be effective. In order to reduce potential fire intensity and spotting, fuel on private land between the fuel treatment and structures should be treated according to FireSmart vegetation management standards. Structures in interface areas should be constructed or retrofitted to FireSmart design standards.

Primary Fuel Break

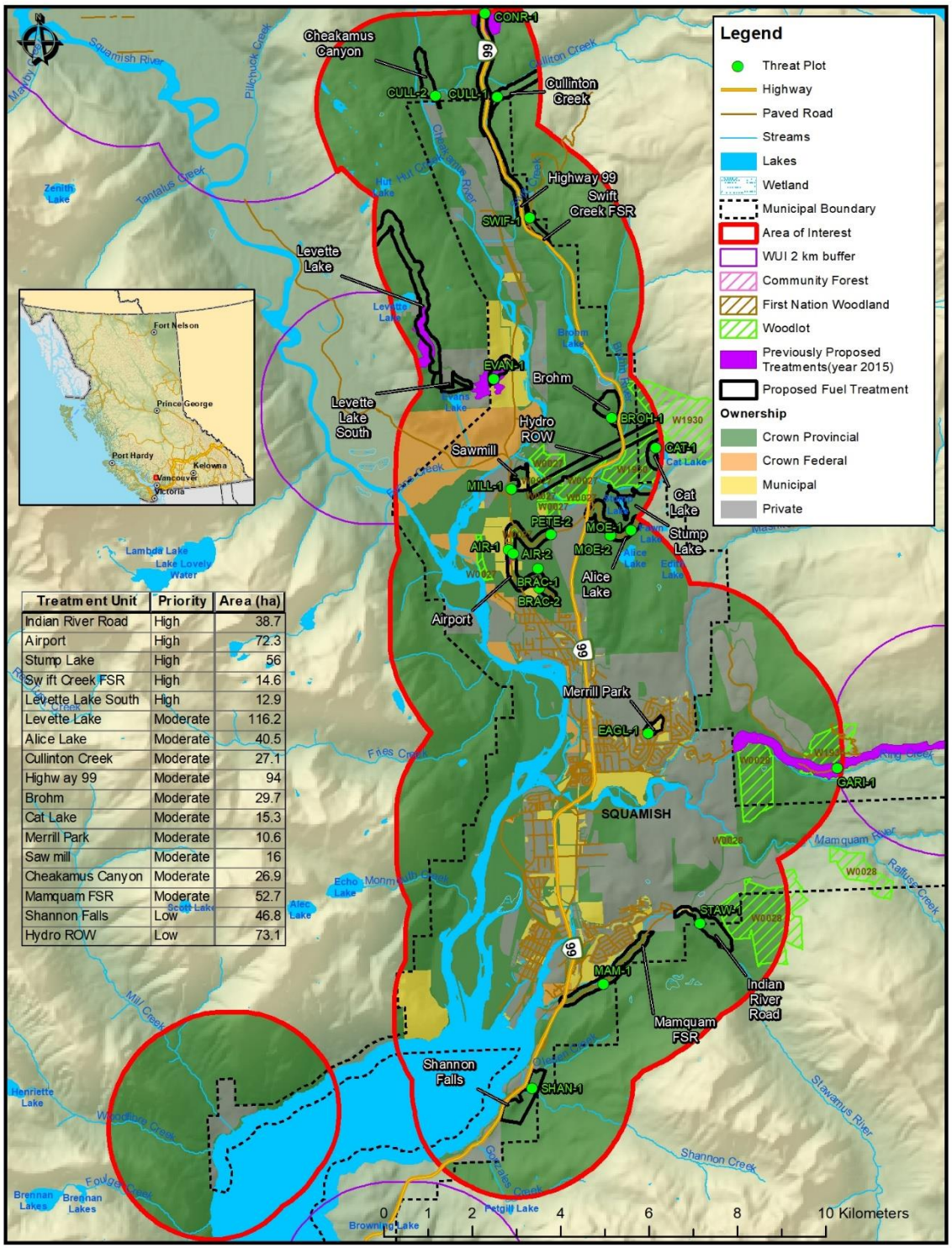
Primary Fuel Breaks are located on Crown Land (at times with portions on private land) in strategic locations beyond the Interface Fuel Break. Private land may be included in a primary fuel break so that the break represents a continuous fuel reduced area. Primary Fuel Breaks are designed to modify fire behaviour and create fire suppression options that reduce the risk of a crown fire reaching a community and/or adjacent private lands. Primary Fuel Breaks may be located to completely surround a community or be strategically placed upwind of communities and perpendicular to fire season winds. Primary Fuel Breaks have sufficient width and appropriate fuel reduction measures to break the crown fire threshold and reduce fire intensity such that overstory fire moves to the ground surface and spread rates are reduced. While there are no absolute standards for fuel break width or fuel manipulation in the literature and fuel break width will vary based on fuel type, topography, and expected fire behaviour[68], a 300-metre fuel break width is generally recommended. Fuel breaks should be designed to take advantage of natural and man-made fire resilient features and topography to enhance effectiveness. Surface fire spread across, and spotting over the fuel break are both concerns, and depend on the application of suppression resources to be effective.

[68] Agree, J.K., Bahro, B., Finney, M.A., Omi, P.N., Sapsis, D.B., Skinner, C.N., van Wagtendonk, J.W., Weatherspoon, C.P. The use of shaded fuelbreaks in landscape fire management. Forest Ecology and Management, 127 (2000), 55-66.

Table 15. Proposed Treatment Area Summary Table.

FTU Name	Total Area (ha)	Priority	Treatment Unit Type/ Objective	Fire Behaviour Threat Classes (ha)			Overlapping Values / Treatment Constraints
				Extreme/ High	Mod	Low	
Indian River Road	38.7	High	Primary	16.3	14.6	2.7	Steep slopes within this polygon; good access
Airport	72.3	High	Interface	10.0	56.5	24.4	Overlaps Squamish FN proposed treatment area*, partially overlaps woodlot ID W0027; very good access
Levette Lake South	12.9	High	Interface	14.7	6.2	0.1	Overlaps portion of Squamish FN proposed treatment area*; good access
Stump Lake	56.0	High	Interface	42.5	13.4	0.0	Overlaps Alice Lake Provincial Park; good access
Swift Creek FSR	14.6	High	Interface	14.6	0.0	0.0	No known overlapping values; very good access
Cullinton Creek	27.1	Moderate	Primary	11.9	15.2	0.0	Steep slopes within polygon; good access
Highway 99	94	Moderate	Primary	53.2	34.4	12.9	Partial overlaps with private land, steep slopes; very good access
Levette Lake	116.2	Moderate	Primary	55.9	75.8	7.1	Partial overlap with Squamish FN proposed treatment area*, steep slopes; good access
Mamquam FSR	52.7	Moderate	Primary	8.6	33.8	38.1	Very good access; steep slopes
Alice Lake	40.5	Moderate	Interface	8.6	27.9	4.6	Overlaps Alice Lake Provincial Park; good access
Brohm	29.7	Moderate	Interface	8.8	14.2	6.6	No known overlapping values; good access
Cat Lake	15.3	Moderate	Interface	15.3	0.0	0.0	Borders woodlot ID W 1930 2 and overlaps Squamish FN proposed treatment area*; good access
Cheakamus Canyon	26.9	Moderate	Interface	19.3	7.6	0.0	No known private land overlap, good access
Merrill Park	10.6	Moderate	Interface	0.0	7.9	2.7	Overlaps District of Squamish park, steep slopes; very good access
Sawmill	16.0	Moderate	Interface	0.0	15.5	0.5	No known overlaps; very good access
Hydro ROW	73.1	Low	Primary	0.0	24.3	49.2	This was chosen as a maintenance treatment. Some small overlaps with woodlots IDs: W0027 A – C; W 1930 2; and W 1930 1
Shannon Falls	46.8	Low	Interface	3.8	31.7	11.3	No known overlaps; however, requires consultation with BC Parks. Good access.

**These treatment areas were identified in the 2016 Squamish FN CWPP. Consultation with the Squamish FN and SWPI must occur before the District applies for part or the entirety of these proposed treatment areas. Ideally, the District and the Squamish FN can cooperate on proposed treatment areas in order to maximize the total area treated.*



Treatment Unit	Priority	Area (ha)
Indian River Road	High	38.7
Airport	High	72.3
Stump Lake	High	56
Swift Creek FSR	High	14.6
Levette Lake South	High	12.9
Levette Lake	Moderate	116.2
Alice Lake	Moderate	40.5
Cullinton Creek	Moderate	27.1
Highway 99	Moderate	94
Brohm	Moderate	29.7
Cat Lake	Moderate	15.3
Merrill Park	Moderate	10.6
Saw mill	Moderate	16
Cheakamus Canyon	Moderate	26.9
Mamquam FSR	Moderate	52.7
Shannon Falls	Low	46.8
Hydro ROW	Low	73.1

Map 11. Proposed Fuel Treatments.

5.1.2 Maintenance of Previously Treated Areas

As no fuel treatments have occurred within the District of Squamish AOI, maintenance activities of previously treated areas are not applicable. However, if fuel treatments are to occur in the District in the future, maintenance activities such as reducing removing standing dead, reducing surface fuels, or additional thinning (overstorey reduction and thinning suppressed conifers or conifer regeneration) should occur as needed to maintain the effectiveness of these treatments. The return interval for maintenance activities depends upon site productivity and type and intensity of treatment. Less productive areas can likely withstand a longer frequency between maintenance activities, while more productive areas would require treatments more often.

5.2 FIRESMART PLANNING AND ACTIVITIES

This section provides detail on: 1) the current level of FireSmart implementation and uptake within the community; 2) identified FireSmart subdivisions and/or acceptance into the FireSmart Canada Community Recognition Program (FSCCRP); and 3) recommended potential FireSmart activities that can be applied within the AOI at a future date.

5.2.1 FireSmart Goals and Objectives

FireSmart® is the comprehensive nationally accepted set of principles, practices and programs for reducing losses from wildfire.[69] FireSmart spans the disciplines of hazard/threat assessment; regional planning and collaboration; policy and regulations; public communication and education; vegetation/fuel management; training and equipment; and, emergency preparedness and response. FireSmart concepts provide a sound framework for advancing the goal of wildfire loss reduction, as it is a common goal shared with CWPPs.

The FireSmart approach and concepts, including recommended FireSmart guidelines[70], have been formally adopted by almost all Canadian provinces and territories, including British Columbia in 2000; FireSmart has become the de facto Canadian standard. FireSmart is founded in standards published by the National Fire Protection Association (NFPA). The objective of FireSmart is to help homeowners, neighbourhoods, whole communities and agencies with fire protection and public safety mandates to work together to prepare for the threat of wildfire in the WUI. Coordinated efforts between all levels of planning and action are integral to effectively and efficiently reducing the risk to communities.

The following are key principles of FireSmart:

- Wildland fires are a natural process and critical to the health of Canadian ecosystems.
- Mitigation and response efforts must be carefully coordinated through all stages of planning and implementation.

[69] FireSmart is the registered trademark held by the Partners in Protection Association.

[70] FireSmart guidelines first published in the 1999 manual "*FireSmart: Protecting Your Community from Wildfire*", with a second edition published in 2003.

- Threats and losses due to wildfires can be reduced by working together. Responsibility for effectively mitigating hazards must be shared between many entities including homeowners, industry, businesses and governments.[71]
- There are seven broad disciplines to help address the threat of wildfire: education, vegetation management, legislation and planning, development considerations, interagency cooperation, emergency planning, and cross training.[71]
- Solutions are required at all scales from individual backyards, to communities and the wider landscape. In order to succeed, these efforts must be integrated across the mosaic of land ownership (Figure 4).
- The ultimate root of the WUI interface problem is the vulnerability of structures and homes to ignition during wildfire events, in particular vulnerability to embers. This leads to an emphasis on risk mitigations on private properties.

The highest level of planning within the FireSmart program is strategic direction, such as that provided in CWPPs.

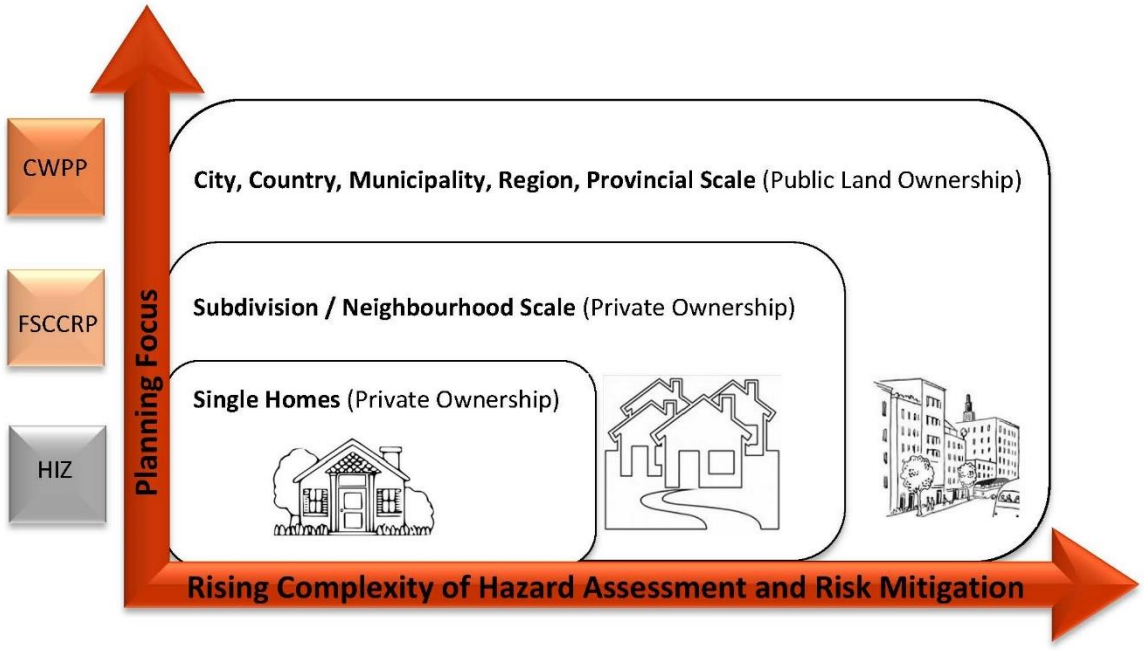


Figure 4. Diagram of the various, coordinated levels of the FireSmart program.[72] CWPP: Community Wildfire Protection Plan, FSCCRP: FireSmart Canada Community Recognition Program, HIZ: Home Ignition Zone.

[71] https://www.firesmartcanada.ca

[72] Figure and content developed by A. Westhaver. Adapted by A. Duszynska, 2017.

Home Ignition Zone

Multiple studies have shown that the principal factors regarding home loss to wildfire are the structure's characteristics and immediate surroundings; the area that determines the ignition potential is referred to as the Home Ignition Zone (HIZ).[73,74] The HIZ includes the structure itself and three concentric, progressively wider Priority Zones. HIZ Priority Zones are based upon distance from structure: 0 – 10 m (Priority Zone 1), 10 – 30 m (Priority Zone 2), and 30 – 100 m (Priority Zone 3). These zones help to guide risk reduction activities, with Recommended FireSmart Guidelines being most stringent closest to the structure. The likelihood of home ignition is mostly determined by the area within 30 m of the structure (Priority Zones 1 and 2). Recommended FireSmart guidelines address a multitude of hazard factors within the HIZ: building materials and design; vegetation (native or landscaped materials); and the presence of flammable objects, debris, and vulnerable ignition sites.

It has been found that, during extreme wildfire events, most home destruction has been a result of low-intensity surface fire flame exposures, usually ignited by embers. Firebrands can be transported long distances ahead of the wildfire, across fire guards and fuel breaks, and accumulate within the HIZ in densities that can exceed 600 embers per square meter. Combustible materials found within the HIZ combine to provide fire pathways allowing spot surface fires ignited by embers to spread and carry flames or smoldering fire into contact with structures.

Because ignitability of the HIZ is the main factor driving structure loss, the intensity and rate of spread of wildland fires beyond the community has not been found to necessarily correspond to loss potential. For example, FireSmart homes with low ignitability may survive high-intensity fires, whereas highly ignitable homes may be destroyed during lower intensity surface fire events.[74] Increasing ignition resistance would reduce the number of homes simultaneously on fire; extreme wildfire conditions do not necessarily result in WUI fire disasters.[75] It is for this reason that the key to reducing WUI fire structure loss is to reduce home ignitability; mitigation responsibility must be centered on homeowners. Risk communication, education on the range of available activities, and prioritization of activities should help homeowners to feel empowered to complete simple risk reduction activities on their property.

Firesmart Canada Community Recognition Program

In the case of adjacent homes with overlapping HIZs, a neighbourhood (or subdivision) approach can be an effective method of reducing ignition potential for all homes within the neighbourhood. The FireSmart Canada Community Recognition Program (FSCCR Program) is an 8-step resident-led program facilitated by trained Local FireSmart Representatives designed for this purpose. It provides groups of residents with critical information and a means of organizing themselves to progressively alter

[73] Reinhardt, E., R. Keane, D. Calkin, J. Cohen. 2008. Objectives and considerations for wildland fuel treatment in forested ecosystems of the interior western United States. Forest Ecology and Management 256:1997 - 2006.

[74] Cohen, J. Preventing Disaster Home Ignitability in the Wildland-urban Interface. Journal of Forestry. p 15 - 21.

[75] Calkin, D., J. Cohen, M. Finney, M. Thompson. 2014. *How risk management can prevent future wildfire disasters in the wildland-urban interface*. 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/.

hazardous conditions within their neighbourhood. The program also facilitates FireSmart knowledge and practices to quickly filter downwards onto the property of individual residents to further mitigate wildfire hazards at the single-home scale within the HIZ.

WUI Disaster Sequence

Calkin et al (2014) coined the 'WUI disaster sequence', a six-step sequence which has been used to describe the situation in which the firefighting capacity of a community is overwhelmed by wildland / interface fires in highly ignitable communities: 1) extreme wildfire behaviour weather combined with, 2) a fire start, which 3) exposes numerous homes with high ignition potential, and results in numerous structures burning, 4) overwhelms suppression efforts and capabilities, and 5) leads to unprotected homes, and therefore 6) considerable structure loss (Figure 5).

Once multiple homes are ignited in an urban area, there is increasing potential for fire to spread from structure to structure, independently of the wildland vegetation. This is known as an urban conflagration. Effective fire protection depends on ignition resistant homes and properties during extreme wildfire events.[76]

Overall, FireSmart leads to communities that are better adapted to wildfire, more resilient and able to recover following wildfires by sustaining fewer losses and disruption, and safer places to live and recreate. Action by homeowners is the number one priority for reducing structure loss in the event of a WUI fire, but the overall adaptation of the community to wildfire is multi-pronged and the landscape should not be ignored.[76]

Figure 5. Wildland/urban interface disaster sequence.[77] It is possible to break up the disaster sequence by decreasing the number of highly ignitable homes exposed to embers, therefore reducing the number of homes ignited and removing the consequences of multiple structures lost.

[76] Calkin, D., J. Cohen, M. Finney, M. Thompson. "*How risk management can prevent future wildfire*"

[77] Graphic adapted from Calkin et. al, by A. Westhaver.

5.2.2 Key Aspects of FireSmart for Local Governments

Reducing the fire risk profile of a community through FireSmart implementation requires coordinated action from elected officials, municipal planners, developers, private land owners and industrial managers. This Section presents various options of FireSmart practices, which when enacted, provide avenues for reducing fire risk within the community. An evaluation of the current level of FireSmart implementation within the District of Squamish is also presented in this Section.

Communication, Education and Partnerships

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. Communication materials must be audience specific and delivered in a format and through media that reach the target audience. Audiences should include home and landowners, school students, local businesses, elected officials, District staff, local utilities, 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.

RECOMMENDATION #27: The District should promote FireSmart literature including pamphlets and materials in paper and digital format on its website, social media outlets, at public meetings and at FireSmart sponsored events.

FireSmart Vegetation Management

Some examples of actionable items for the District of Squamish with regards to vegetation or fuel management and the FireSmart approach include: 1) policy development and implementation of FireSmart maintenance for community parks and open spaces; 2) implementing fire resistive landscaping requirements as part of the development permitting process; and 3) provision of collection services for private landowners with a focus on pruning, yard and thinning debris.

RECOMMENDATION #28: The District should apply for a FireSmart demonstration grant through funding agencies. This type of fuel treatment can display the practices and principles of FireSmart activities to the public in the form of demonstration treatments. These small projects are not necessarily completed to reduce fire behaviour or increase stand resiliency in any measurable way, but instead are prioritized more by their visibility to the public and combining the treatment with elements of public education (signage, community work days, public tours, active demonstrations of operations, etc.).

RECOMMENDATION #29: Develop and implement a community chipper program with the help of neighbourhood representatives. As a demonstration, this program can begin twice per year in two separate neighbourhoods. This program can also be implemented in tandem with community clean up days.

Planning and Development

Municipal policies and bylaws are tools available to mitigate wildfire risk to a community. It is recognized that, to be successful, all levels of government (municipal, provincial, and federal) and individual landowners need to work together to successfully reduce their risk. To that end, local government can use a range of policy tools to help the community to incrementally increase FireSmart compliance over the mid-term (5 – 20 years) and therefore play a role in reducing the chance of structure loss from wildfire. Recommendations for amendments to policies and bylaws were discussed fully in Section 2.5.3.

FireSmart Compliance within the AOI

Although the District does not have a developed FireSmart program in place currently, there is vaying FireSmart compliance on private properties in the District of Squamish. There are large differences in the degree to which FireSmart best practices are visible within individual HIZs, and in neighbourhoods throughout the District. Landscaping in the AOI is also in a range of FireSmart compliance. For example, most homes in the Paradise Valley area do not maintain a 10 m defensible space while downtown Squamish/Dentville displays the highest FireSmart compliance rate.

District neighbourhoods were unofficially surveyed during field work. The following observations were made:

- Wildfire hazard levels range from low to high across neighbourhoods within the study area;
- The bulk of hazards are associated with conditions of natural and landscaped vegetation immediately surrounding residential properties;
- For new development, where landscaping is not yet completed, educational approaches may aid in promoting fire resistant landscaping options and achieving defensible space in the HIZ;
- Hazards are magnified in some neighbourhoods due to the poor access (private and gated roads) and distance from nearest water supply or fire hydrant location.

RECOMMENDATION #30: The District should hire a qualified professional or SFR staff member to assist the community in complying with FireSmart principles at the neighbourhood and individual home-level.

5.2.3 Priority Areas within the AOI for FireSmart

Table 16 outlines the identified areas where FireSmart activities have been prioritized. These priorities are based on general field observations and are not based on a scientific sample or formal data collection. Recommended FireSmart activities are essentially the same for each neighbourhood or area; however, it is recommended that the District prioritize the neighbourhoods in Table 16. In addition, every neighbourhood (including the downtown and surrounding areas) within the AOI should continue and improve upon existing FireSmart activities and equally participate in the District's FireSmart program.

Table 16. Summary of FireSmart Priority Areas.

Area ID	Wildfire Risk Rating (E/H/M/L)	FireSmart Y/N	FireSmart Canada Recognition Received Y/N	Recommended FireSmart Activities
North Tantalus Road/Depot Road	E	N	N	*Develop strategic plan with 2018 FireSmart Planning & Activities Grant Program funding, promote FSCCR program, ongoing communication/community engagement and education partnering with local BCWS.*
Paradise Valley Area	H	N	N	
Garibaldi Highlands Neighbourhood	M	N	N	
Northridge/ Valleycliffe Neighbourhood	M	N	N	
Brackendale Neighborhood	M	N	N	
Alice Lake Provincial Park Campsites	M	N	N	*Invite BC Parks to work with the DOS regarding FireSmart initiatives and promote any synergies between activities or funding sources*
Sea to Sky Gondola	M	N	N	*Invite the Sea to Sky Gondola to work with the DOS regarding FireSmart initiatives and promote any synergies between activities or funding sources*

5.3 COMMUNICATION AND EDUCATION

Moving from the CWPP to implementation of specific activities requires that the community is well informed of the reasons for, and the benefits of specific mitigation activities. In order to have successful implementation, the District should develop a strategic plan that utilizes appropriate recommendations within this Update. The following steps have been found to be successful in strategic planning with emphasis on communication and education:

RECOMMENDATION #31: This CWPP should be made available to all District residents, business owners and the public at large. If possible, the Update should be published online and advertised on the District's social media accounts. The communication of the availability and existence of this Update should also be announced at public meetings, press releases and education events. In addition, this Update should be shared with local industry partners; in particular industrial forest companies who may be interested in collaborating on direct fuel management treatments or with other sections of this CWPP Update document.

RECOMMENDATION #32: The District's Wildfire Working Group should continue to meet and discuss options and recommendations presented within this Update. Through these meetings, the Wildfire Working Group can develop a strategic plan for the District which includes a separate communication

plan. This communication plan should include the methods in which the District will communicate the CWPP and its ongoing progress of implementation. In addition, this communication plan should include the methods in which the District will execute its FireSmart program. Future milestones for FireSmart activities should be determined and a relative action plan should be developed. This should include digital, paper (pamphlet, flier) and signage communication that describes the District's future achievements. This communication should be shared with BCWS and other non-District partners. In addition to a communication plan, the District's Wildfire Working Group should also develop a coincident education plan.

RECOMMENDATION #33: The District or its Wildfire Working Group should consider leading the establishment of a local interface steering committee to coordinate wildfire risk reduction efforts.

RECOMMENDATION #34: Encourage all local schools (private and public) to adopt and deploy existing school education programs to engage youth in wildfire management and risk reduction. There is emergency preparedness curriculum available provincially, which includes preparedness for a variety of natural hazards, including wildfire (Master of Disaster). Other activities include consulting with Association of BC Forest Professionals (ABCFP) and British Columbia Wildfire Service (BCWS), as well as local fire officials and FireSmart representatives to facilitate and recruit volunteer teachers and experts to help with curriculum development to be delivered in elementary (and/or secondary) schools.

RECOMMENDATION #35: Explore potential partnerships with local literacy programs to either include FireSmart and emergency preparedness into currently existing programming or to facilitate development of an environmental literacy class, which can include information on FireSmart, emergency preparedness, and bear aware, as examples.

RECOMMENDATION #36: The District has undertaken some public education outreach including a Community Wildfire Preparedness Day held on May 6, 2017. The District should build off this initiative and continue to hold Community Wildfire Preparedness Days into the future. The District should also consider having school fire education programs, with an increased element of wildfire preparedness education included, to be presented annually in elementary schools. Programming could include volunteer/advocacy work from professional foresters, wildland firefighters or prevention officers, and District staff. Timely educational materials to increase preparedness would be most effective immediately prior to the fire season.

RECOMMENDATION #37: Provide more public education that targets tourists/visitors to the area (e.g. Mountain FM and speed corridor signs with messaging).

5.4 OTHER PREVENTION MEASURES

RECOMMENDATION #38: Promote and provide information to private landowners related to residential sprinklers as a FireSmart measure.

RECOMMENDATION #39: In addition to the existing three forest fire danger rating signs (1-southbound along Highway 99 at Alice Lake; 2-westbound along Squamish Valley Rd; and 3-eastbound along Mamquam FSR), construct and operate a fire danger sign northbound along Highway 99 at northbound, south of Squamish. This location would provide key information to travelers and recreationalists who visit the area. Consider an electronic sign which could be updated remotely to ensure messaging remains current, thereby removing the need for the manual update of fire danger rating. Investigate the possibility of collaborating with FLNRORD to acquire and operate this fire danger sign.

SECTION 6: WILDFIRE RESPONSE RESOURCES

The intent of this section is to provide a high-level overview of the resources that are available to local governments in the case of a wildfire.

6.1 LOCAL GOVERNMENT AND FIRST NATION FIREFIGHTING RESOURCES

The intent of this sub-section is to identify implications of wildfire that impact firefighting efforts (eg. loss of electrical power and water pressure and supply), the contingencies that have been put in place, and any recommended measures that would help to make community firefighting more effective. It also includes a high-level summary of mutual aid agreements.

The District of Squamish Fire Services Bylaw (#2314), limits the use of fire department apparatus to the geographical boundaries of the District of Squamish, except as expressly agreed to in writing or approved by Council prior to the proposed use, with an exception in the case of road rescue. Squamish has a mutual aid agreement with Whistler that has rarely been exercised. Mutual aid is often utilized with the BCWS for wildland fires on jurisdictional borders and wildfires within the District boundaries that exceed their capabilities such as air support tankers.

The Woodfibre LNG Limited power generation plant and the District land surrounding it would be actioned by the BCWS in the event of a wildfire. BCWS report that firefighters from Squamish would be transported via helicopter.

6.1.1 Fire Department and Equipment

The SFR has two paid chiefs, 6 paid career firefighters and fifty volunteer paid on-call firefighters. The following SFR sponsored wildfire training occurs annually:

- A Wildfire & Structural Protection Certification course (three District staff are SPP-WFF-1 certified), and
- A spring practise session with the Squamish Initial Attack (BCWS crew).

In addition, the Squamish Firefighters Association runs an annual one-two day Junior Firefighter Academy. Candidates are selected from the local high school that have applied and shown interest in furthering a career or volunteering in the fire service. The Firefighters Association has had a great

response from the school and community with the interested students outnumbering the available spots.

The SFR has three structural fire engines (600-800 U.S. gallon capacity), one wildfire response truck (250 U.S. gallon capacity), one 75' ladder apparatus (300 U.S. gallon capacity). Additionally, the Public Works department has a 2000 U.S. gallon tank and two <500 U.S. gallon trailer tanks (personal communication, Spring 2018). Although the District does not have a water tender; the District can contract these given that they are available at that time. A pre-qualified list of contractor tenders could be organized and made available to facilitate the efficient mobilization of resources ready for hire when the need arises.

6.1.2 Water Availability for Wildfire Suppression

Water is the single most important suppression resource. In an emergency response scenario, it is critical that a sufficient water supply be available. The secondary and tertiary sources of water for the District are Stawamus River and Mashiter Creek, which are both located in Community Watersheds. In terms of the effects of fire suppression activities on water quality, the Mamquam and Mashiter Creek watersheds are considered a Community Water Supply Area under the Sea to Sky Land and Resource Management Plan and as such, the use of chemicals for wildfire suppression is prohibited in these areas[78]. Public use of all Community Water Supply Areas is also discouraged by the District.

The impacts of wildfire extend past the time a fire is extinguished. Depending on fire size and severity, there is the potential for significant hydrological impacts, extending for years post-burn.[79] Some areas may have a lower threshold for precipitation triggered events and would be particularly vulnerable to post-wildfire debris flows, mass wasting, landslides, or flooding. This may impact the community directly, through structure loss and risk to public safety, or indirectly, through loss or damage of critical infrastructure, such as BC Hydro infrastructure, roads, or impacts on the watershed affecting water quality. A goal to increase awareness of, and define, post-wildfire risk levels in the area is recommended. The District should consider the option of conducting future assessments to explore the potential hydrologic and geomorphic impacts of wildfire on the watershed and community. Alternatively, there may be an option to complete a stand-alone assessment to help identify and quantify the post-fire risk to the community. Exploration of potential funding opportunities through the province and the National Disaster Mitigation Program may be worthwhile.[80]

Water service within the community is an important component of emergency response for a wildland urban interface fire in the event of a large-scale emergency, and in particular for structural fires. For suppression within the District, 647 hydrants are available and tested annually. The majority of the developed portions of the District have adequate water supply for fire suppression. Woodfibre is not connected to the District water supply. Raven/Finch neighbourhood can be connected to the District

[78] Sea to Sky Land and Resource Management Plan. 2008.

[79] Jordan, P., K. Turner, D. Nicol, D. Boyer. 2006. Developing a Risk Analysis Procedure for Post-Wildfire Mass Movement and Flooding in British Columbia. Part of the 1st Specialty Conference on Disaster Mitigation. Calgary, AB May 23 -26, 2006.

[80] https://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/dsstr-prvntn-mtgtn/ndmp/index-en.aspx

water supply if necessary and Fernwood Rd is supplied by well. In consultation with a Woodfibre representative it was determined that the plant conducts drills in order to test the fire hydrants' viability and pressure. In addition, Woodfibre has backup portable pumps that can use creek water if and when the hydrants no longer function.

There are significant areas within the District which are not serviced by fire hydrants, including Klahanie, Cheekye, the Squamish Airport, and Paradise Valley. Furthermore, no hydrants are located outside of the District boundary, therefore significant portions of the AOI do not have access to hydrants.

The District can draft from natural water sources only when dry hydrant and suction hose are stored on-site because most trucks do not carry large diameter suction hoses for drawing water (personal communication, Spring 2018). The natural water sources are known and were mapped and updated in 2017.

6.1.3 Access and Evacuation

Road networks in a community serve several purposes including providing access for emergency vehicles, providing escape/evacuation routes for residents, and creating fuel breaks. Access and evacuation during a wildfire emergency often must happen simultaneously and road networks and anchor points should have the capacity to handle both.

If wildfire were to block Highway 99, evacuation of District of Squamish would be difficult. Smoke and poor visibility, car accidents, wildlife, and other unforeseen circumstances can further complicate evacuations and hinder safe passage. Egress was a concern identified by the Wildfire Working Group as some neighborhoods within the District are single access/egress with limited turn-around capabilities for apparatus.

Valleycliffe/Hospital Hill/Crumpit Woods:

- Guilford to Clarke or Valley Dr. are the only egress routes, and traffic bottlenecks should be expected before the split.
- Access at Valleycliffe (at the end of Cherry Dr) to the Mamquam FSR which leads to Highway 99, but a locked gate poses a barrier.
- Hospital Hill does have a gravel road alternate route to Highway 99 (Clarke Dr. to Scott Cres.) and may not be considered optional egress / access by the public as the road is not a regular daily route for people.

Garibaldi Highlands:

- Garibaldi Highlands would most likely bottleneck before people decide to take either the Highlands Way South or Skyline Dr route.
- Another exit to Highway 99 but not a direct route is Mamquam Rd (via Quest University). This route would encounter traffic from the housing developments above Quest University.

Paradise Valley:

- The entire length of Paradise Valley Rd (including Midnight Way, Elkins Lane, Caribou Lane) leads out via Squamish Valley Rd to Highway 99 or to Government Rd.

Squamish Valley

- The entire span of Squamish Valley Rd has only one-way egress, until Government Rd is reached where the choice can be made to either 1) take Government Rd south to Brackendale, or 2) continue on Squamish Valley Rd to Highway 99.

Within the AOI, some of the critical infrastructure is reached via narrow, forested roads, which may impede suppression efforts and response times. Nine highway bridges cross the riparian systems located within the District of Squamish, some of which are susceptible to flooding and associated damage from high water levels. Furthermore, there is significant land within the Fire Service Area which is inaccessible by roads, but for which the Squamish Fire Rescue is responsible for suppression. Review of the Fire Service Area and the accessibility, risks and benefits of the current boundary is recommended.

Emergency access and evacuation planning is of particular importance in the event of a wildfire event or other large-scale emergency. The District of Squamish is currently developing an Evacuation Plan as an annex to the All Hazards Plan. The District of Squamish and the Resort Municipality of Whistler are also partnering to create a Sea to Sky Evacuation Plan.

RECOMMENDATION #40: Participate in regular testing of, and updates to, the evacuation plan.

RECOMMENDATION #41: Recreation trails built to support ATVs can provide access for ground crews and can act as fuel breaks for ground fires, particularly in natural areas. Strategic recreational trail development to a standard that supports ATVs, and further to install gates or other barriers to minimize access by unauthorized users can be used as a tool that increases the ability of local fire departments to access interface areas.

RECOMMENDATION #42: In order to effectively use the trails as crew access or as fuel breaks during suppression efforts, it is recommended to develop a Parks Access Plan, or Total Access Plan. The plan should be updated every five years, or more regularly, as needed to incorporate additions and / or changes. This plan should be made available to the SFR and the BCWS in the event that they are aiding suppression efforts on an interface fire in Squamish. The plan should include maps and spatial data, identify the type of access available for each access route, identify those trails that are gated or have barriers, and provide information as to how to unlock barriers. The plan should also identify those natural areas where access is insufficient. Access assessment should consider land ownership, proximity of values at risk, wildfire threat, opportunities for use as fuel break / control lines, trail / road network linkages where fuel-free areas or burn off locations can be created, and requirements for future maintenance activities such as operational access for fuel treatments and other hazard reduction activities. In addition to providing the safest, quickest, and easiest access routes for emergency crews, a Total Access Plan would minimize the need for using machinery or motorized access in an otherwise undisturbed area. This would reduce the risk of soil disturbance and other environmental damage, as well as reduce rehabilitation costs.

RECOMMENDATION #43: The creation of a map book or spatial file that displays the trail network available for the SFR to access during an emergency or for fire suppression planning must accompany any fire access trail building activities.

6.1.4 Training

The SFR should maintain its strong relationship with local BCWS staff. Attrition has been a challenge for the SFR. Many applicants join the SFR initially; however, the SFR loses the equivalent numbers annually due to attrition. This type of attrition is causing an experience gap. The attrition gap is currently being addressed in the SFR 5-year strategic plan.

RECOMMENDATION #44: The District should cooperatively identify potential wildfire risk reduction opportunities with local BCWS.

RECOMMENDATION #45: That SFR obtain S100 training. The District should also work on continuing (and / or regularizing frequency of) annual cross training opportunities with BCWS. Interface training could include completion of a mock wildfire simulation in coordination with BCWS. Training could be coordinated with other fire departments in the area to enhance regional firefighting capabilities. It is recognized that BCWS crew resources are limited and their availability is highly dependent upon the current fire season and other BCWS priorities.

6.2 STRUCTURE PROTECTION

The structure protection objectives for the District are to:

- Encourage private landowners to voluntarily adopt FireSmart principles on their properties and to reduce existing barriers to action,
- Enhance protection of critical infrastructure from wildfire (from wildfire and post-wildfire impacts), and
- Enhance protection of residential / commercial structures from wildfire.

The District does not own a sprinkler protection unit (SPU) and a need for this type of unit was not identified in the CWPP process. SFR staff have not been trained in SPU deployment and use. The UBCM owns four complete SPUs, each equipped to protect 30 – 35 structures. The kits are deployed by the MFLNRORD / 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. An SPU is being procured for 2018 via a joint agreement between DOS and RMOW.

RECOMMENDATION #46: The Wildfire Working Group noted that the wildfire response truck should have a larger GVW and greater tank capacity. SFR could also be trained to operate the SPU.

RECOMMENDATION #47: The Wildfire Working Group mentioned that apart from two private dry hydrants, the District has very limited ability to draft from static sources. Therefore, the District may want to investigate the installation of additional strategically located dry hydrants.

RECOMMENDATION #48: The District should consider purchasing a water tender.

APPENDIX A – WILDFIRE THREAT ASSESSMENT – FBP FUEL TYPE CHANGE RATIONALE

Provided separately as a PDF package.

APPENDIX B – WILDFIRE THREAT ASSESSMENT WORKSHEETS AND PHOTOS

Provided separately as a PDF package.

APPENDIX C – MAPS

Provided separately as a PDF package.

APPENDIX D – WUI THREAT PLOT LOCATIONS

Table 17 displays a summary of all WUI threat plots completed during CWPP field work. The original WUI threat plot forms and photos will be submitted as a separate document. The following ratings are applied to applicable point ranges:

- Wildfire Behaviour Threat Score – Low (0-40); Moderate (41 – 95); High (96 – 149); Extreme (>149); and,
- WUI Threat Score – Low (0 – 13); Moderate (14 – 26); High (27 – 39); Extreme (>39).

Table 17. Summary of WUI Threat Assessment Worksheets.

WUI Plot #	Geographic Location	Wildfire Behaviour Threat Class	WUI Threat Class*
AIR-1	Squamish Airport, Paradise Valley	Moderate	N/A
AIR-2	Squamish Airport, Paradise Valley	Moderate	N/A
BRAC-1	Brackendale, north	Moderate	N/A
BRAC-2	Brackendale	Moderate	N/A
BROH-1	Brohm Lake Interpretive Site	Moderate	N/A
CAT-1	Cat Lake Recreation Site	High	Low
CONR-1	Conroy Creek	Moderate	N/A
CULL-1	Culliton Creek	High	Moderate
CULL-2	Culliton Creek	High	Moderate
EAGL-1	Merrill Park	Moderate	N/A
EVAN-1	Evans Demonstration Forest	Moderate	N/A
GARI-1	Garibaldi Lake Road	Moderate	N/A
MAM-1	Mamquam FSR	Moderate	N/A
MILL-1	Brackendale near lumber mill	Moderate	N/A
MOE-1	Alice Lake Provincial Park	Moderate	N/A

WUI Plot #	Geographic Location	Wildfire Behaviour Threat Class	WUI Threat Class*
MOE-2	Alice Lake Provincial Park, Ministry of Environment Office	Moderate	N/A
PETE-2	West of Alice Lake Provincial Park (Ray Peters Trail area)	Moderate	N/A
SHAN-1	Shannon Falls Provincial Park	Moderate	N/A
STAW-1	Stawamus FSR	High	Low
SWIF-1	Off of Sea to Sky Highway (northern Area of Interest)	Moderate	N/A

*Note that WUI threat scores are only collected for untreated polygons that rate high or extreme for Wildfire Behaviour Threat score.

APPENDIX E – FUEL TYPING METHODOLOGY AND LIMITATIONS

The initial starting point for fuel typing for the study area was the 2017 provincial fuel typing layer provided by BCWS as part of the *2017 Provincial Strategic Threat Analysis* (PSTA) data package. This fuel type layer 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 provincial fuel type data is very low on private land. The PSTA threat class for all private land within the AOI was not available. Fuel types within the study area have been updated using orthoimagery of the study area with representative fuel type calls confirmed by field fuel type verification. Polygons not field-verified were assigned fuel types based upon similarities visible in orthophotography to areas field verified. Where polygons were available from the provincial fuel typing layer, they were utilized and updated as necessary for recent harvesting, development, etc.

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 FBP system. The FBP system was almost entirely developed for boreal and sub-boreal forest types, which do not occur within the study area. As a result, the AOI fuel typing is a best approximation of the Canadian Forest Fire Danger Rating System (CFFDRS) classification, based on the fire behaviour potential of the fuel type during periods of high and extreme fire danger within the South Coast region. Additionally, provincial fuel typing depends heavily on Vegetation Resource Inventory (VRI) data, which is gathered and maintained in order to inform timber management objectives, not fire behaviour prediction. For this reason, VRI data often does not include important attributes which impact fuel type and hazard, but which are not integral to timber management objectives. Examples include: surface fuels and understory vegetation.

In some cases, 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, necessitating adjustments required to the PSTA data. In some areas, aerial imagery is not of sufficiently high resolution to make a fuel type call. Where fuel types could not be updated from imagery with a high level of confidence, the original PSTA fuel type polygon and call were retained.

For information on the provincial fuel typing process used for PSTA data as well as aiding in fuel type updates made in this document, please refer to Perrakis and Eade, 2015[56].

APPENDIX F– CWPP WILDFIRE THREAT 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 AOI 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 AOI were determined through the completion of the following methodological steps:

- Update fuel-typing using 2015 orthophotography provided by the client and field verification.
- Update structural data using critical infrastructure data provided by the client and orthophotography
- Complete field work to ground-truth fuel typing and threat ratings
- 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 Appendix F Table 1 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.

Appendix F, Table 1.

WUI Threat Sheet Attribute	Used in analysis?	Explanation
Fuel		
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 Deciduous 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		

WUI Threat Sheet Attribute	Used in analysis?	Explanation
BEC Zone	Yes	Although included, these are broad classifications, meaning most polygons in the AOI will have the same value
Historical Fire Weather Occurrence	Yes	
Topography		
Aspect	Yes	
Slope	Yes	Elevation model was used to determine slope.
Terrain	No	
Landscape/topographic Limitations to Wildfire Spread	No	
Structural		
Position of Structure/Community on slope	No	Too difficult to quantify – this is a relative value.
Type of development	No	Too difficult to analyze spatially.
Position of assessment area relative to values	Yes	Only distance to structures is used in this analysis, being above, below or sidehill too difficult to analyze spatially.

The field data is used to correct the fuel type polygon attributes provided in the PSTA. This corrected fuel type layer is then used as part of the 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. Appendix F Table 2 below summarizes the components and scores to determine the Fire Behaviour Threat and Appendix F Table 3 summarizes fire behaviour classes.

Appendix F, Table 2: Components of Fire Threat Analysis.

Attribute	Indicator	Score
Fuel Type	C-1	35
	C-2	
	C-3	
	C-4	
	M-3/4,>50% dead fir	
	C-7	20
	M-1/2, >50% conifer	
	M-3/4, <50% dead fir	

Attribute	Indicator	Score
	C-5	5
	C-6	
	M-1/2, <50% conifer	
	O-1a/b	10
	S-1	
	S-2	
	S-3	
	D-1/2	0
	W	0
	N	0
Weather - BEC Zone	AT, irrigated	1
	CWH, CDF, MH	3
	ICH, SBS, ESSF	7
	IDF, MS, SBPS, CWHsds1 & ds2, BWBS, SWB	10
	PP, BG	15
Historical Fire Occurrence Zone	G5, R1, R2, G6, V5, R9, V9, V3, R5, R8, V7	1
	G3, G8, R3, R4, V6, G1, G9, V8	5
	G7, C5, G4, C4, V1, C1, N6	8
	K1, K5, K3, C2, C3, N5, K6, N4, K7, N2	10
	N7, K4	15
Slope	<16	1
	16-29 (max N slopes)	5
	30-44	10
	45-54	12
	>55	15
Aspect (>15% slope)	North	0
	East	5
	<16% slope, all aspect	10
	West	12
	South	15

Appendix F, Table 3: Fire Behaviour Classes and their associated summed scores.

Very Low	0
Low	0 - 20
Moderate	20 - 40
High	40 - 60
Extreme	>60

These attributes are summed to produce polygons with a final Fire Behaviour Score. To determine the Fire Threat score, only the distance to structures is used. Buffer distance classes are determined (as per the WUI Threat Assessment worksheet; < 200, 200-500 and >500) but only for polygons that had a 'high' or 'extreme' Fire Behaviour score from previous assessment. In order to determine Fire Threat; those aforementioned polygons 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. Structures are considered, but there is no consideration for structure type (also not included on threat assessment worksheet). This method uses the best available information to produce accurate and useable threat assessment across the AOI in a format which is required by the UBCM SWPI program.