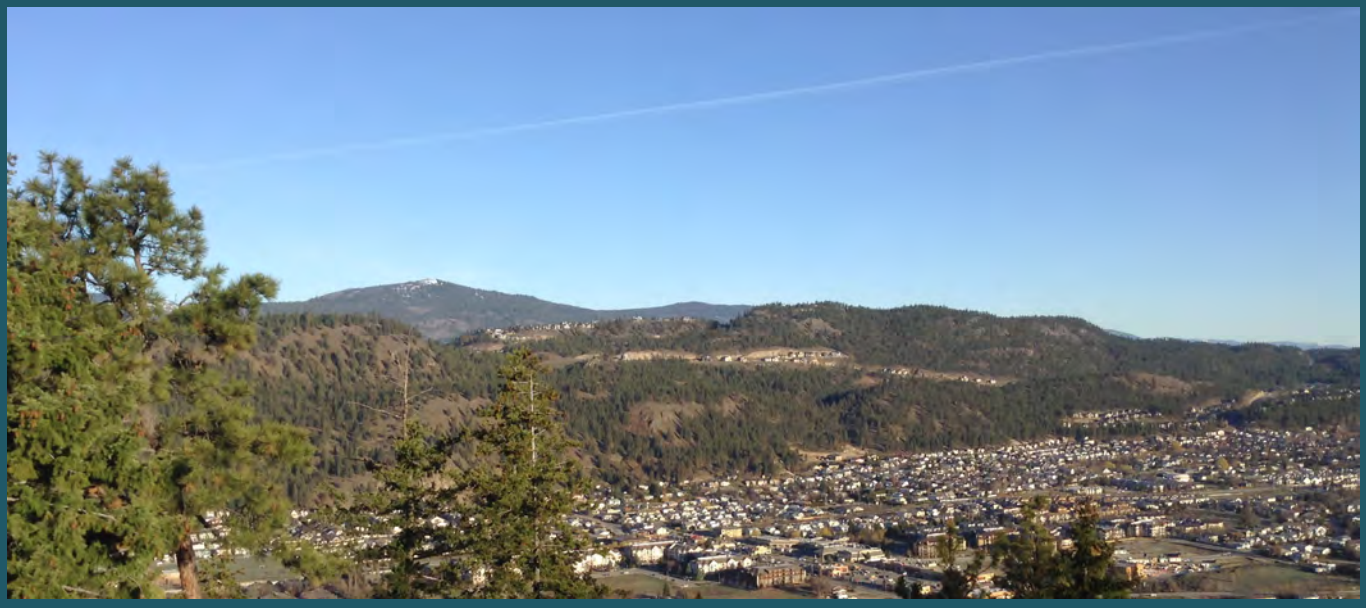
City of Kelowna
Community Wildfire Protection Plan
2016 Update



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EXECUTIVE SUMMARY

The Community Wildfire Protection Plan (CWPP) Program was created in British Columbia (BC) as a response to the devastating 2003 wildfire in Kelowna. As an integral part of the Strategic Wildfire Prevention Initiative (SWPI), managed and funded through the Union of British Columbia Municipalities (UBCM), CWPPs aim to develop strategic recommendations to assist in improving safety and to reduce the risk of damage to property from wildfires. In 2004 the first CWPP for the City of Kelowna was completed. In 2011, the original CWPP was updated to help guide the City of Kelowna in wildfire risk reduction and mitigation activities.

This document intends to further update the 2011 CWPP and the threat of wildfire within and around the City of Kelowna, as well as to identify the four greatest wildfire-related challenges facing the city today. It will acknowledge and assess effectiveness of work completed, offer improvements to currently existing programs, and recognize opportunities for improvements as well as identify opportunities for new initiatives.

Since the development of the last CWPP update in 2011, the City has made significant progress at implementing recommendations from the 2011 CWPP and has shown provincial leadership in many aspects of strategic wildfire management. The most notable actions include implementation of the following:

- Fuel treatment of 95% of the polygons identified as moderate threat or greater in the 2011 CWPP;
- Fire Department acquisition of a Utility Terrain Vehicle (UTV) for wildland fire suppression and access;
- Monitoring and removal of pine beetle and other mortality in the wildland urban interface;
- Recruitment of four neighbourhoods into the FireSmart Canada Community Recognition Program; and,
- Additional FireSmart initiatives, overseen and implemented by the Fire Department, such as a youth educational program, presence of FireSmart and prevention representatives both at public meetings and throughout the community, and partnership with the Parks Department to develop a wildfire management awareness program.

The City continues to face many challenges related to wildfire risk and threat reduction. The four most significant challenges are:

- Increasing FireSmart compliance on private land within the interface area, including building materials, building location (setbacks), and landscaping;
- Large areas of City-owned, natural forested land adjacent to values at risk, introducing significant wildfire liability and maintenance costs;
- Location of new developments in the interface are almost exclusively in high threat areas (steep slopes, surrounded by, or intermixed with, forested land and limited access); and,
- Hazard associated with continuous, thick, tall grasses which, when cured, have the ability to support rapidly spreading and structure destroying fires.

Wildfire management requires a multi-faceted approach for greatest efficacy and risk reduction. A total of 47 strategic recommendations in five different categories are outlined for the City of Kelowna, as part of this CWPP update. They are displayed in totality in Table 1.

Table 1. Wildfire mitigation recommendations for the City of Kelowna.

Item	Priority	Recommendation	Estimated Cost ($)
Communication and Education (Section 7.1)			
Objective: To improve public understanding of fire risk and personal responsibility by increasing resident awareness of the wildfire threat in their community and to establish a sense of homeowner responsibility.			
1	Moderate	• Establish/ expand a school education program to engage youth in wildfire management. Consult Association of BC Forest Professionals (ABCFP) and BC Wildfire Service (BCWFS - the zone) to facilitate and recruit volunteer teachers and experts to help with curriculum development and to be delivered in elementary and/or secondary schools. Educational programming can be done in conjunction with currently running programs on fire extinguisher training.	Within current operating budget
2	High	• Summaries of this report and associated maps to be made publicly available through webpage, social media, and public FireSmart meetings.	Within current operating budget
3	Moderate	• Add a Wildfire-specific Fire Prevention Week (or day) in the spring, immediately prior to the fire season.	Within current operating budget
4	Moderate	• Distribute FireSmart informational material to homeowners within 100 m of the interface (ongoing recommendation from 2011). Currently, Kelowna Fire Department (KFD) is targeting Glenmore, with plans to expand the program to Clifton, Wilden, Black Mountain and Kirschner in the spring of 2017.	$2,500
Objective: To enhance the awareness of elected officials and stakeholders regarding the resources required to mitigate fire risk.			
5	Moderate	• Lead the re-establishment of a regional interface committee to coordinate wildfire risk reduction efforts between multiple jurisdictions and aim to integrate forest licensees that are operating within the timber supply area (TSA). Coordination of fuel management activities with forest licensees could significantly aid in the establishment of large, landscape-level fuel breaks or compliment current or proposed fuel treatment areas. Consider including local planning departments to develop regional development permit standards, provide a group voice to the Building and Safety Standards Branch and other provincial entities, and align municipal bylaws.	Within current operating budget
Structure Protection and Planning (Section 7.2)			
Objective: Enhance protection of critical infrastructure from wildfire.			
6	High	• Convert tabular list of critical infrastructure into spatial data. Spatial data of critical infrastructure is included as a component of the data package for this project.	Within current operating budget

Item	Priority	Recommendation	Estimated Cost ($)
7	Moderate	• Complete a fire flow/ water vulnerability assessment across all five water purveyors and identify and map all alternative water sources (reservoirs, streams, lakes, etc). Identify which areas may have insufficient or unreliable water supplies and provide recommendations to reduce City's vulnerability. The water vulnerability assessment should explore the development of alternative water sources, such as reservoirs, in areas of poor water supply (those identified here as Southeast Kelowna, North Glenmore, South Lakeshore Rd, and the Belgo area, as well as any new areas identified in the water vulnerability assessment).	$10,000/ Investigate grant opportunities from Okanagan Water Basin Board
8	Moderate	• Assess all critical infrastructure in interface areas and develop FireSmart recommendations.	Within current operating budget
9	High	• Complete a detailed review of back-up power source options for all critical infrastructure and upgrade as required.	Cost dependent on upgrading required
Structure Protection and Planning (Section 7.2.1)			
Objective: Encourage private homeowners to voluntarily adopt FireSmart principles on their properties.			
10	High	• Complete Wildland Urban Interface (WUI) Site and Structure Hazard Assessments for interface homes, make hazard mapping for assessed homes publicly available, and provide informational material to homeowners on specific steps that they can take to reduce fire hazard on their property.	$10 -$12/ home
Emergency Preparedness (Section 7.3)			
Objective: To improve structural and wildfire equipment and training available to City Fire and Rescue.			
11	High	• Annual structural and interface training with MFLNRO BCWS. As part of the training, it is recommended to conduct annual reviews to ensure PPE and wildland equipment resources are complete, in working order, and the crews are well-versed in their set-up and use. Interface training should include completion of a mock wildfire simulation in coordination with BCWS and safety training specific to wildland fire and risks inherent with natural areas.	$2,000 (annually)
12	Moderate	• Provide Structure Protection Program – Wildland Firefighter (SPP-WFF) Level 1 Training to all/some members of the City Fire Department to enhance wildfire suppression training. The KFD completes S215 and similar training for members as budget allows.	~$600/ member
13	Low	• Review sprinkler protection unit (SPU) request procedure, for both locally-owned and UBCM-owned systems. The KFD Structure Protection Specialists should be well-versed in the rental/ request procedure and operation of the SPU to help guide the KFD and the City should this type of protection be deemed appropriate during a wildfire.	Within Current Operating Budget
Objective: To improve access and egress to neighbourhoods at risk and natural areas within the City.			
14	Low	• Facilitate completion of emergency evacuation plans for interface neighbourhoods with limited access and long response times, such as Finch Road, North Clifton, and Lakeshore Road.	Within current operating budget

Item	Priority	Recommendation	Estimated Cost ($)
15	High	• Develop a Total Access Plan to map and inventory trail and road network in natural areas for suppression planning, identification of areas with insufficient access and to aid in strategic planning. The plan should be updated every five years, or more regularly, as needed to incorporate additions or changes.	$8,000
Municipal Policy: Development and planning (Section 7.4)			
Objective: To reduce wildfire hazard on private land and increase number of homes in FireSmart compliance.			
16	High	• Complete a review of the Official Community Plan (OCP)/ Wildfire Development Permit (DP) process to strengthen and expand reach of the existing policy. Review District of North Vancouver DP process as a model. Amend OCP to incorporate recommendations within this document.	~ $35,000
17	High	• Wildfire development permit should be triggered for new builds and major retrofits/ renovations (as part of the building permit), as well as for land subdivisions. This will align the wildfire hazard development permit with the other hazardous conditions development permits and expand the number of FireSmart compliant homes gradually as development, re-builds, and major renovations occur (major renovations usually defined as a complete re-build on a previously existing foundation).	$160,000 (Based on generation of 600 – 800 new DP files per year and 2 additional FTE in planning department)
18	High	• Obtain legal confirmation regarding the Building Act, specifically regarding the temporarily unrestricted matters and local government authority to set exterior building materials requirements. Use local government authority to mandate FireSmart construction materials beyond BC Building Code in wildfire hazard development permit area. Construction materials (roofing, soffits, siding, vents, windows, doors, and overhanging projections/ decks) should be FireSmart compliant. FireSmart building materials should also be required on all outbuildings, garages, or sheds within 10 m of the residence or adjacent residences.	$1,000 for legal confirmation. City costs for implementation depend on outcome of confirmation and implementation strategy.
19	Moderate	• Conduct a workshop, or series of workshops, to inform, engage, and consult the development community. Topics could include revisions to the DP process and terms of reference, and FireSmart building and landscaping.	Cost included in recommendation #16

Item	Priority	Recommendation	Estimated Cost ($)
20	High	• Formalize a Terms of Reference document to be provided to the developers and QPs completing assessments. Two standards are recommended: one for sub-divisions and one simpler standard for individual builds. o Elements for the basic wildfire hazard report should include: professional qualification of QP, assessment and quantitative description of surface, ladder, and crown fuels; reference to building materials, design and placement; setbacks from forested edge and top of slope; a FireSmart WUI site and structure assessment; landscaping; representative photos; any existing covenants; mitigative actions required to ensure that the home meets FireSmart compliance; and maintenance regime to ensure that risks are minimized to the extent possible. The report should clearly state any required elements or conditions which would render the development not within an acceptable range of wildfire risk for its intended purposes. Peer reviews may be required at the expense of the applicant. The report should include a map showing, at a minimum building footprint, proposed mitigative actions, and FireSmart priority zones.	Cost for formalizing terms of reference included in recommendation #16 (updating current process/ DP guidelines). Costs for implementing terms of reference update for individual builds included in FTE in recommendation #17.
21	High	• Ensure that development bonds levied at the time of development permit application are sufficient to cover wildfire mitigation activities (among other factors for which the bond is intended to cover). One condition of bond return should be submission of a FireSmart post-development inspection of building and landscaping. The inspection is to be completed by a QP to ensure that the development meets the requirements of the wildfire hazard assessment report. Photographs of the completed site and structure should be included in the sign-off.	~$10,000 annually for additional clerical resources. For individual builds, cost is included in FTE in recommendation #17.
22	High	• Require a landscaping plan, or plant-selection list, to be provided as part of the development permit application. The landscaping plan/ plant-selection list should be FireSmart compliant and consistent with City standard (recommendation #24), as well as include plans for re-vegetation of disturbed areas. o Highly flammable plants should not be planted within 10 m of structures (this includes juniper, cedar, and other flammable conifers). Disturbed areas, such as roadsides and buried water and utilities, should be re-vegetated with a native grass-seed mix and native deciduous and evergreen low-flammability shrubs according to the site conditions and distance from structures.	City costs included in FTE costs in Recommendation #17 (single-family homes). Sub-division and multi-family homes are within current operating costs. Additional costs should be expected by the developer.
23	Moderate	• City of Kelowna to work with the Building and Safety Standards Branch to provide input into the Building Code revisions which would apply within the development permit areas to prevent the spread of wildfire. The City of Kelowna should lobby for FireSmart building materials and design, consistent with development permit requirements. The Fire Chiefs' and Fire Prevention Officers' Association can provide valuable influence in this arena.	Within current operating budget

Item	Priority	Recommendation	Estimated Cost ($)
24	High	• Develop a landscaping standard to be applied in interface/ DP areas based on FireSmart guidelines. The standard should list flammable non-compliant vegetation, non-flammable drought and pest resistant alternatives, and tips on landscape design to reduce maintenance, watering requirements, and reduce wildfire hazard.	Cost for standard development included in recommendation #16. Implementation as "guide or best practices" is within current operating budget. Implementation as regulation included in FTE costs in Recommendation #17.
Municipal Policy: Subdivision design (Section 7.4.1.1)			
Objective: To incorporate wildfire hazard reduction considerations in subdivision design.			
25	High	• New subdivisions should be developed with access points that are suitable for evacuation and the movement of emergency response equipment. The number of access points and their capacity should be determined during subdivision design and be based on threshold densities of houses and vehicles within the subdivision.	Within current operating costs
26	High	• Where forested lands border new subdivisions, consideration should be given to requiring roadways to be placed adjacent to those lands. If forested lands surround the subdivision, ring roads should be part of the subdivision design. These roads both improve access to the interface for emergency vehicles and provide a fuel break between the wildland and the subdivision.	Within current operating costs
27	High	• Proximity of hydrant locations to access points for forested parks should be a consideration during the design process for new subdivisions. The KFD should continue to review hydrant spacing and location for all new developments to ensure that water availability is sufficient for suppression purposes.	Within current operating costs
Municipal Policy: City parks obtained through development process (Section 7.4.1.2)			
Objective: To reduce hazard and liability in the short and long term in City-owned natural parks obtained through development process.			
28	High	• Formalize the current checklist into a Terms of Reference document to be provided to the developers and Qualified Professionals (QPs) completing assessments. Recommended elements for assessment, above those already outlined in recommendation 21, are: minimum levels of experience for QPs, road access/ egress, water availability/ hydrant location, fuel treatment prescriptions, natural areas access plan, reference or links to standards, WUI threat plot forms and SWPI prescription templates, required mapping elements, and Target Stand Conditions (TSCs) to help guide prescribed mitigation activities.	Cost included in recommendation #16

Item	Priority	Recommendation	Estimated Cost ($)
29	High	• The City should adopt a consistent standard for Registered Professional Forester wildfire hazard assessments and fuel treatment prescriptions required as part of the Development Permit process. This would help to ensure that hazard mitigation activities are consistent and appropriate within all subdivisions, that multiple values are considered in the prescription process, and help to streamline the evaluation process. The fuel treatment prescriptions should make use of the SWPI fuel management prescription template (or Kelowna-developed equivalent). Wildfire hazard assessment report standards can be adapted from the proposed standard contained in the Review of Policies, Procedures and Bylaws Relating to Wildland Fire, or adapting the proposed standard from the table of contents provided in APPENDIX J: FIRE HAZARD ASSESSMENT STANDARD.	Cost included in recommendation #16
30	High	• Consult with purchasing regarding an approved contractor shortlist for QPs from which a high standard of work and professionalism can be expected. Solutions may include contractors submitting an Expression of Interest from which the City can evaluate their knowledge, skills, and experience.	Within current operating costs
31	High	• Development Permit for sub-divisions should require an access plan for areas to be turned over to the City as parks. Access plans should be completed by a QP with experience in operational fuel treatment and with a strong understanding of fire behaviour. The plan should consider crew access for fire suppression, fuel breaks and control lines for suppression and future maintenance burns, and crew and equipment access for future maintenance activities. The access plan should be reviewed and approved by the Parks Department as part of the wildfire hazard assessment.	Within current operating costs (Costs borne by developer)
32	High	• The lands designated as future City parks should be reviewed and approved by the Parks Department, early in the DP process. This can be accomplished with a 'preliminary' development permit report with proposed park lands submitted early in the process which will allow for meaningful review and input from Parks. Review should include wildfire threat, location relative to slope and values at risk, access, and associated liability to the City.	Within current operating costs
33	High	• Ensure that bonds levied at the time of the development permit application are sufficient to cover wildfire mitigation activities. The bond should be returned upon post-treatment inspection of operational fuel treatment and threat rating of lands to be assumed by the City (along with any other non-wildfire related cost factors incorporated into the bond amount). The inspection is to be completed by a QP to ensure that the development meets the requirements in the wildfire hazard assessment report and fuel treatment prescription. Representative photographs should be included in the sign-off.	Within current operating costs
34	High	• Create a decision matrix analysis that allows the City to transparently and effectively evaluate multiple options (i.e. assume parkland as designed or request redesign of parkland) according to multiple weighted factors (social, environmental, and economic).	$2,000

Item	Priority	Recommendation	Estimated Cost ($)
Municipal Policy: Other (Section 7.4.2)			
Objective: To reduce hazard and liability on private land.			
35	High	• The City should enforce Section 8.1.1 of Bylaw No. 10760 requiring owners to maintain their properties hazard free on all properties, with a focus on interface properties and properties in Wildland Fire Hazard Development Permit areas. Enforcement will serve to minimize fuel risks on problematic private properties which have allowed hazardous accumulation of fuels and provide improved protection to adjacent lands.	Increased costs dependent of extent of enforcement
36	High	• The City should alter the zoning bylaw to require that developers leave building set backs on private land consistent with FireSmart recommendations. This standard should be applied to housing bordering both City owned and forested private land within the Development Permit area.	Cost included in recommendation #16
Fuel Management (Section 7.5)			
Objective: Reduce wildfire threat on private and public lands through fuel management.			
37	High	• Apply for funding to conduct maintenance for previously treated areas, starting with priority 1 areas.	UBCM SWPI Funding / Municipal Funding
38	Moderate	• Apply for funding to continue fuel management projects on lands identified for treatment which are eligible for UBCM SWPI funding.	UBCM SWPI Funding / Municipal Funding
39	Moderate	• Engage with BC Parks regarding hazardous fuels and fuel treatment implementation in identified polygons in Myra Bellevue Provincial Park.	Within current operating costs
40	High	• The City should work with developers to ensure that all lands turned over to the City as natural parks are in a moderate hazard state prior to taking ownership. This should include thinning, pruning, and/or burning. Priority areas are Kirschner and Black Mountain (currently privately held).	Within current operating costs
41	High	• Continue roadside mowing program to maintain grass and remove dense conifer regeneration along roadways.	Within current operating costs
42	N/A	• Prescribed fire (pile burning and broadcast burning) should be a tool available to land managers for fuel treatments and maintenance activities to improve cost efficiency and efficacy of fuel treatments. Any use of fire should strictly follow smoke management guidelines to limit the health impacts of smoke and be done in cooperation with the BCWFS.	Within current operating costs
43	Moderate	• The City should adopt a standard for fuel management in parks and green spaces.	$2,000
Objective: Maintain previously treated areas under an acceptable level of wildfire fire threat (moderate).			
44	Moderate	• Implement a 3 – 5 year grazing pilot program, including engagement of a grazing/ range specialist, consultation with jurisdictions with a similar program, and consultation regarding funding from UBCM.	UBCM SWPI Funding/ Municipal Funding

Item	Priority	Recommendation	Estimated Cost ($)
45	High	• Implement a prescribed burn pilot project, including a burn plan and smoke management plan and public relations plan. Post-burn analysis of results should include measuring treatment efficacy (fuels and ecological analysis), as well as efficacy of smoke management plan and public reaction/ support.	UBCM SWPI Funding/ Municipal Funding/ BCWFS Support
46	Low	• Establish a monitoring program for the previously treated areas. A formalized program can inform future maintenance schedules, help track natural areas newly acquired through the development process, and help to more effectively manage the City's rapidly expanding natural areas lands. Cost reduction options include recruiting a graduate student to undertake this project as a research opportunity.	$10,000 (explore graduate student opportunity to reduce costs)
Objective: Reduce the wildfire threat to the City and neighbouring jurisdictions with a cooperative regional approach.			
47	High	• Submit phase 1 application for Forest Enhancement Society of BC (FESBC) funding for a landscape level fuel break in the southeast of the study area and to the east of the study area. Look for synergies with other funding sources, initiate engagement with other agencies, jurisdictions, and governments (MFLNRO, RDCO, licensees, Westbank First Nation), and identify opportunities to enhance/ satisfy multiple selection criteria, such as wildlife habitat enhancement/ ecosystem restoration, forest health salvage, and fiber recovery.	FESBC funding

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INTRODUCTION

The Community Wildfire Protection Plan (CWPP) Program was created in British Columbia (BC) to aid communities in developing plans to assist in improving safety and reducing the risk of damage to property. The Program was developed in response to recommendations from the "Firestorm 2003 Provincial Review"[1].

The 2003, 2004, 2009, 2010, and 2015 BC wildfire seasons resulted in valuable economic, social and environmental losses. Devastating wildfires south of the border in the 2014 and 2015 wildfire seasons (Pateros and Wenatchee, WA) served additional notice of the risk and vulnerabilities of communities in the wildland urban interface (WUI). Within Canada, tragedies like those experienced in Slave Lake and Fort McMurray, Alberta are further evidence of the potential toll of wildfires on the community and economy of entire municipalities. These losses emphasized the need for greater consideration and due diligence with respect to fire risk in the WUI. In considering the wildfire risk in the WUI, it is important to understand the unique risk profile of a given community. While there are common themes that contribute to the risk profile of communities across BC, each community has unique aspects that require consideration during the CWPP process. Understanding the factors is important in developing a comprehensive plan to identify and reduce wildfire risk. The 2003 Okanagan Park fire and the 2011 fire in Slave Lake, Alberta, as well as the Carlton Complex and the Sleepy Hollow Fire in Pateros, WA and Wenatchee, WA, respectively, demonstrated that the consequences of a WUI fire can be very significant and devastating to communities and that proper consideration and pre-planning is vital to reducing the impacts of wildfire.

In 2016, B.A. Blackwell and Associates Ltd. were retained by the City of Kelowna (the City or Kelowna) to complete an update of the City of Kelowna Community Wildfire Protection Plan, completed by Diamondhead Consulting Ltd, Valhalla Consulting Ltd, and Geographica Group in 2011 (hereinafter referred to as the '2011 CWPP'). The 2011 CWPP was an update of a similar document developed in 2004 (previously called a Fuel Management Plan), which will not be referenced further in this document. Since 2011, considerable new development in the WUI has occurred. These areas either were not previously assessed for hazard, or the hazard and associated threat will have changed (increased) due to the location and siting of the new development in relation to the assessment polygons. Additionally, methods for assessing wildfire threat have been enhanced since 2011; this update will make use of the methodology and baseline data that is the current provincially accepted standard for hazard and threat analysis. This CWPP update provides a reassessment of the level of risk with respect to changes in the community and reflects the current conditions.

Specifically, the objectives of this update are to:

- Summarize implemented recommendations from the 2011 CWPP;
- Summarize wildfire risk mitigative actions implemented by the City which may be outside the recommendations of the 2011 CWPP;
- Provide the City with an updated threat assessment;

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

- Prioritize mitigative action recommendations to address communication and education, structure protection, emergency response, and fuel management;
- Provide a prioritized maintenance schedule for the areas that have been treated; and,
- Provide a current document that highlights best practices for smoke management and safe prescribed burning practices, as well as explores alternative avenues.

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

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

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

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

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

1.0 COMMUNITY WILDFIRE PROTECTION PLANNING PROCESS

This CWPP document will review the background information related to the study area which includes the City of Kelowna boundary and a 2 km buffer around the City boundary. The study area does not extend to the west shores of Lake Okanagan, as this area is under alternate jurisdiction and covered in other CWPPs. The CWPP update consists of seven general phases:

1. **Background research** - general community characteristics, such as demographic and economic profiles, critical infrastructure, environmental and cultural values, fire weather, fire history, relevant legislation and land jurisdiction.
2. **Initial GIS analyses** – updating fuel typing, creating threat polygons for the study area, assigning initial threat based upon fuel type, aspect, slope, and proximity to structure.
3. **Field work** - site visits to the area to allow for 1) meetings with City staff; 2) fuel type verification; 3) completing hazard assessment forms, 4) ground-truthing initial threat ratings, and 5) identification of site specific issues.
4. **Consultation** – meetings and consultation with Okanagan-Shuswap Forest District staff (land manager) and Fire Zone representatives.
5. **Secondary GIS analyses** – final fuel type updating and threat rating based upon field ground-truthing and results of hazard assessment forms.

6. **Report and map development** - identification of City challenges and successes, identification of measures to mitigate risks, and recommendations for action.
7. **Report review** - by City staff and representatives from the Okanagan Shuswap Forest District, BCWS, and Westbank First Nation.

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

Since 2011, the City has made significant progress at implementing recommendations from the current CWPP and has shown provincial leadership in many aspects of wildfire mitigation activities. A summary of the most pertinent recommendations implemented can be found throughout the document in the relevant sections. A comprehensive table of recommendations and implementation status can be found in APPENDIX A: STATUS OF 2011 CWPP RECOMMENDATIONS.

2.0 COMMUNITY PROFILE

The City of Kelowna is on the Southern Interior Plateau of the Central Okanagan (DHC 2011[2]). The City was incorporated in 1905 when agriculture was the main economic driver of the region. Today, Kelowna is the largest city in British Columbia's Okanagan Valley, with a population of 117,312 as of the 2011 Census and a more recent population estimate of 123,500.[3] This represents a 5.3% increase over five years. From 2006 to 2011 the City experienced ~9.5% increase in population. The growth in the City is primarily driven by in-migration to the community.[4] According to the 2011 census, the City of Kelowna had approximately 50,000 private dwellings, of which 50% were single-detached homes.

Kelowna has a strong economy based upon year-round tourism, agriculture, and a light industrial sector. The primary industries include health care and social assistance, construction and retail trade. Wineries, golf courses, shopping, water recreation, and natural beauty are draws to the region; Kelowna's International Airport is the 10th busiest airport in Canada.[5] Recent trends have shown increases to the housing sector and technology.[4]

Kelowna encompasses 214 square kilometers of land and an additional 42 square kilometers of water. The City's downtown core is located in the middle of the town adjacent to the lake. The population density of the region is approximately 62 persons per square kilometer. There are numerous high density, primarily single-family home

[2] Statistics Canada. 2012. Focus on Geography Series, 2011 Census. Statistics Canada Catalogue no. 98-310-XWE2011004. Ottawa, Ontario. Analytical products, 2011 Census. Last updated October 24, 2012.

[3] http://www.kelowna.ca/CM/Page67.aspx. Accessed 31 March, 2016.

[4] City of Kelowna. 2015. Our Future in Focus 2015 Community Trends Report.

[5] http://www.kelowna.ca/CM/Page67.aspx#Industry

neighbourhoods built in the WUI and multiple new neighbourhoods in various phases of the development process. The majority of the low-slope areas within the City are either part of the Agricultural Land Reserve (ALR), or have been developed, pushing new developments to mid or upper slope locations, and often adjacent to forested areas.

Figure 1. The new-subdivision, Wilden is representative of locations of recent development occurring within the City of Kelowna: mid and upper slope and surrounded by coniferous forested land. These locations are desirable for providing homeowners with beautiful valley and lake views, but also present access, suppression, and wildfire threat concerns.

The City of Kelowna is bounded on the West by Lake Okanagan, to the north by Lake Country, and to the east and south by the Regional District of Central Okanagan. Directly across the lake is neighbouring municipality West Kelowna. Westbank First Nations have multiple reserves in the area, both within the municipal boundary, as well as across the lake.

Access from the west and north are provided by Hwy 97; the east is accessed by Hwy 33. There is no access to the south; the south is undeveloped land much of which is protected by the Provincial Park system.

An overview of the City of Kelowna and the study area is illustrated below (Figure 1).

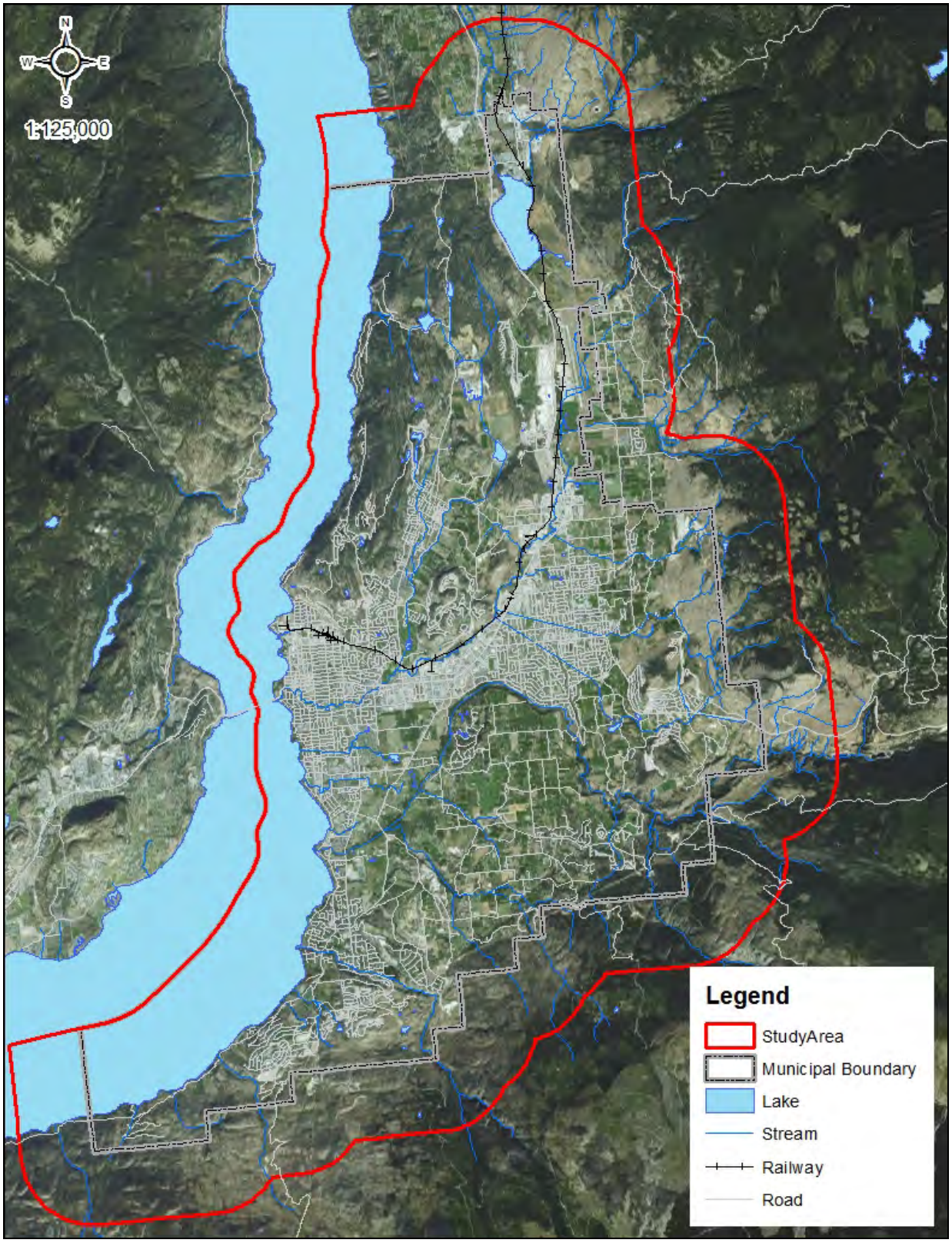


Figure 2. Overview of the Community Wildfire Protection Plan Update study area for the City of Kelowna.

2.1 CRITICAL INFRASTRUCTURE

Protection of infrastructure during a wildfire event is important to ensure that emergency response is as effective as possible, to ensure coordinated evacuation can occur if necessary, and essential services in the study area can be maintained and/or restored quickly. Critical infrastructure includes emergency and medical services, water, electrical service, transportation, major water infrastructure, and communications infrastructure. Critical infrastructure locations were provided by the City (Kelowna Fire dispatch) and are illustrated below (Figure 3). Schools and government offices may serve as critical infrastructure, though they are not analyzed as part of this report.

The KFD maintains a tabular list of the critical infrastructure within, and adjacent to, the study area. As part of this CWPP, information from the tabular list, such as water, communications, emergency services, electrical, and medical infrastructure, have been located spatially (Figure 3). It is recognized that there are many other physical structures, systems, and facilities that are extremely valuable to the City and are required for the healthy, efficient functioning of the economy and the City.

Emergency services within the study area include 6 R.C.M.P. / police facilities (detachments, district headquarters, community policing, telecommunications and radio workshop), 911 dispatch service (police, ambulance or fire), Kelowna General Hospital including the BC Cancer Agency, 7 Kelowna Fire Department (KFD) stations, 2 BC ambulance service stations, an established Emergency Operations Centre (EOC) located at KFD Station 1, and the Kelowna International Airport and associated services. The EOC is operated by the KFD on behalf of the Regional District and is used in times of emergency or disaster. There are four radio/ television broadcast facilities and nine communication towers within the study area.

Electrical service for most of the study area is received through a network of wood pole transmission and underground distribution infrastructure supplied through Fortis BC. Those neighbourhoods that depend on wood pole distribution lines (small, street-side poles) to connect homes and subdivisions would be vulnerable to fire, which could disrupt service to portions of the community.

The City owns, operates and maintains one of the five separate water infrastructure systems. The other four are operated and maintained by four separate, independent organizations, each operating under the Local Government Act. Water systems will be discussed in more detail in Section 2.2.

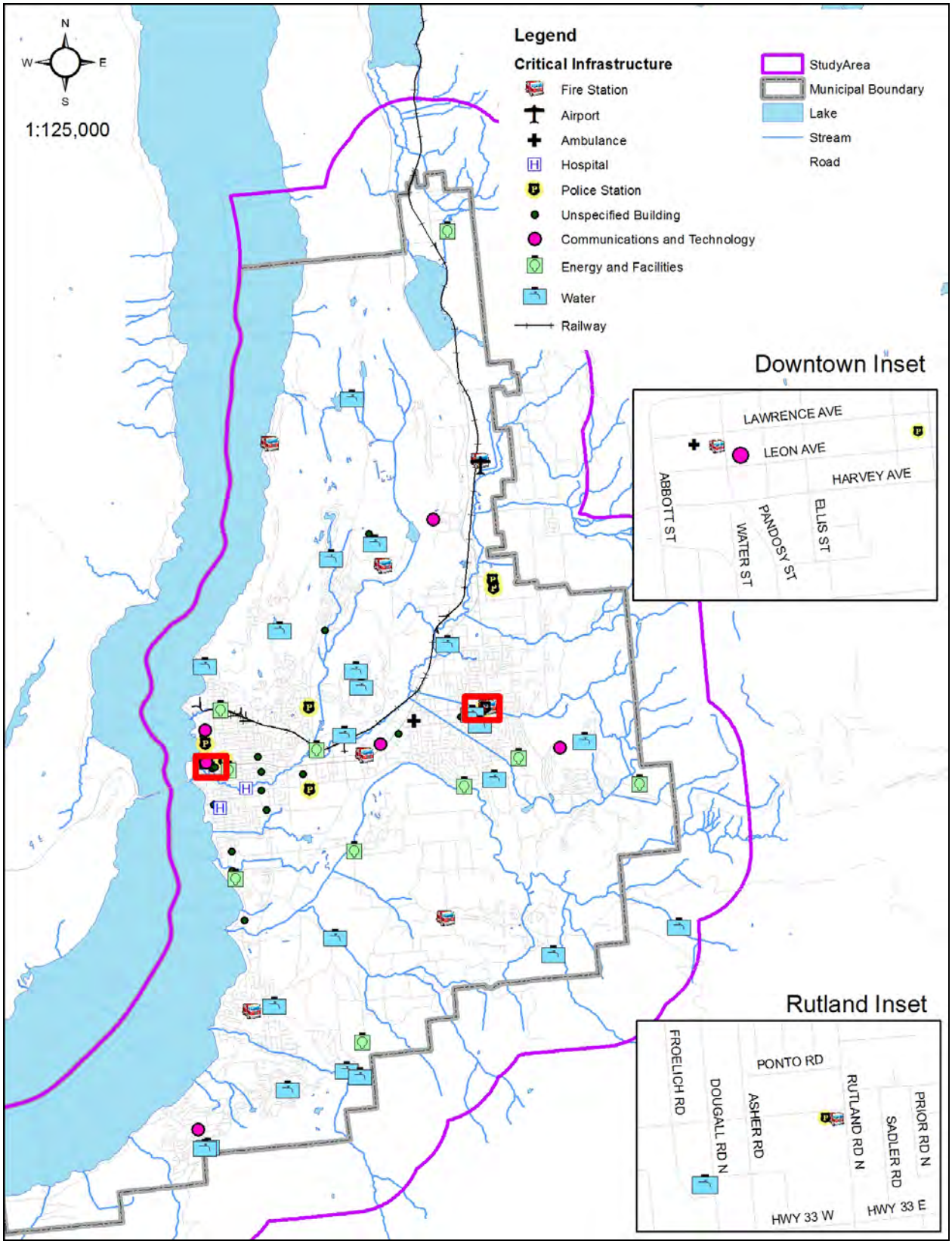


Figure 3. City of Kelowna critical infrastructure locations.

2.2 WATER

2.2.1.1 WATER SYSTEMS

There are five independent water providers that operate within the municipal boundaries, one of which is the City of Kelowna. The five water purveyors operate over 19 different systems. Each water provider (improvement district or irrigation district) is a public water utility responsible for providing water to, and maintaining infrastructure for, various communities, neighbourhoods, institutions, and agricultural areas within the study area. The five water providers are listed below.

- City of Kelowna provides water to approximately 60,000 customers from three pump stations (Poplar Point, Eldorado, and Cedar Creek) and another 300 customers from the Swick Road system.[6]
- Glenmore Ellison Improvement District (GEID) serves ~18,000 residents in Glenmore Valley, the Sexsmith area, UBCO, Kelowna Airport, and Quail Ridge.[7] This system is a combination of pumped and gravity fed distribution.
- Black Mountain Irrigation District (BMID) water supply system consists of 600 km^2 in Mission Creek and Scotty Creek basins. It serves ~22,000 residents through 8,449 connections to residential, commercial, industrial, and institutional properties and over 800 irrigation connections for agricultural lands.[8] This is a gravity-fed system.
- Rutland Waterworks District (RWD) is the smallest district in Kelowna, both in size and population served. Water is pumped from a ground water source.
- South East Kelowna Irrigation District (SEKID) is a gravity fed distribution system from McCulloch Lake.

Each water provider is independently governed by a board of elected trustees; the *Local Government Act* is the primary legislation. Although there is a joint water committee, each irrigation district has their own individual bylaws, not all of which are consistent with City bylaws. Lack of consistency in bylaws can create operational challenges, such as inconsistent or unreliable fire flows and hydrant spacing, and systems vulnerable to wildfire and/or power outages. It should be noted that the water systems represent a range in quality and comprehensiveness of maintenance record keeping, as well as differences in infrastructure maintenance and sustainability. Despite the risk of the operational challenges noted above, the KFD has not experienced a failed hydrant or other major operational failure due to the water systems during a suppression incident in recent memory.[9] Although the City is generally well-serviced by hydrants, there are interface areas within the municipal boundary where hydrant spacing has been recognized by the KFD as insufficient. These areas include southeast Kelowna, Belgo area, North Glenmore, and South Lakeshore Road.

[6] City of Kelowna. 2015. Drinking Water Annual Report City of Kelowna.

[7] Glenmore Ellison Improvement District. http://glenmoreellison.com/about/geid_system_info/. Accessed 06 April, 2016.

[8] Black Mountain Irrigation District. http://www.bmid.ca/who-we-are/intro-to-the-bmid.aspx. Accessed 06 April, 2016.

[9] Consultation with the KFD. April 2016.

The 2011 CWPP noted the importance of alternative water sources for suppression activities, such as helicopter bucketing and pump sites, particularly in rural settings or where hydrant coverage is limited. The City should continue their implementation work regarding alternative water sources, as identified in the 2011 CWPP. Detailed information regarding these recommendations is found in the Action Plan, Section 7.2.

2.3 ENVIRONMENTAL & CULTURAL VALUES

Environmental, cultural and recreational values are high throughout the study area. The City offers a range of outdoor activities for tourists and residents, and cultural values within or overlapping the study area include Okanagan (Syilx) Nation and Westbank First Nation traditional lands which comprise fish bearing habitat, hunting grounds, archaeological sites, and sites of cultural significance. The City has a memorandum of understanding with the Westbank First Nation and drafts of this document were supplied to the Westbank for their review and input.

Other values within the study area include heritage buildings, Crown and private forest lands, and land that is administered by the Provincial Agricultural Land Commission (ALC), where the ALC is responsible for the administration of the *Agricultural Land Commission Act*. This land is part of the Agricultural Land Reserve (ALR). Subdivision and land use within the ALR is regulated by the ALC and the priority use of this land is for agriculture.[10] The ALR lands, which include farmed, forested or vacant lands, are valuable to the community and the Province. A significant wildfire would result in an impact on various values at risk throughout the study area, including valuable forest and farmland.

2.3.1 ENVIRONMENTAL VALUES

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

Within the study area there are 8 occurrences of red-listed species and 12 occurrences of blue-listed species. There are overlaps with at least one secured occurrence, which will not be discussed further here. Site level, operational plans must determine through consultation with the CDC and biologist or qualified professional if these occurrences (masked or publicly available) will be impacted by fuel management or other wildfire mitigation activities. All future fuel treatment activities or those associated with recommendations made in this plan should consider the presence of, and impact upon, potentially affected species. Additionally, all site level operational plans should consult the most recent data available to ensure that any new occurrences or relevant masked occurrences are known and considered in the operational plan to mitigate any potential impacts on species at risk. A detailed table of all publicly available occurrences within the study area is found in APPENDIX B: SPECIES AT RISK WITHIN STUDY AREA.

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

2.3.2 ARCHAEOLOGICAL VALUES

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

As noted in the 2011 CWPP, "features of historical and cultural significance… should be considered for protection during wildfire planning and suppression activities". The plan recommended an update of the archaeological features map every five years. Current data sourced from the MFLNRO Archaeology Branch (April, 2016) shows 238 identified archaeology sites within the study area. Due to site sensitivity, the exact locations of the sites may not be made public. The City should apply for direct access to Remote Access to Archaeological Data (RAAD) to look up or track any archeological sites in the area.[11]

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

A draft of this strategy was referred to Westbank First Nation for review and input.

2.4 COMMUNITY SUPPORT

There is widespread recognition and awareness, both in City staff and the community members in general, of the threat posed to the community by wildfire, and general support for hazard mitigation activities. The City of Kelowna has displayed their commitment to reduce the threat posed by wildfire; the City has been active in implementing fuel treatment projects, enacting policy, including wildfire considerations in their planning, and implementing recommendations from the 2011 CWPP.

2.5 KEY CONTACT, PARTNERSHIP AND FUNDING OPPORTUNITIES

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

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

- **Federal Government** – funding is inconsistent, but there are opportunities to take advantage of programs designated for on-reserve works that would not be funded by the provincial government.
- **Provincial Government**
    - FNESS/UBCM – funding opportunities through the SWPI program.
    - Forest Enhancement Society of BC – funding opportunities for wildfire risk reduction and FireSmart activities that are not eligible under the UBCM funding structure.
    - Okanagan Shuswap Natural Resource District
        - BC Wildfire Service – support is already established with the zone. This relationship will be integral for any future prescribed burning.
        - Landscape level fire management planning at the District level has the potential to impact activities undertaken by the City and funding opportunities, particularly for landscape level fuel breaks which would benefit the region.
    - BC Parks – Provincial parks within the study area pose significant wildfire threat to the City. Other areas that are not currently high threat will increase with time, as these areas revegetate and recover from previous large-scale forest fires.
- **BC Hydro** – right of way clearing and fuel hazard should be discussed in future contract work between the Band and BC Hydro. BC Hydro should be encouraged to maintain its rights of way in a low hazard state (frequent brushing, with brushed material removed prior to curing).
- **Licensees** – Gorman Brothers, BCTS, Weyerhaeuser, Tolko – there may exist an opportunity for partnerships in commercial harvest of hazardous areas that may not qualify under the SWPI program (i.e., too far from infrastructure, but which may still pose a spotting risk to the community or could be leveraged into a landscape level fuel break).
- **Adjacent jurisdictions** – Regional District of Central Okanagan, Westbank First Nation, West Kelowna, Lake Country, Vernon – a regional approach to wildfire management has been successful in other areas. There may be an opportunity to create a regional steering committee to help guide and implement strategic wildfire initiatives.

2.6 FOREST FUEL AND PAST WILDFIRE INFORMATION

2.6.1 BIOGEOCLIMATIC UNITS

The biogeoclimatic information and classifications have not changed since the previous CWPP; the information from the previous CWPP was confirmed as accurate and is summarized in APPENDIX C: BEC ZONES WITHIN THE STUDY AREA.

2.6.2 NATURAL DISTURBANCE TYPES

Biogeoclimatic subzones are categorized into natural disturbance types (NDTs) based on the size and frequency of natural disturbances (largely fire) that historically occur within the subzone. The NDT classifications have not changed since the development of the 2011 CWPP; the entirety of the study area falls into NDT 4 or ecosystems with frequent stand maintaining fires. A summary of NDTs can be found in APPENDIX D: NATURAL DISTURBANCE TYPES.

2.6.3 TIMBER HARVESTING LANDBASE

The study area is surrounded by the Okanagan Timber Supply Area (TSA) and covers approximately 2.25 million hectares of the region. Approximately 55% of the TSA is considered productive forest land and 32% of the TSA, or 1.04 million hectares, is within the current timber harvesting landbase. This equates to 41% of the productive forested area not available for timber harvesting.[12] The timber harvesting landbase is dominated by Douglas-fir and lodgepole pine. The most recent data package compiling information on forest resources inventory was completed in 2010 and has not been updated since the 2011 CWPP.[13] The allowable annual cut (AAC) has been increased four times since 1986; all were uplifts to enable harvesting of mountain pine beetle affected timber.[12]

2.7 FOREST HEALTH

A major forest health factor for the study area has been the mountain pine beetle. The impact of mountain pine beetle on fire hazard in the area was well-documented in the 2011 CWPP and include the recommendation to "(m)onitor the pine beetle and be proactive to remove all dead and dying pine in the urban/wildland interface". Though this is an ongoing recommendation, the City has sanitized much of the beetle-impacted WUI areas, which has been effective at reducing the hazard associated with dead and dying pine. Although mountain pine beetle attack in the area has continued to decline and the most recent recorded attack was scattered and of low intensity, this recommendation should be continued to be implemented, as mortality occurs.

A secondary forest health factor in the area is Douglas-fir tussock moth, a defoliator that mainly attacks Douglas-fir, but may also attack ponderosa pine if adjacent to an infested Douglas-fir.[14] Tussock moth infestations usually occur in a 10 - 12 year cycle and can cause significant mortality to Douglas-fir stands in peaks of heavy infestation (Maclauchlan 2013). The City of Kelowna has implemented a direct control strategy to control the moth; the last infestation was sprayed in 2010. Because the building phase of a tussock moth outbreak can take 1 – 2 years, it should be recognized that another infestation is likely to occur 2018 – 2022 (Maclauchlan 2013).

Western spruce budworm, a Douglas-fir defoliator, is a minor forest health factor in the study area. Recently identified outbreaks are considered light (<10% of the trees in the polygon impacted) and have been confined to

[12] Ministry of Forests, Lands, and Natural Resource Operations Forest Analysis and Inventory Branch. 2011. *Okanagan TSA Timber Supply Analysis Public Discussion Paper*.

[13] Okanagan Timber Supply Area Timber Supply Review. 2010.

[14] Field Guide to Forest Damage in British Columbia. http://www2.gov.bc.ca/assets/gov/environment/air-land-water/land/forest-health-docs/field_guide_to_forest_damage_in_bc_web.pdf.

the eastern edge of the study area. At this time, budworm is not considered to significantly impact the City's fire hazard.

During the summer of 2015, the Southern Interior Plateau experienced drought and significant growing season moisture deficits. Trees stressed by drought are more vulnerable to attack by insects and disease. Drought stress and mortality (primary or secondary causal factor) was identified in approximately 10 – 15% of the stems in the forested parts of the study area (see photo of dead crowns/ die back). According to many climate change models, drought stress will continue to be a factor in the Okanagan, as the expected trend for southern and central BC is for higher temperatures and drier summers.[15] [16]

3.0 WILDFIRE BEHAVIOUR AND WUI THREAT ASSESSMENT

3.1 FUEL TYPE SUMMARY

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

The initial starting point for study area fuel typing is the 2015 Provincial Strategic Threat Analysis (PSTA), which is based on the FBP fuel typing system. PSTA data is limited by the accuracy and availability of information within the Vegetation Resource Inventory (VRI) provincial data; confidence in fuel type provincial fuel type data is low on private land. For the above reasons, fuel types from the PSTA data have been updated using recent (2015) orthophotographs of the study area and with field fuel type verification.

Similarly to the 2011 CWPP, it should be noted that fuel types represent a fire behaviour pattern and may not exactly match the fuel types described in the classification system. In addition, fuel type polygons may not adequately describe the variation in the fuels present within a given polygon, due to errors within the PSTA and VRI data and adjustments required in the data.

Table 2 summarizes the fuel types by general fire behaviour and total area for the study area. In general, the fuel types considered hazardous in terms of dangerous fire behaviour and spotting potential are C3 and C7 at higher density or with continuous bunch or pine grass surface fuels. An M2 fuel type can sometimes be considered hazardous, depending on the proportion of conifers within the forest stand. An O1-b fuel type often can support a rapidly spreading grass or surface fire capable of damage or destruction of property and human life. These fuel types were used to guide the threat assessment.

[15] MFLNRO. Climate Change. https://www.for.gov.bc.ca/hre/topics/climate.htm

[16] Wang, T. and Hamann, H. Climate BC Map. http://www.climatewna.com/climateBC_Map.aspx/. Centre for Forest Gene Resource Conservation.

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

Table 2. A summary of fuel types, associated hazard and areas within the study area.

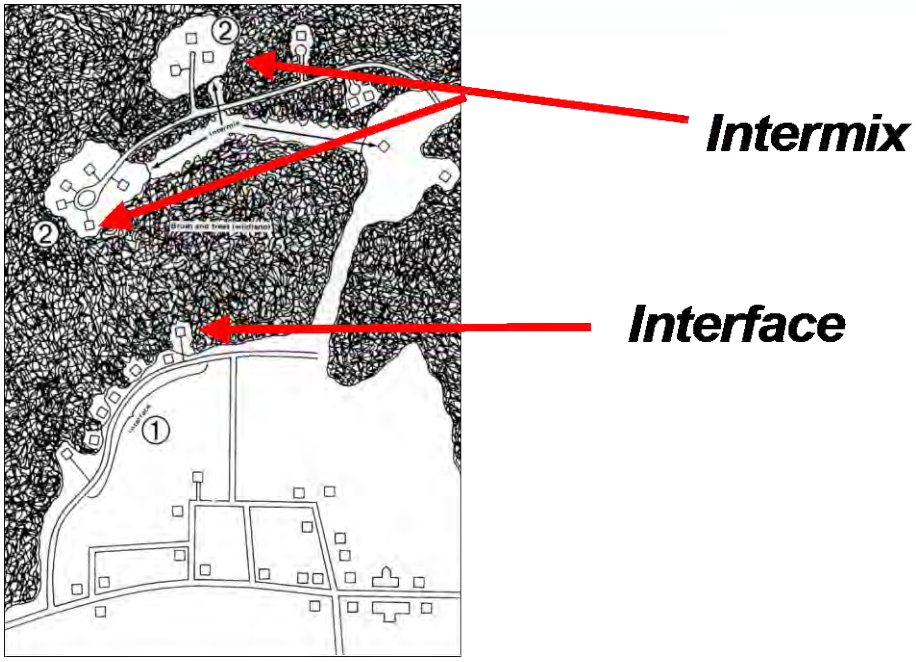
Fuel Type	Description	Wildfire Behaviour Under High Wildfire Danger Level	Area (ha)	Percent (%)
C-3	Fully stocked, mature forest, crowns separated from the ground	Surface and crown fire, low to very high fire intensity and rate of spread	27	0.1
C-7	Open, uneven-aged forest, crowns separated from the ground except in conifer thickets, understorey of discontinuous grasses, herbs	Surface fire spread, torching of individual trees, rarely crowning (usually limited to slopes > 30%), moderate to high intensity and rate of spread	9,924	25.5
M-2	Moderately well-stocked mixed stand of conifers and deciduous species, low to moderate dead, down woody fuels, crowns nearly to the ground	Surface fire spread, torching of individual trees and intermittent crowning, (depending on slope and percent conifer)	553	1.4
D-1/2	Moderately well-stocked deciduous stands	Always a surface fire, low to moderate rate of spread and fire intensity	226	0.6
O-1a/O-1b	Short grass/ Sparse or scattered shrubs, long grass, and down woody fuels.	Rapid spreading, intense surface fire	6,833	17.6
W	Water	N/A	5,557	14.3
NF	Non-fuel	N/A	15,773	40.5
		Total:	**38,893**	**100%**

It should be noted that developed areas have been accurately identified as non-fuel areas, as they do not fit into the classification system, a system which is only appropriate to use to classify forested lands. The assignation of non-fuel should not be interpreted as areas representing low, or no hazard, as planted landscaping and other vegetation, planted and naturally regenerating, on private lands and within a developed matrix may present extreme hazard. This is particularly relevant for the City of Kelowna, as planted landscaping on private lands presents a considerable hazard in interface areas.

3.2 THE WILDLAND URBAN INTERFACE

The WUI is generally defined as the place where the forest meets the community. There are different WUI conditions, which are variations on ‘perimeter interface’ and ‘intermix’. A perimeter interface condition is generally where there is a clean transition from urban development to forest lands. Smaller, more isolated developments that are embedded within the forest are referred to as intermixed areas. An example of interface and intermixed areas is illustrated in Figure 4 .

Figure 4. Illustration of intermix and interface areas.



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

3.2.1 VULNERABILITY OF THE WILDLAND URBAN INTERFACE TO FIRE

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

1. From sparks or burning embers carried by the wind, or convection that starts new fires beyond the zone of direct ignition (main advancing fire front), and alight on vulnerable construction materials or adjacent flammable landscaping (*i.e.* roofing, siding, decks, juniper, etc.) (Figure 5).

2. From direct flame contact, convective heating, conductive heating or radiant heating along the edge of a burning fire front (burning forest), or through structure-to-structure contact. Fire can ignite a vulnerable structure when the structure is in close proximity (within 10 meters of the flame) to either the forest edge or a burning house (Figure 6).

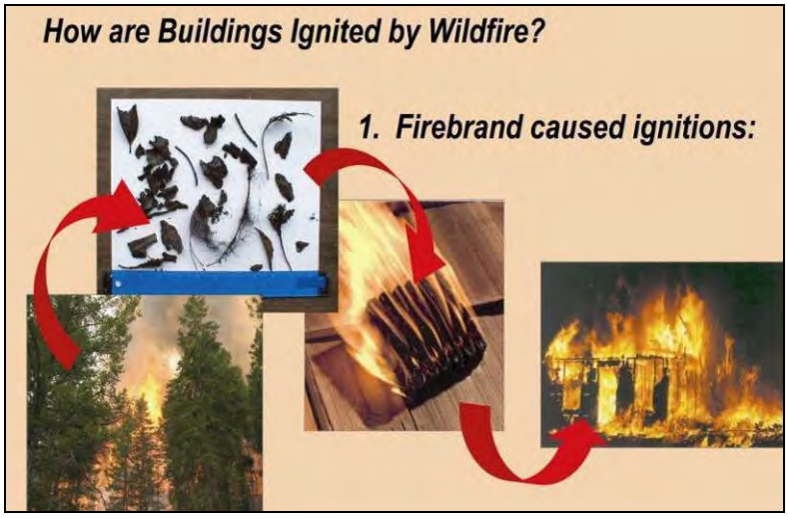


Figure 5. Firebrand caused ignitions: burning embers are carried ahead of the fire front and alight on vulnerable building surfaces.

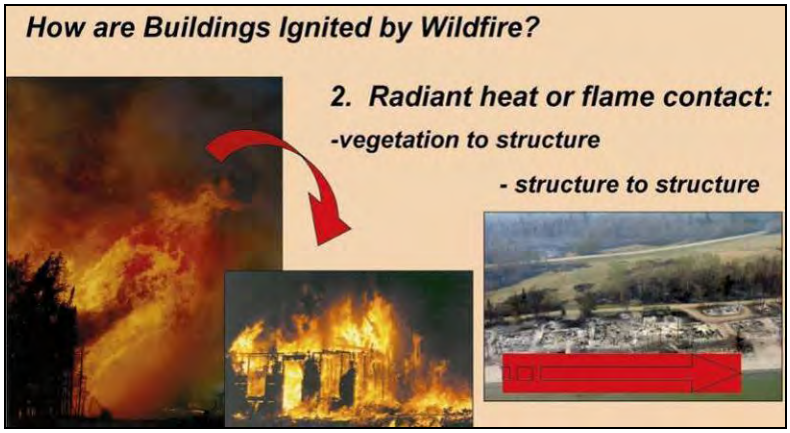


Figure 6. Radiant heat and flame contact allows fire to spread from vegetation to structure or from structure to structure.

3.2.2 WUI THREAT ASSESSMENTS

WUI Threat assessments were completed on March 7 – 9 and May 9 -13, 2016, in conjunction with verification of fuel types. WUI Threat Assessments were completed in the interface areas of the study area, in order to support 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.

A total of 46 WUI threat plots were completed and more than 120 other field stops (qualitative notes and/or photograph documentation) were made across the study area over the 7 field days spent in the study area. The data collected and field observations recorded from the plots and field stops inform much of this document. A table detailing WUI plot locations and threat ratings by worksheet component can be found in APPENDIX E: WUI THREAT PLOT DETAILS.

3.2.2.1 STUDY AREA THREAT RATING

There are two main components of the threat rating system: the wildfire behaviour threat class (fuels, weather and topography sub-components) and the WUI threat class (structural sub-component). Figure 7 and Figure 8 display the fire behaviour threat ratings and WUI threat class ratings within the study area.

The areas within the study area that represent the highest wildfire behaviour threat to the City are from Knox Mountain to the northern extent of the study area, the southeastern portion of the study area around Myra Bellevue Provincial Park and Scenic Canyon, and the northeast portion of the study area outside the municipal boundary. More isolated pockets of high or extreme threat are Dilworth Mountain, Black Mountain, Kirschner, Mission Creek Regional Park, Quail Ridge, and Academy Hill.

The majority of the areas mentioned above are on private land, reserve land, or within a provincial park, and are ineligible for UBCM/SWPI funding for treatment. For example, from the north side of Knox Mountain Park to the northern extent of the study area is almost exclusively privately held land. Figure 9 displays the high and extreme wildfire behaviour threat areas with areas of land ownership that are ineligible for UBCM-funded activities. This underscores the importance of reducing wildfire threat on private land and the need for collaborative efforts with multiple agencies and organizations in order to reduce the overall risk profile of the City.

Beyond the study area to the southeast and east, continuous forested areas represent a threat that is outside the scope of this document. Although these areas were not part of the threat assessment, field observations and orthophotos show that they are similar fuel types to those with high and extreme fire behaviour threat ratings within the study area, and thus likely would exhibit similar fire behaviour threat. The newly established Forest Enhancement Society fund may be a funding opportunity to explore for areas previously ineligible for funding, due to their location outside the 2 km WUI area, land jurisdiction, or larger and more complex projects. See section 7.5.3 for more details.

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

Furthermore, the threat class rating is based upon forested landscape and fuel types. The result is that developed areas that do not fit into the fuel type classification system, but which represent higher hazard due to landscaping, have underestimated threat ratings using the WUI threat worksheet methodology. For the City of Kelowna, where a planted flammable landscaping represents a significant wildfire hazard, this is problematic as it underestimates the hazard on private, developed land. The City's threat class rating should be viewed keeping these limitations in mind.

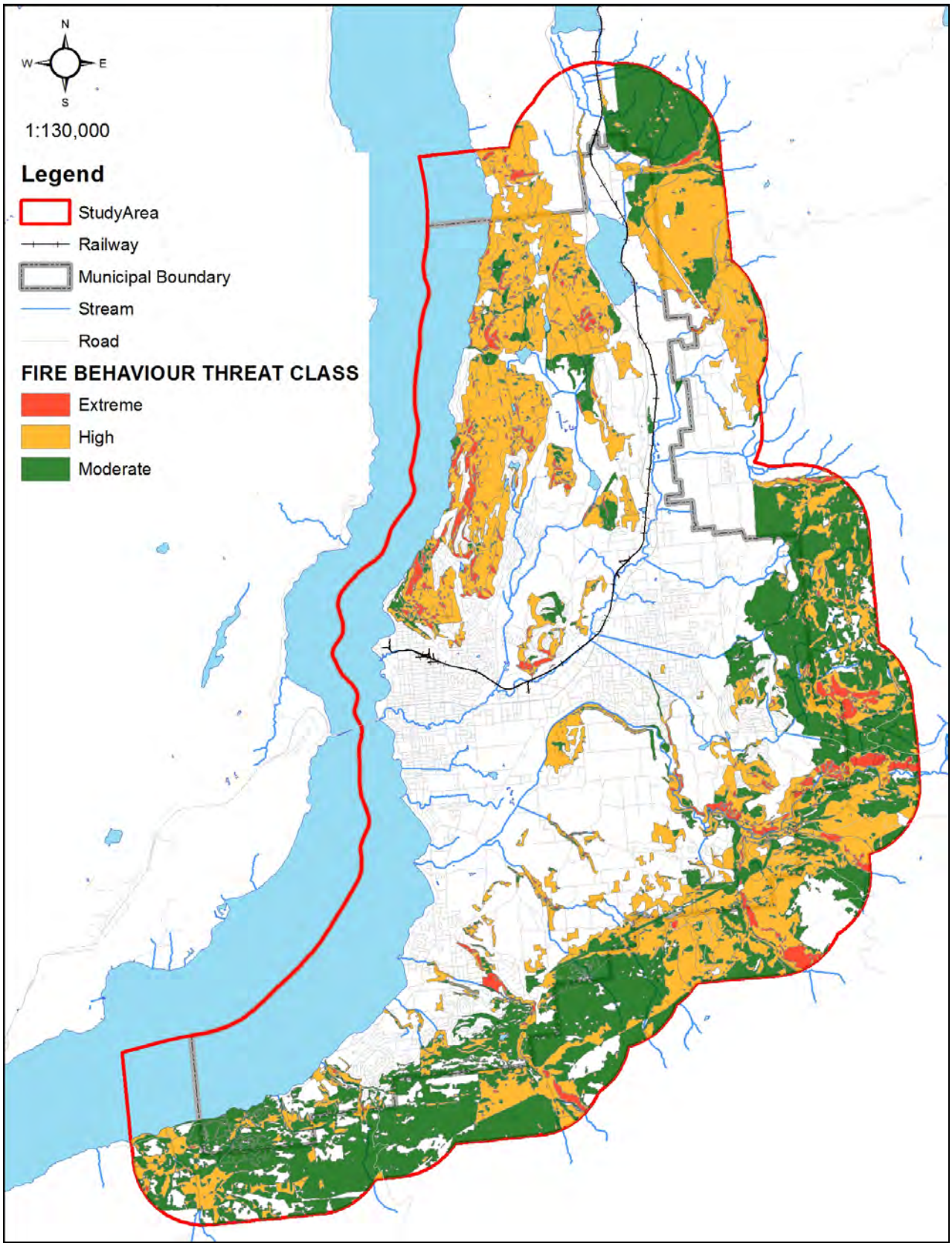


Figure 7. Areas of moderate, high and extreme fire behaviour threat class rating for the study area.

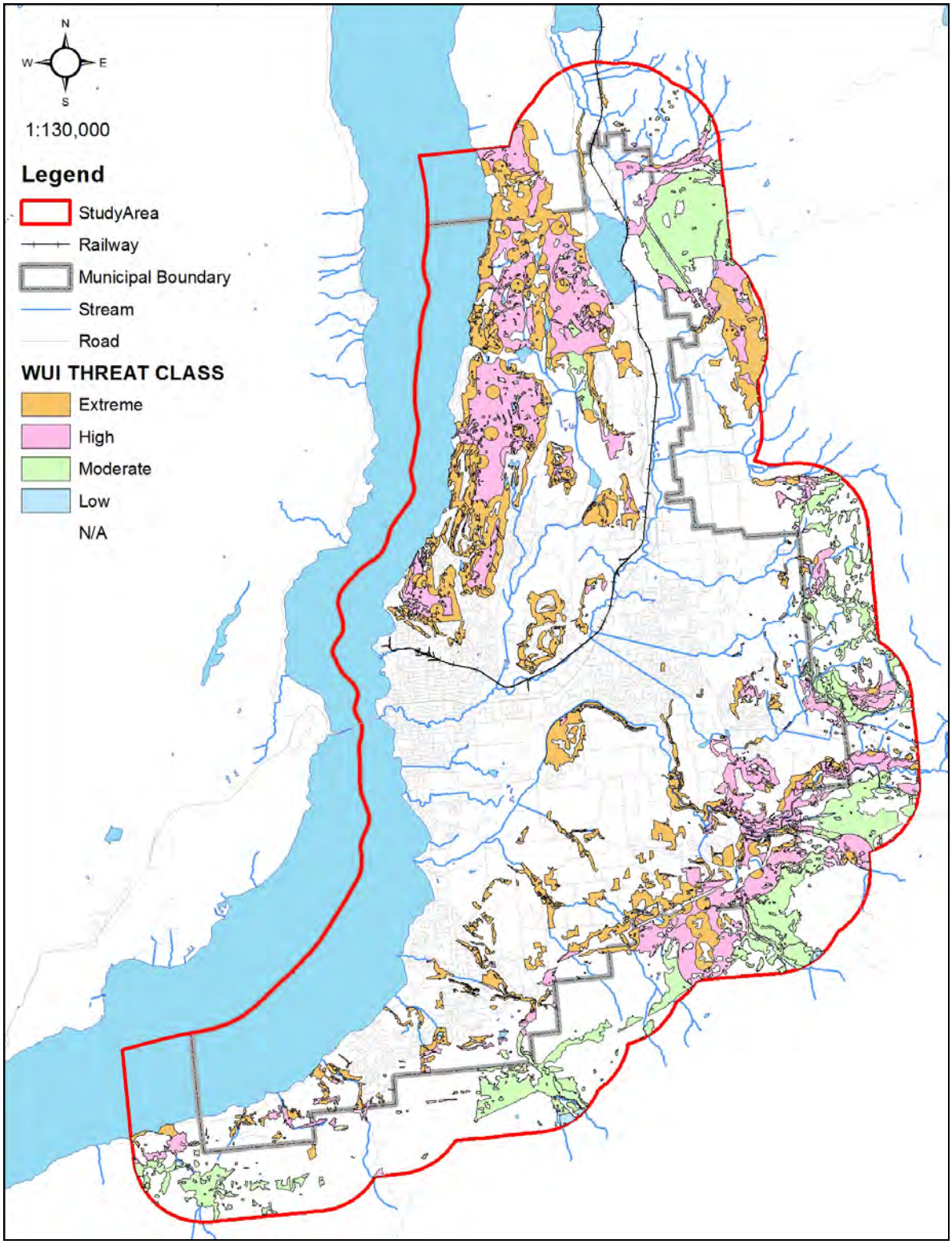


Figure 8. WUI threat class rating within the study area. Areas rated as N/A are based upon WUI threat assessment form methodology where the structural component is only assessed high or extreme fire behaviour threat rated polygons for untreated areas and moderate to extreme rated polygons for previously treated areas.

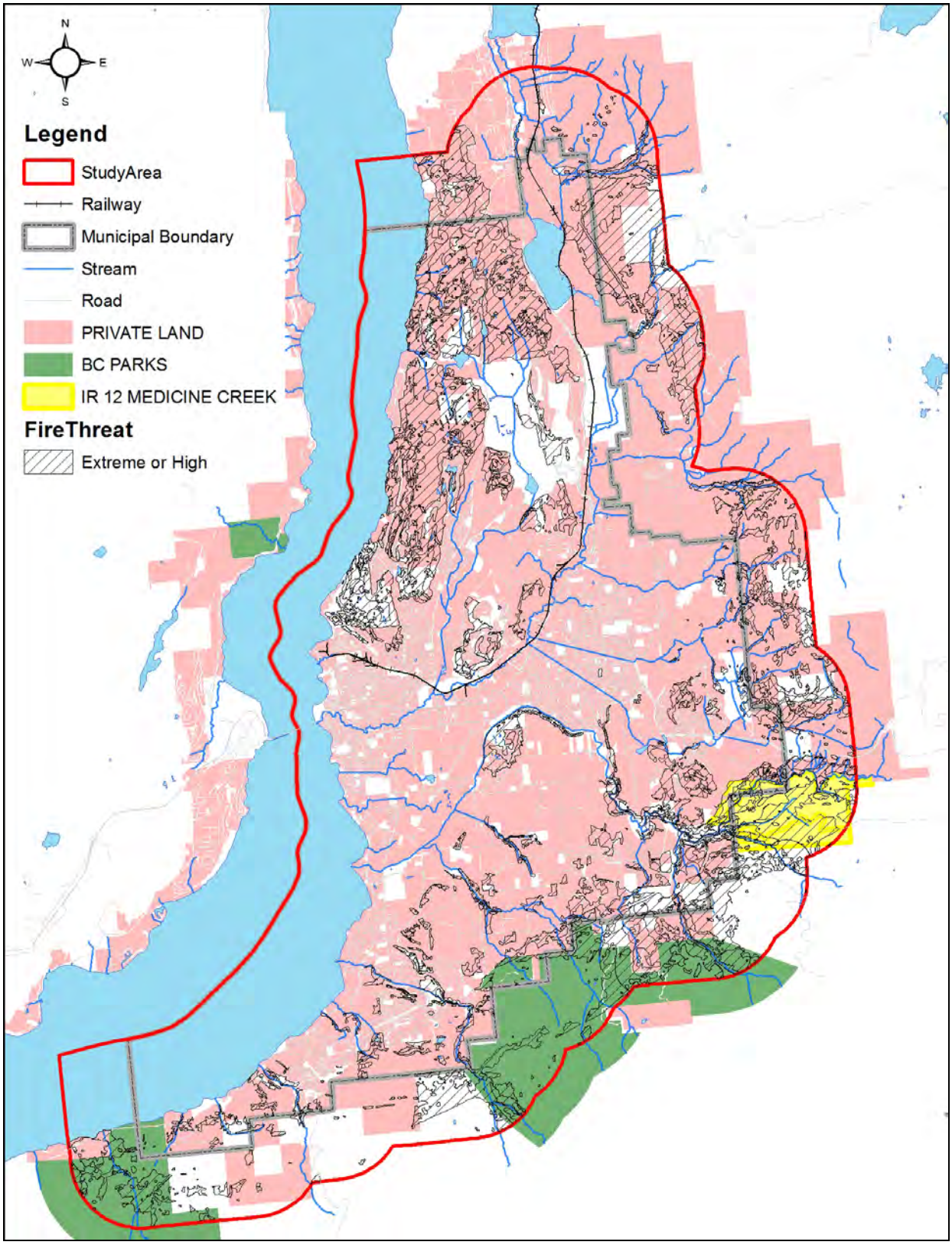


Figure 9. Map displaying high and extreme fire behaviour threat rating and land ownership. Shaded areas (pink – private land, yellow – Medicine Creek IR 12, and green – BC Parks) are not eligible for UBCM-funded activities.

3.2.2.2 WUI THREAT ASSESSMENT METHODOLOGY

Threat assessment for the study area was completed using the WUI threat plots and methodology outlined in the Wildland Urban Interface Wildfire Threat Assessments in BC handbook.[18] Detailed methodology can be found in APPENDIX F: WUI THREAT ASSESSMENT METHODOLOGY.

3.3 LOCAL WILDFIRE HISTORY

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

Within the study area, most of the historical ignition points are attributed to human causes (78%); approximately 22% of the ignitions were attributed to lightning. More than half of total ignitions (55%) can be attributed to what could be best described as "the general public"; causes include campfire use, fire use, juvenile fire setter, and smoker. Considering the high number of human ignitions compared to lightning caused ignitions, the importance of fire education and regulation must be emphasized. In 2015, there were seven ignitions in the study area, five of which were human-caused and one of which the cause was not identified.

Fire perimeters were also compiled for the study area for the years 1919 - 2015. There have been a number of significant fires within the study area, the distribution and frequency of which demonstrates the natural role of wildfire in the ecosystem. The most notable (and largest) fire, the Okanagan Mountain Park fire, occurred in 2003, burned over 25,000 ha and destroyed more than 230 homes. Since 1919, there have been 9 fires greater than 100 ha, and another 25 fires greater than 5 ha.

Although there were no BCWFS-actioned wildfires within the Study area in 2015, there were at least 61 brush/ wildfire callouts for the KFD, 45 of which were grass, brush or tree fires. The most notable of these fires was human-caused and burned an estimated 2 ha on Knox Mountain before KFD was able to suppress it (Figure 11).

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

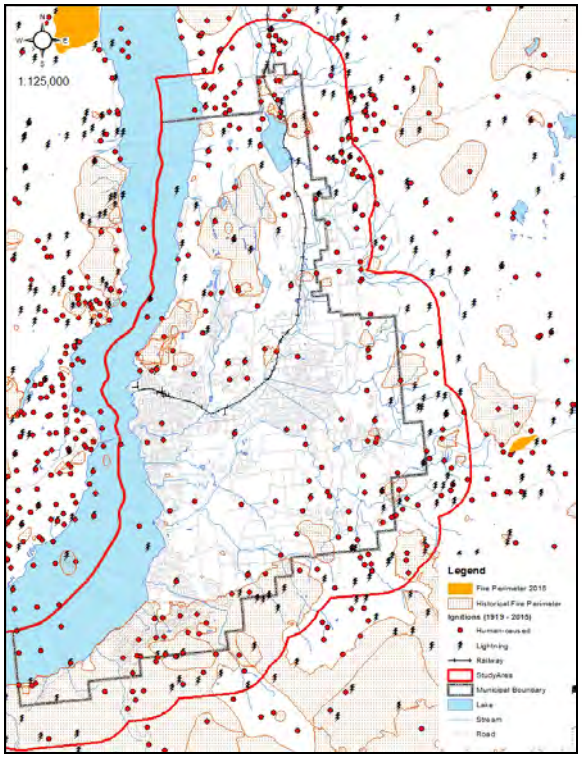


Figure 10. A display of how fire has helped to shape the landscape in the study area. The map shows all BCWS-data for ignitions (1919 – 2015) and fire perimeters greater than 5 ha.

Figure 11. Knox Mountain Fire, 2015. Photo by A. Hunsberger.

3.3.1 FIRE WEATHER DATA

A historic fire weather data analysis was completed as part of the 2011 CWPP. As part of the CWPP update, fire weather data through 2015 was collected and analyzed. Although the authors of the 2011 CWPP used slightly different methods of analysis, our findings were consistent with those from the previous report: for about four months of the year in the summer (June – September), there is a high risk of a significant wildfire event. Details can be found in APPENDIX G: FIRE WEATHER DATA.

4.0 EXISTING POLICIES AND GUIDELINES

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

4.1 MUNICIPAL

Many of the local policies and guidelines that were identified and summarized in the 2011 CWPP are still current and relevant. These policies and guidelines will not be re-summarized, but include:

- City of Kelowna Official Community Plan (OCP) and Development Permit (DP) Guidelines for the Protection of Development from Hazardous Conditions
    - The OCP and Wildfire Hazard DP are reviewed in Section 7.4.
- City of Kelowna Tree Protection Bylaw No. 8041
- City of Kelowna's Air Quality Program

Other relevant bylaws:

- City of Kelowna Bylaw 10760 Fire and Safety Bylaw – allows Fire Chief to issue an open-air burning permit for the purpose of fuel reduction or hazard abatement on public or private property or for the purpose of burning wood waste damaged by mountain pine or western pine beetles. Prohibits any owner or occupier from accumulating combustible materials on their property and grants the Fire Inspector the authority to issue an order to remove or deal with the accumulations or to take necessary action to remove the accumulations at the expense of the person to whom the issue to order is directed (owner or occupier).
- Central Okanagan Clean Air Strategy[19] – a collaborative multi-agency, multi-jurisdictional effort to define strategies to meet set goals regarding air quality in the region. Of the sixteen strategies outlined, two are directly related to prescribed fire and fuel management:
    1. Aim to eliminate smoke from burning (agriculture, forestry, and land clearing), and
    2. Aim to eliminate backyard burning in residential neighbourhoods.

[19] Central Okanagan Clean Air Strategy. 2015. Pinna Sustainability.

4.2 PROVINCIAL

The Okanagan Shuswap Land and Resource Management Plan (LRMP) sets the strategic direction for the management of Crown lands within the Okanagan- Shuswap. The plan provides objectives for the conservation of soil, wildlife, and biodiversity; restoration of natural landscape appearance; maintenance of values associated with timber and silviculture, mule deer, big horn sheep, mountain goat, recreation, visual landscapes, and access; minimize adverse impacts caused by access construction; provide increased conservation of water, fish and riparian wildlife and biodiversity; and to maintain Williamson's sapsucker breeding sites. Specific areas for the management of coarse woody debris enhancement, recreation areas, trail corridors, tourism areas, elk, marten, and fisher have been established and mapped. Fuel treatments and landscape level fuel breaks should consider these strategic objectives to ensure that treatments meet fire hazard reduction/ threat mitigation objectives without compromising other values at risk, including those explicitly outlined and mapped in the LRMP.

The Okanagan Shuswap Natural Resource District (DOS) Fire Management Plan was last updated in 2014. Section One is focussed on integrating resource management into fire response; the intended audience is those involved in wildfire response. Section Two, which at the date of this report was not completed, will focus on integrating wildfire into resource management. Section Two will be more directly relevant to the land management of the study area and strategic wildfire hazard reduction.

In consultation with the DOS[20], it was communicated that landscape level fuelbreaks and other fire hazard reduction activities on Crown land would be most successful and supported when planned for areas that can be dovetailed geographically with other landscape level fuel management opportunities, such as ones funded through the SWPI program or as part of a commercial licensee harvest. Landscape level fuel breaks should also look to manage for or enhance more than one value on the landbase.

4.3 ADJACENT JURISDICTIONS

The Regional District of Central Okanagan, District of Westside/ District of West Kelowna, and District of Lake Country have completed CWPPs to guide their strategic wildfire planning. There may be opportunity to share costs and benefits of implemented recommendations regionally, for example creating events or public information blitzes with synergistic effects. Examples include, but are not limited to: sharing curriculum/ content development for FireSmart events, pamphlets, or websites; or coordinating region-wide FireSmart information days.

Wildfire hazard Development Permit Areas are established in West Kelowna, Lake Country, and the RDCO with the objective of minimizing the risk of life and property from wildfires within established interface/ WUI areas.

5.0 PAST WILDFIRE RELATED PROJECTS

The City of Kelowna has been very active with respect to community wildfire planning. As mentioned above, the City completed a CWPP in 2011 and they have implemented, or are in the process of implementing, the majority of the recommendations outlined in that plan. This has taken a cooperative effort from three departments,

[20] Personal communication, Pam Shumka, DOS, 28 April, 2016.

previously which had previously been working more independently within the City: Parks, Planning, and Fire. Future successes in wildfire threat reduction activities will require continued intra-department communication and cooperation to move them forward. A complete list of the status of the recommendations from 2011 can be found in APPENDIX A: STATUS OF 2011 CWPP RECOMMENDATIONS.

5.1 FUEL TREATMENTS

Fuel treatments have been completed on approximately 600 ha of land in the study area since 1998 (Figure 19). The treatments have largely been on Municipal property and funded through the UBCM/SWPI program. The RDCO, with UBCM/ SWPI funding, and private landowners, privately funded, have also treated large areas of hazardous fuels. These treatments have reduced the risk profile of the City, but will require additional treatments to maintain effectiveness. See Section 7.5.2 for more details.

5.2 FIRESMART AND PUBLIC EDUCATION INITIATIVES

The KFD leads FireSmart initiatives through the Fire Prevention Branch. The Fire Prevention Branch has held school information days and distributes FireSmart educational materials to the community actively and through more passive means, such as its website and Facebook©. The Prevention Branch holds a Fire Prevention Week in October, which has an interface fire component. The Knox Mountain caretaker's house was designated as a FireSmart Demonstration home as part of a joint public education initiative. The home, located at the top of Knox Mountain Park is a living example of the practices and principles of FireSmart. The home displays FireSmart practices to reduce fire risk to homes in the WUI; an interpretive sign describes them as a visual guide for those living in the urban interface area. The City has erected fire danger informational signage throughout natural parks (Figure 12).

Figure 12. Example of fire danger informational signage erected at the entrance to McKinley Landing.

The KFD has been successful at recruiting four neighbourhoods into the FireSmart Canada Community Recognition Program: two have since been recognized as FireSmart communities (Quail Ridge and the Gallagher Canyon Golf community), two others are in the program and actively working towards that distinction (Clifton/ Magic Estates and McKinley Landing). The KFD are actively recruiting additional neighbourhoods into the program.

5.3 EMERGENCY RESPONSE

The KFD purchased a UTV to aid in wildland fire suppression. The vehicle was used almost immediately in the Knox Mountain Fire in 2015.

5.4 RELEVANT WILDFIRE REPORTS

Community Wildfire Protection Plan 2011

The 2011 CWPP provided 44 key recommendations to help reduce the City's wildfire risk profile. The document, though requiring updating, identifies many opportunities for action and improvement that are still relevant today. The City has implemented 8 of the recommendations and another 27 are ongoing, demonstrating the City's commitment to wildfire risk reduction. The ongoing action items from the 2011 CWPP are valuable to the wildfire reduction program and should be continued; this document was written to complement and add to these recommendations, rather than nullify them.

City of Kelowna Review of Policies, Procedures, and Bylaws Relating to Wildland Fire

In 2006, BA Blackwell and Associates Ltd completed a review of wildland fire related policies and procedures. As part of this document, 25 key recommendations were made. Those recommendations which were not implemented by the City were updated and inserted into this document. The policy review has valuable information and should be reviewed periodically.

6.0 FIRESMART

One of the most important areas with respect to forest fire ignition and the damages associated with a wildfire is the zone adjacent to buildings and homes. *FireSmart, Protecting Your Community from Wildfire*[21] is a guide developed by Partners in Protection that provides practical tools and information on how to reduce the risk of loss from interface fires. The FireSmart website can be visited at: www.firesmartcanada.ca.

We often consider wildfire an external threat to our residences; however, in many cases fire can originate as a house fire and spread into the interface. Regardless of the origin of the fire, home owners and businesses can take steps to reduce the probability of this occurring. There are two main avenues to FireSmart a home: 1) change the vegetation type, density, and setback from the building (fuel treatments and landscaping) and 2) change the structure to reduce vulnerability to fire and the potential for fire to spread to or from a building.[21]

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

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

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

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

During extreme wildfire events, most homes that have been destroyed have occurred as a result of low-intensity flame exposures. For example, during the 2010 Fourmile Canyon fire outside Boulder, Colorado, 17% of the 162 homes destroyed were attributed to crown fire.[22, 23] Instead of high intensity flames, the majority of homes ignited as a result of firebrands, which ignited lower-intensity surface fires adjacent to structures or the home directly.[22] The likelihood of home ignition is mostly determined by the area within 30 m of the structure: the building materials, design, landscaping, and maintenance (accumulation or presence of flammable debris on or near the structure). Additionally, areas of denser suburban development have additional risk associated with direct house to house transmission, overwhelming the firefighting capacity available. Effective fire protection depends on ignition resistant homes and properties during extreme wildfire events.[22]

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

6.1 FIRESMART STRUCTURE PROTECTION

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

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

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

primary considerations in developing FireSmart neighbourhoods. Housing built using appropriate construction techniques and materials are less likely to be impacted by interface fires.[21]

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

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

6.1.1 BUILDING MATERIALS AND DESIGN IN THE STUDY AREA

Individual interface homes in the City are in various states of FireSmart conditions. The majority of homes have rated roofing, though there are still a considerable number of homes with unrated cedar shake roofs (Figure 13). Cladding, soffits, and eaves throughout the study areas are constructed of a range of materials, from unrated vinyl to non-combustible materials, such as stone and stucco. The majority of newer homes are, in general, constructed of materials which are compliant with FireSmart standards. A 2015 study of fire hazard across the City supports the field observations. The authors found that FireSmart adoption levels pertaining to building material guidelines were good; newly constructed homes had high FireSmart compliance level and a low hazard ascribed to the building materials (Westhaver 2015).

Figure 13. New shake roofing in the North Clifton neighbourhood. Mature pine trees adjacent will likely contribute additional combustible material to the roof, if allowed to accumulate.

FireSmart compliant construction information is found in APPENDIX H: FIRESMART CONSTRUCTION AND LANDSCAPING.

6.1.2 LANDSCAPING/ VEGETATION IN THE STUDY AREA

Landscaping on private property within the study area is largely non-compliant with FireSmart standards and represents arguably the largest proportion of hazard to individual properties and the developed portion of the study area. In a 2015 study focused on fire hazard within 30 meters from homes, up to 70% of all fire hazard to homes in the City of Kelowna was attributed to non-conforming vegetation/ fuel factors, much of which was observed to be planted landscaped materials (Westhaver 2015).

Field observations found that older neighbourhoods are landscaped with mature, sprawling juniper hedges, tall cedar privacy hedges, and/or coniferous trees with interconnected crowns (Figure 14, Figure 15). Within the study area it is not uncommon to have 30%, or more, of each lot covered with flammable, coniferous vegetation (Figure 15). Newer developments, while generally complying with FireSmart building standards, are not FireSmart compliant in regards to landscaping. Site visits to new developments show juniper and cedar hedging are still the predominant selection for landscaping vegetation within the study area. The City must address the FireSmart landscaping challenge to adequately reduce the wildfire risk profile.

Figure 14. Hazardous landscaping of an interface home. Note sprawling juniper hedge, 3 m tall cedar hedge to the right and directly against the front of the home and under eaves.

Figure 15. Examples of hazardous interface landscaping representative of the study area. Top left: aerial photograph of urban area with mostly flammable, coniferous landscaping and surrounding overstorey. Top right: home almost completely obscured by immature conifers. Bottom center: yard of juniper hedge, with cedar hedge directly under eaves of main home and home directly to the right.

Juniper, cedar, and other coniferous hedging are highly flammable. Coniferous overstory, such as ponderosa pine, deposit dry and flammable needles onto roofing and can accumulate on roof corners and in gutters. Cedar hedges planted below eaves are flammable material which can convey flames directly to the soffits.

There are considerable challenges to achieving FireSmart landscaping throughout the study area. In older neighbourhoods where the landscaping is mature, there is little incentive to replace landscaping. In new

developments, the City has identified that the covenants are difficult to enforce due to lack of staff time. FireSmart landscaping is seen by some as not aesthetically pleasing (devoid of vegetation and/or lacking privacy), costly, or high-maintenance. Developers and homeowners often do not understand the significance of non-compliant landscaping; they are not cognizant of how their, seemingly small and inconsequential landscaping decisions for their individual lots play into cumulative fire hazard of a neighbourhood, contribute to the ferocity of a wildfire, and put their home and neighbourhood at greater risk of destruction by wildfire (Figure 16).

It is recommended that a multi-prong plan be put in place that addresses reducing the fire hazard created by planted landscapes on private land. This plan should incorporate public awareness around hazard on their property and within their neighbourhood, increased enforcement of already existing covenants, requirement of landscaping plans as part of the building permit process, and additional landscaping covenants triggered by re-builds or major renovations which often damage existing landscaping. Some initial resistance may be able to be overcome by public education regarding the potential hazard their landscaping selections represent, and the opportunities for affordable, aesthetic, low flammability landscaping options that are adapted to the climate.

For more detailed FireSmart landscaping information, see APPENDIX H: FIRESMART CONSTRUCTION AND LANDSCAPING.

Figure 16. Landscaping representative of those properties in older neighbourhoods with more mature landscape. Note the common use of cedar hedging as lot borders/ privacy hedges, juniper hedges and conifer trees within 10 m of homes. While some homes are FireSmart compliant (yard in far right fore-front), the majority of homes have considerable amounts of highly flammable landscaping, which when viewed in perspective of the entire neighbourhood, represents continuous or nearly continuous, high hazard fuels.

6.2 FIRESMART FUEL TREATMENTS

FireSmart fuel treatments are an effective method of reducing the ease with which fire can move to and from a home. Treatments are completed by altering the vegetation around the home; the type of alteration required is determined by the distance from the home, or value at risk (Figure 27). The principles and practices of FireSmart fuel treatments have not changed since 2011 and they are discussed in depth in the previous CWPP (p 95). Further details can also be found in APPENDIX I: FIRESMART FUEL TREATMENTS.

7.0 ACTION PLAN

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

7.1 COMMUNICATION & EDUCATION

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

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

- To improve public understanding of fire risk and personal responsibility by increasing resident awareness of the wildfire threat in their community and to establish a sense of homeowner responsibility; and
- To enhance the awareness of elected officials and stakeholders regarding the resources required to mitigate fire risk.

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

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

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

The City has undertaken many public education and FireSmart initiatives in schools, the community, and paper and digital formats. These can be expanded upon and/or adapted to further enhance wildfire preparedness and education. The City should consider expanding their current school fire education program to include wildfire preparedness education to be presented annually in elementary schools. Programming could include volunteer/ advocacy work from professional foresters, wildland firefighters or prevention officers, and City staff (KFD). The City should consider holding an additional wildland specific Fire Prevention Week, or similarly formatted event, in

the spring prior to the wildfire season. Timely educational materials to increase preparedness would be most effective immediately prior to the fire season.

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

FireSmart information material is readily available and simple for municipalities to disseminate. It provides concise and easy-to-use guidance that allows homeowners to evaluate their homes and take measures to reduce fire risk. However, the information needs to be supported by locally relevant information that illustrates the vulnerability of individual houses to wildfire. As per the 2011 CWPP, it is recommended that educational material is distributed to all private land owners within 100 m of the Wildfire DP areas.

Bringing organizations together to address wildfire issues that overlap physical, jurisdictional or organizational boundaries is a good way to help develop interagency structures and mechanisms to reduce wildfire risk. Engagement of various stakeholders can help with identifying valuable information about the landscape and also help provide unique and local solutions to reducing wildfire risk. The City should consider leading the establishment of a regional interface committee to coordinate wildfire risk reduction efforts and aim to integrate forest licensees that are operating within the TSA. Coordination of fuel management activities with forest licensees could significantly aid in the establishment of large, landscape-level fuel breaks or compliment current or proposed fuel treatment areas.

Table 3. Summary of Communication and Education recommendations.

Communication and Education			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: To improve public understanding of fire risk and personal responsibility by increasing resident awareness of the wildfire threat in their community and to establish a sense of homeowner responsibility.			
1	Moderate	• Establish/ expand a school education program to engage youth in wildfire management. Consult ABCFP and BCWFS (the zone) to facilitate and recruit volunteer teachers and experts to help with curriculum development and to be delivered in elementary and/or secondary schools. Educational programming can be done in conjunction with currently running programs on fire extinguisher training.	Within current operating budget
2	High	• Summaries of this report and associated maps to be made publicly available through webpage, social media, and public FireSmart meetings.	Within current operating budget
3	Moderate	• Add a Wildfire-specific Fire Prevention Week (or day) in the spring, immediately prior to the fire season.	Within current operating budget

Communication and Education			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
4	Moderate	• Distribute FireSmart informational material to homeowners within 100 m of the interface (ongoing recommendation from 2011). Currently, KFD is targeting Glenmore, with plans to expand the program to Clifton, Wilden, Black Mountain and Kirschner in the spring of 2017.	$2,500
Objective: To enhance the awareness of elected officials and stakeholders regarding the resources required to mitigate fire risk.			
5	Moderate	• Lead the re-establishment of a regional interface committee to coordinate wildfire risk reduction efforts between multiple jurisdictions and aim to integrate forest licensees that are operating within the TSA. Coordination of fuel management activities with forest licensees could significantly aid in the establishment of large, landscape-level fuel breaks or compliment current or proposed fuel treatment areas. Consider including local planning departments to develop regional development permit standards, provide a group voice to the Building and Safety Standards Branch and other provincial entities, and align municipal bylaws.	Within current operating budget

7.2 STRUCTURE PROTECTION & PLANNING

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

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

The two main avenues for implementing FireSmart include:

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

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

Detailed FireSmart assessments were not completed for critical infrastructure, but general observations were made. In general, infrastructure was constructed of fire resistant material. Vents on some structures may require non-combustible screens to prevent embers from entering the building envelope and should be reviewed. Critical

infrastructure seemed to be generally FireSmart compliant, both in structure and vegetation setbacks. It is recommended that the KFD consult with City staff to systematically assess critical infrastructure in interface areas, such as water intake and waste water treatment facilities, and to provide FireSmart recommendations based on their field findings.

In order to aid in critical infrastructure protection, the tabular list of addresses should be converted into spatial data compatible with the City's internet mapping website and made available for the KFD and emergency services dispatch. Further it is recommended that the dataset be initially checked to ensure that it is complete and correct, and updated regularly as new critical infrastructure is built or expanded.

As noted in the 2011 CWPP, water is the single most important suppression resource. Recommendations provided in the 2011 CWPP are still valid; implementation work on the recommendations is ongoing. Recommendations include: installing reservoir or hydrant systems in areas of poor water availability, identifying and mapping alternative water sources, and ensuring new developments have sufficient hydrant coverage. Hydrant coverage and locations are reviewed by the KFD as part of the Development Permit process. Improving water availability in identified areas and mapping alternative water sources is ongoing and should continue.

Full assessments of the water availability and vulnerability of the five water purveyors was not possible under the scope of this report. Back-up power sources should be installed for all critical infrastructure, including pump-supplied water systems, to ensure the City can continue to operate at an acceptable level during a wildfire event. It is recommended that the City complete a Fire Flow/ Water Supply Vulnerability Assessment across all five water purveyors and systems to identify those areas which may have insufficient/ unreliable water supplies and to provide recommendations to reduce the City's water supply vulnerability.

Table 4. Summary of Structure Protection and Planning recommendations.

Structure Protection and Planning			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: Enhance protection of critical infrastructure from wildfire.			
6	High	• Convert tabular list of critical infrastructure into spatial data. Spatial data of critical infrastructure is included as a component of the data package for this project.	Within current operating budget
7	Moderate	• Complete a fire flow/ water vulnerability assessment across all five water purveyors and identify and map all alternative water sources (reservoirs, streams, lakes, etc). Identify which areas may have insufficient or unreliable water supplies and provide recommendations to reduce City's vulnerability. The water vulnerability assessment should explore the development of alternative water sources, such as reservoirs, in areas of poor water supply (those identified here as Southeast Kelowna, North Glenmore, South Lakeshore Rd, and the Belgo area, as well as any new areas identified in the water vulnerability assessment).	$10,000/ Investigate grant opportunities from Okanagan Water Basin Board
8	Moderate	• Assess all critical infrastructure in interface areas and develop FireSmart recommendations.	Within current operating budget

Structure Protection and Planning			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
9	High	• Complete a detailed review of back-up power source options for all critical infrastructure and upgrade as required.	Cost dependent on upgrading required

7.2.1 WUI SITE AND STRUCTURE ASSESSMENTS

Currently, the study area includes Wildfire Hazard Development Permit Areas, however homes outside the reach of the DP process, particularly in older subdivisions, need to ensure they consider and adopt FireSmart principles as required and as opportunities arise (*e.g.*, exterior home construction and landscaping). Many of the older homes do not have rated roofs and have significant flammable vegetation in Priority Zone 1. Some strata still currently enforce the sole use of cedar shake roofing in their covenants. Fire research indicates that roofing adjacent to burnable materials and landscaping play the greatest role in structure ignitability. Additionally, many homes in the interface and intermix areas store combustible materials within 10 m of residences and this is a significant fire issue. Woodpiles or other flammable materials adjacent to homes provides fuel and an ignitable surface for embers, increasing wildfire risk and impacts to the homes and community. Flammable planted landscaping is the biggest contributor to fire hazard on most private properties within the study area.

There are a number of mechanisms that can be employed to motivate/ compel homeowners to reduce the threat to their home, and in turn, to the neighbourhood. One mechanism is to compel change through bylaws or covenants. The City has established a Wildfire Development Permit Area as part of its Hazardous Conditions Development Permit (DP). The DP will be discussed at length in Section 7.4.1.

Another way to motivate change is through education and increased awareness of fire hazard on private property. The reduction of wildfire hazards on private lands generally depends on the homeowner. This includes choices in exterior building materials, setbacks from forest edges and landscaping. In other jurisdictions (notably Colorado Springs, CO and Whistler, BC), programs to increase awareness of fire hazard and spur homeowner action have been implemented successfully. In these jurisdictions, fire hazard assessments were completed for homes in the Wildland Urban Interface. The results of the assessments were shared with the homeowner/ property owner at the time of assessment. The results of the hazard assessments were compiled into a geo-spatial database and made available to the public. Each home and property owner could look up to see the hazard of their property, as well as their neighbours' and how both may contribute to, or lessen, the overall fire hazard and risk of their neighbourhood (Figure 17). This database may be useful for the KFD as triage assessments and aid in suppression planning.

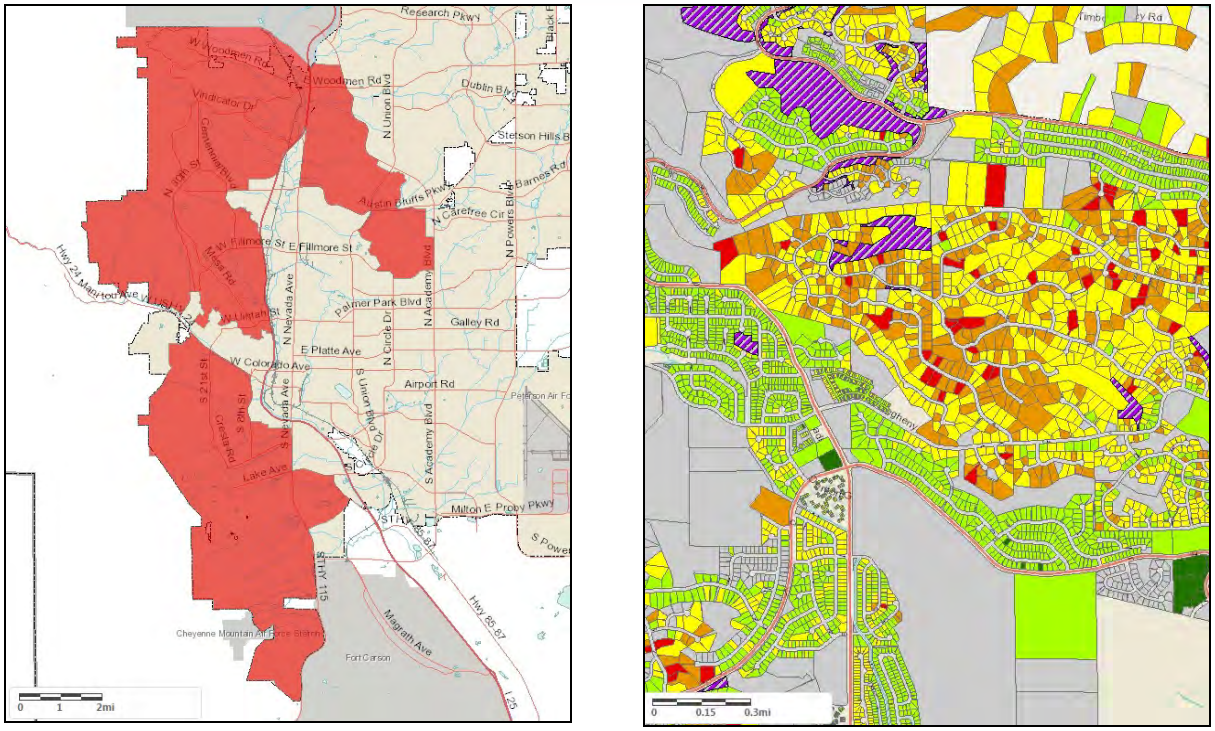


Figure 17. Screen captures of Colorado Springs, Colorado public internet mapping service. The left figure displays the WUI area in red in which fire hazard assessments were completed. The right figure displays a neighbourhood within the WUI area and the fire hazard for each individual property (red is extreme, orange is very high, yellow is high, bright green is moderate and dark green is low).[24]

It is recommended that the City develop a similar fire hazard assessment program. Individual properties within the established Wildfire DP Area should be assessed using a FireSmart site and structure assessment form and to provide the results and opportunities for hazard mitigation to the property owner/ resident. The City's internet mapping site should make available to the public the fire hazard results by property. Property owners could request a re-assessment upon completion of various mitigative actions and updates posted periodically on the mapping site.

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

It is recognized that this program could come at considerable cost to the City. Opportunities for savings may include options such as utilizing a student or work experience program participant to complete the assessments,

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

retaining a consultant to complete the work, or targeting the program to the highest priority (highest threat) neighbourhoods, and then expanding the program in phases, as resources allow.

The recently launched 2015 SWPI FireSmart Grant Program provided funding of up to $10,000 to undertake FireSmart planning activities for private lands. At the time of report development, applications for this program are no longer being accepted. Running on a calendar year, it is expected that UBCM will open another FireSmart intake for fall/winter of late 2016/ early 2017. It is recommended that the City stay up to date on all UBCM/SWPI funding initiatives, in order to leverage FireSmart funding for this and other FireSmart programs, if funding again becomes available.

Table 5. Summary of structure protection and planning recommendations, specific to WUI site and structure hazard assessments.

Structure Protection and Planning			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: Encourage private homeowners to voluntarily adopt FireSmart principles on their properties.			
10	High	• Complete WUI Site and Structure Hazard Assessments for interface homes, make hazard mapping for assessed homes publicly available, and provide informational material to homeowners on specific steps that they can take to reduce fire hazard on their property.	$10 -$12/ home

7.3 EMERGENCY PREPAREDNESS

The Kelowna Fire Department (KFD) is a well-resourced, highly organized department which is able to provide high quality emergency and public safety services to the City and surrounding area. There are 122 full-time personnel in the department and another 45 paid-on-call members.[25] In 2015, there were 1,652 fire call-outs, which is characteristic of an average year in Kelowna. Additionally, there was a total of 61 wildfire or brush-related call outs in the 2015 fire season.[26] Statistics for call-outs are on an increasing trend, but this is attributed to population growth within the community.[9]

Within the City limits, the KFD provides emergency services. Fire departments within and adjacent to the study area (Kelowna Fire Department, West Kelowna Fire Department, Regional District of Central Okanagan Ellison and Joe Rich) are responsible for first response within their fire protection area. Outside the municipal boundary, the KFD has mutual aid agreements in place with all RDCO Fire Departments; this mutual aid agreement with the RDCO is utilized once per year, on average. The KFD responds to areas outside the municipal boundary on both RDCO and Crown land to engage in wildfire suppression until BCWFS arrives, after which time KFD may also remain on scene, in an assistance capacity, if appropriate, able, and/or requested.

[25] City of Kelowna. 2015. 2015 Annual Report. Kelowna Fire Department.

[26] Statistic provided by the Kelowna Fire Department.

The KFD provides valuable non-fire related emergency response including the regional hazmat response, technical rescues, and marine rescue throughout the RDCO, as well as the fire dispatch to all fire departments within the region.

The majority of training for the KFD focuses on structural firefighting but does include annual wildland interface training as part of the spring training curriculum. Some KFD members participate in EOC training, which involves multiple agencies. There has been very little recent cross-training with MFLNRO BCWS. It is recommended that all KFD members at a minimum have S100 and S215 (or equivalent SPP-WFF 1) training. It is also recommended that the KFD City coordinate annual cross-training events with the BCWFS, for example a joint wildfire simulation exercise. This could be completed in cooperation with other area Fire Departments (West Kelowna, Peachland, RDCO) to further strengthen regional emergency response training.

The KFD has 23 emergency response vehicles, 10 general purpose vehicles, and has recently procured a UTV Gator with a fast attack suppression pack. The new UTV was utilized almost immediately; it was used twice last in the 2015 fire season in emergency response, one of which was the Knox Mountain Fire when it proved highly effective at providing access to an interface fire that was threatening homes and a City park (Knox Mountain Park).

The KFD does not own a sprinkler protection unit (SPU). The UBCM owns four complete SPUs, each equipped to protect 30 – 35 structures. The kits are deployed by the MFLNRO/ BCWFS incident command structure and are placed strategically across the province during the fire season based on fire weather conditions and fire potential. There are also SPUs available which can be rented from neighbouring jurisdictions. When the kits are not in use, they may be utilized by fire departments for training exercises. SPUs can be useful tools in the protection of rural/ interface homes in the event of a wildfire. It is recommended that the City stays up to date on the location of, and request process for, an SPU in the event of a wildfire where SPUs would be an effective structural protection tool. It is also recommended that the KFD consider an SPU training session to gain experience with the SPUs available, as well as to assess whether an SPU may be a good investment for the City.

The City of Kelowna manages the Regional Emergency Management (EM) Program, which provides support to emergency responders and residents within the study area and adjacent jurisdictions of RDCO, City of West Kelowna, Westbank First Nation, District of Lake Country, and District of Peachland. The EM program is initiated during incidents such as wildfires, when community resources are insufficient or over-capacity. The EM Program is responsible for the region's Emergency Support Services (ESS) which provides food, shelter, and other provisions for displaced residents, such as those evacuated for wildfire.[27]

The EM Program includes an established Emergency Operations Centre (EOC) which operates out of KFD Station 1, and is staffed by local governments from around the region. The EOC was activated four times in the 2015 fire season for wildfire events in the area: Knox Mountain Fire, Joe Rich Fire, Bear Creek Fire, and the Shelter Cove Fire. There were no challenges identified in activation of the EOC; the Centre operated successfully as planned.

[27] City of Kelowna. 2015. *2015 Annual Report Kelowna Fire Department*.

Many homes could benefit from triage assessments to ensure accessibility and safety for firefighters. Fire triage is an important tool used by fire suppression crews to improve the potential for structures to survive a fire event. The process involves determining which houses have the greatest likelihood of surviving a wildfire and therefore should be prioritized for additional protective measures such as setting sprinklers or spraying retardant. Triage assessments are dependent on five main factors which include: firefighter safety, structure design and material, fuels around the structure, fire behavior, and available resources. Houses that follow FireSmart guidelines have a better probability of being prioritized for protection. Conducting assessments of housing in the WUI prior to a fire can assist in suppression efforts. The assessments can also be used to educate homeowners as to what protection they might receive during a fire event and what changes they can make to improve the probability of their home surviving a fire event. See Section 7.2.1 for details regarding WUI wildfire hazard assessments and associated recommendations.

Table 6. Summary of Emergency Response recommendations.

Emergency Response			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: To improve structural and wildfire equipment and training available to City Fire and Rescue.			
11	High	• Annual structural and interface training with MFLNRO BCWS. As part of the training, it is recommended to conduct annual reviews to ensure PPE and wildland equipment resources are complete, in working order, and the crews are well-versed in their set-up and use. Interface training should include completion of a mock wildfire simulation in coordination with BCWS and safety training specific to wildland fire and risks inherent with natural areas.	$2,000 (annually)
12	Moderate	• Provide SPP-WFF 1 (S100/S215) training to all/some members of the City Fire Department to enhance wildfire suppression training. The KFD completes S215 and similar training for members as budget allows.	~$600/ member
13	Low	• Review SPU request procedure, for both locally-owned and UBCM-owned systems. The KFD Structure Protection Specialists should be well-versed in the rental/ request procedure and operation of the SPU to help guide the KFD and the City should this type of protection be deemed appropriate during a wildfire.	Within Current Operating Budget

7.3.1 EVACUATION AND ACCESS

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 should have the capacity to handle both. Access throughout the study area is variable; however, most areas within the City boundary have multiple access routes for evacuation and capacity for emergency vehicle access.

There are communities within the study area which are accessed by cul-de-sac or dead end roads; these neighbourhoods are of particular concern for fire suppression, emergency response, and evacuation. Identified areas of concern due to single access routes include: Wilden, McKinley, Clifton, Towers Ranch, and Black Mountain. These areas should be reviewed for secondary access options. Additional communities which, due to

their location and/or access, have longer emergency response times include: McKinley Landing, Finch Road, Clifton Road, end of Lakeshore Road, and the north industrial area of Kelowna.

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

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

Recommendation #33 of the 2011 CWPP is: "Develop and distribute neighbourhood evacuation plans for all high risk interface areas." To that end, the McKinley Landing Residents Association (MLRA), with the assistance of the KFD, developed the McKinley Landing Emergency Evacuation Plan. This plan is readily available to the McKinley Landing residents on the MLRA website (http://www.mckinleylanding.org/community/fire/), along with other useful links for emergency preparedness planning.

As identified in the 2011 CWPP, recreation trails built to support ATVs can provide access for ground crews and act as fuel breaks for ground fires, particularly in natural areas. One recommendation was to encourage strategic recreational trail development in parks to a standard that supports ATVs, and further to install gates or other barriers to minimize access by unauthorized users. The City parks department has worked on this recommendation, strategically expanding their trail network and gating most of the trails. Although the City action on these recommendations is ongoing, considerable progress has been made. It is recognized that creation of ATV trails, whether gated or not, may contribute to the perennial conflict between motorized and non-motorized park and trail network users.

Because the Parks Department has led the trail network expansion and maintenance, its members are most familiar with the trail network. Currently, there is no mapping or spatial data of the trail network available for the KFD to access during an emergency or for fire suppression planning. 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. This plan should be made available to the KFD and the BCWS in the event that they are aiding suppression efforts on an interface fire in Kelowna Parks. The plan at a minimum should include maps and spatial data, identify the type of access available for each access route (foot, ATV, etc), identify those trails which are gated and/or have barriers, and provide information as to how to unlock/ remove barriers (key location, etc). The plan 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, and requirements for future maintenance activities (operational access for fuel treatments and other hazard reduction activities).

In addition to providing the safest, quickest, and easiest access routes to 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.

Table 7. Summary of Evacuation and Access recommendations.

Emergency Response (Evacuation and Access)			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: To improve access and egress to neighbourhoods at risk and natural areas within the City.			
14	Low	• Facilitate completion of emergency evacuation plans for interface neighbourhoods with limited access and long response times, such as Finch Road, North Clifton, and Lakeshore Road.	Within current operating budget
15	High	• Develop a Total Access Plan to map and inventory trail and road network in natural areas for suppression planning, identification of areas with insufficient access and to aid in strategic planning. The plan should be updated every five years, or more regularly, as needed to incorporate additions or changes.	$8,000

7.4 PLANNING AND DEVELOPMENT

Municipal policy and bylaws are tools available to mitigate wildfire risk to the City. It is recognized that, in order to be successful, all levels of government (municipal, provincial, and federal) and individual landowners need to work together to successfully reduce their risk.[28] To a large extent, private landowners and industry can determine whether a municipal policy can be successfully implemented. On the other hand, it is important for local and regional governments to educate the public on the associated risks, and to show leadership to help reduce that risk to the City and the individual community members, their homes and properties, and other values at risk.

7.4.1 WILDFIRE HAZARD DEVELOPMENT PERMIT AREA

The City has established a Wildfire Development Permit Area as part of its Hazardous Conditions Development Permit (DP). The DP process is triggered by rezoning or subdivision applications and multifamily or institutional development in the interface (designated wildfire DP area). The Wildfire DP, unlike the other hazardous conditions DPs, is not triggered by alteration of land or construction of, addition to, or alteration of a building or structure for those properties within the DP area; this makes development of individual single-family homes exempt. Within the Wildfire DP Area, use of FireSmart compliant building materials and landscaping should be enforced on all new sub-divisions, as well as in existing sub-divisions and built up areas when major renovations or individual new-builds occur. Field observations showed that the current development permit process, while an appropriate policy tool, is insufficient at reducing the fire hazard on private lands; it should be more broadly applied, with stronger requirements, and more stringent enforcement.[29]

Applicants must provide the City with a wildfire hazard assessment completed by a qualified professional (QP) (Registered Professional Forester licensed in BC). As part of the DP, the City may require developers to complete,

[28] Blackwell, B. and A. Needoba. 2006. City of Kelowna Review of Policies Procedures and Bylaws Relating to Wildland Fire.

[29] Issues which impact the effectiveness of Kelowna's policy tools are detailed in the 2006 document *Review of Policies, Procedures and Bylaws Relating to Wildfire*.

according to a fuel management prescription, wildfire mitigation on adjacent lands and/or land to be turned over to the City for parks. Wildfire hazard assessments and the development plans are reviewed by the Planning Department, the KFD, and the Parks Department and respective recommendations are implemented through the DP process.

The objectives of the Hazardous Condition Development Permits are to:

- Prevent personal injury and property loss;
- Protect structures from damage; and
- Provide stable and accessible building sites.[30]

The wildfire hazard development permit process can most effectively achieve these objectives through the following strategies:

- Increase the number of homes and properties in the interface which are FireSmart compliant (building materials, design and landscaping) and are thus less vulnerable to ignition through radiant heat or ember spotting. This can be achieved by extending the reach of the Development Permit;
- Ensure that future development is completed with public safety and property protection in mind (road network facilitates suppression and emergency vehicles and public evacuation in the case of wildfire, water availability is sufficient for suppression activities, sufficient setbacks from forested edge and top of slope, and required sub-division design which reduces the overall threat of the sub-division);
- Ensure that natural lands assumed by the City and adjacent to new development are a moderate threat rating or lower; and,
- Ensure that the natural lands turned over to the City are accessible to fire crews, as well as for future maintenance activities to keep the areas at a moderate or lower threat rating.

Given that Kelowna is a high-risk community and there have been significant interface wildfires over the last fifteen years, more effort in the areas of development and planning are required to adequately address the risk posed by individual lots and homes.

A review of other jurisdictions' successfully implemented DP processes suggests that DPs can be used effectively to gradually phase in FireSmart practices on private land, both in the sub-division and individual lot re-development phase. The District of North Vancouver has a robust Wildfire Hazard Development Permit process, which could serve as a model for opportunities to improve current practices for the City. Within the Wildfire Hazard DP area in the District of North Vancouver, DPs are triggered at the building permit phase. Wildfire hazard assessments include review and approval of building materials, building design, setbacks, and landscaping (natural and planted). Bonds collected by the District are not returned to the homeowner or developer until a QP has provided a post-development inspection sign off and photographs to ensure that recommendations

[30] Chapter 13. Hazardous Condition DP. City of Kelowna Official Community Plan.

regarding landscaping, setbacks, and building materials were met. Through this process, the new lots and existing housing stock within the District of North Vancouver is rapidly converting to meeting FireSmart standards in both building materials and landscaping.

For sub-divisions, two wildfire reports are required: one preliminary report which is submitted early in the DP/ development process and one detailed report, submitted much later. Kelowna could adopt this practice to allow the City to have meaningful review and input into the design process. This would be particularly beneficial in review parks location and design.

Costs to individual homeowners/ builders for the wildfire hazard assessment and post-development sign-off can be estimated at $700 - $1,200: representing approximately 0.003% of the total price for an average 2,000 square foot build.[31] There may be additional construction costs, as well. In other jurisdictions the construction community estimated that FireSmart construction requirements added an estimated $15,000 per build. It should be noted that these costs were in a jurisdiction where the developers were not using FireSmart materials for the major cost components of the new builds (for example, vinyl and wood siding and decking were common-place). In our field observations, the vast majority of new homes within the study are using FireSmart building materials for siding and roofing. Therefore, it is estimated that additional construction costs over and above what is 'industry standard' in Kelowna will likely be less than that experienced in the example jurisdiction.

Through consultation with the planning department, it is evident that increasing the reach of the Development Permit would require additional City resources to process the permits. The planning department estimates that Development Permits on single-family homes would increase planning department workload by 600 – 800 files per year. An additional 2 full-time equivalent (FTE) staff to process the files would be needed, as City planning resources are currently running at maximum workload. This cost is approximately $160,000 annually, but would allow implementation of many of the planning and development recommendations. Furthermore, DP implementation on single-family builds would turn over the housing stock within the City to FireSmart compliant development at a rate of 600 – 800 homes per year, which is a considerable rate.

Section 5 of the Building Act provides local governments the authority to set local building bylaws for unrestricted and temporarily unrestricted matters, such as exterior design and finish of buildings in relation to wildfire hazard and within a development permit area. Until revisions of the Building Code to include requirements specific to prevention of wildfire spread are completed, local governments have the ability to set exterior requirements within the development permit area.[32] It is recommended that the City of Kelowna seek legal confirmation regarding the Building Act and to mandate and enforce within the Development Permit process that exterior building materials and landscaping are FireSmart compliant to the extent legally possible.

[31] It is recognized that costs of "an average build" are nearly impossible to estimate, as costs per square foot depend variables too numerous to include in the scope of this report. For the purposes of arriving at 0.003%, the authors applied $200 per square foot for a 2,000 square foot home and an assessment report cost of $1,200.

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

It is also recommended that the City of Kelowna work with the Building and Safety Standards Branch to provide input into the Building Code revisions which would apply within the development permit areas to prevent the spread of wildfire. This is of particular importance in ensuring that Kelowna maintains their regional and provincial competitiveness in development and building costs. California is a good example of a jurisdiction with state-wide interface building requirements.[33] The City may be able to leverage the Fire Chiefs' and Fire Prevention Officers' Associations to influence Province.

The current DP has been shown to be ineffective in adequately reducing wildfire risk, particularly regarding FireSmart landscaping compliance. Many homes within the interface are landscaped with highly flammable vegetation, increasing fire hazard on private properties and immediately adjacent to homes (Priority Zone 1). Furthermore, the standard practice of grass seeding disturbed areas is leading to high grass hazard, oftentimes on slopes directly below houses (Figure 18). Re-vegetation of disturbed areas should be completed using a combination of native grass seed[34] and planted native shrubs suitable for the site. Examples include, but are not limited to, Oregon grape (*Mahonia aquifolium*) and snowberry (*Symphocarpus albus*). See section 7.5.2.1 for further information on grass hazard within the study area.

It is recommended the City develop a landscaping standard to be applied within the DP area (included as an appendix in the Terms of Reference) based upon FireSmart guidelines. The landscaping standard should be applicable to the landscaping of individual lots, any landscaped (non-natural) parks assumed by the City, and re-vegetation for disturbed areas. If enforcement is not possible with currently available resources, consider including landscaping activities as a requirement for the development bond. A condition of bond return would be a post-development sign-off from a third-party QP, paid for by the builder or developer, to reduce enforcement costs. As part of the development permit, a landscaping plan should be required, reviewed and approved. The City should take leadership to demonstrate to the public and development community the importance of FireSmart compliance in landscaping, as well as building, and the wildfire hazard that non-compliant landscaping pose for neighbourhoods.

[33] http://www.fire.ca.gov/fire_prevention/fire_prevention_wildland_codes

[34] For example, Pick Seeds' Interior Native Dryland grass seed mix applied at the recommended rate of 20 – 40 kg/ha.

Figure 18. East aspect slope in Wilden. Surface fuel continuity is >90%. Grass is ~1 m in height and matted. No ground is visible. This slope was disturbed and re-seeded with a non-native grass mix.

Table 8. Summary of planning and development recommendations.

Planning and Development			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: To reduce wildfire hazard on private land and increase number of homes in FireSmart compliance.			
16	High	• Complete a review of the OCP/ Wildfire Development Permit process to strengthen and expand reach of the existing policy. Review District of North Vancouver DP process as a model. Amend OCP to incorporate recommendations within this document.	~ $35,000

Planning and Development			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
17	High	• Wildfire development permit should be triggered for new builds and major retrofits/ renovations (as part of the building permit), as well as for land subdivisions. This will align the wildfire hazard development permit with the other hazardous conditions development permits and expand the number of FireSmart compliant homes gradually as development, re-builds, and major renovations occur (major renovations usually defined as a complete re-build on a previously existing foundation).	$160,000 (Based on generation of 600 – 800 new DP files per year and 2 additional FTE in planning department)
18	High	• Obtain legal confirmation regarding the Building Act, specifically regarding the temporarily unrestricted matters and local government authority to set exterior building materials requirements. Use local government authority to mandate FireSmart construction materials beyond BC Building Code in wildfire hazard development permit area. Construction materials (roofing, soffits, siding, vents, windows, doors, and overhanging projections/ decks) should be FireSmart compliant. FireSmart building materials should also be required on all outbuildings, garages, or sheds within 10 m of the residence or adjacent residences.	$1,000 for legal confirmation. City costs for implementation depend on outcome of confirmation and implementation strategy.
19	Moderate	• Conduct a workshop, or series of workshops, to inform, engage, and consult the development community. Topics could include revisions to the DP process and terms of reference, and FireSmart building and landscaping.	Cost included in recommendation #16
20	High	• Formalize a Terms of Reference document to be provided to the developers and QPs completing assessments. Two standards are recommended: one for sub-divisions and one simpler standard for individual builds. o Elements for the basic wildfire hazard report should include: professional qualification of QP, assessment and quantitative description of surface, ladder, and crown fuels; reference to building materials, design and placement; setbacks from forested edge and top of slope; a FireSmart WUI site and structure assessment; landscaping; representative photos; any existing covenants; mitigative actions required to ensure that the home meets FireSmart compliance; and maintenance regime to ensure that risks are minimized to the extent possible. The report should clearly state any required elements or conditions which would render the development not within an acceptable range of wildfire risk for its intended purposes. Peer reviews may be required at the expense of the applicant. The report should include a map showing, at a minimum building footprint, proposed mitigative actions, and FireSmart priority zones. Recommended elements for the detailed reports are discussed in the following Section.	Cost for formalizing terms of reference included in recommendation #16 (updating current process/ DP guidelines). Costs for implementing terms of reference update for individual builds included in FTE in recommendation #17.
21	High	• Ensure that development bonds levied at the time of development permit application are sufficient to cover wildfire mitigation activities (among other factors for which the bond is intended to cover). One condition of bond return should be submission of a FireSmart post-development inspection of building and landscaping. The inspection is to be completed by a QP to ensure that the development meets the requirements of the wildfire hazard assessment report. Photographs of the completed site and structure should be included in the sign-off.	~$10,000 annually for additional clerical resources. For individual builds, cost is included in FTE in recommendation #17.

Planning and Development			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
22	High	• Require a landscaping plan, or plant-selection list, to be provided as part of the development permit application. The landscaping plan/ plant-selection list should be FireSmart compliant and consistent with City standard (recommendation #24), as well as include plans for re-vegetation of disturbed areas. o Highly flammable plants should not be planted within 10 m of structures (this includes juniper, cedar, and other flammable conifers). Disturbed areas, such as roadsides and buried water and utilities, should be re-vegetated with a native grass-seed mix and native deciduous and evergreen low-flammability shrubs according to the site conditions and distance from structures.	City costs included in FTE costs in Recommendation #17 (single-family homes). Sub-division and multi-family homes are within current operating costs. Additional costs should be expected by the developer.
23	Moderate	• City of Kelowna to work with the Building and Safety Standards Branch to provide input into the Building Code revisions which would apply within the development permit areas to prevent the spread of wildfire. The City of Kelowna should lobby for FireSmart building materials and design, consistent with development permit requirements. The Fire Chiefs' and Fire Prevention Officers' Association can provide valuable influence in this arena.	Within current operating budget
24	High	• Develop a landscaping standard to be applied in interface/ DP areas based on FireSmart guidelines. The standard should list flammable non-compliant vegetation, non-flammable drought and pest resistant alternatives, and tips on landscape design to reduce maintenance, watering requirements, and reduce wildfire hazard.	Cost for standard development included in recommendation #16. Implementation as "guide or best practices" is within current operating budget. Implementation as regulation included in FTE costs in Recommendation #17.

7.4.1.1 SUBDIVISION DESIGN

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

entrapments and vehicle collisions during wildfires (DeRonde, 2002). Methodologies for access design at the subdivision level can provide tools that help manage the volume of cars that need to egress an area within a given period of time (Cova 2005). New subdivisions should be developed with access points that are suitable for evacuation and movement of emergency response equipment.

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

The width of water mains can impact the water pressure available to fire fighters. The spacing of fire hydrants influences how effectively fire fighters can protect structures. Water mains and hydrant spacing can be improved in new subdivisions with a marginal increase in cost. However, the cost of changing these factors in existing subdivisions is extremely high and is not generally practical. Currently, the KFD reviews plans and provides input into hydrant location and spacing for new developments within the DP area. This practice should continue.

Table 9. Summary of planning and development recommendations, specific to subdivision design.

Planning and Development (Subdivision design)			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: To incorporate wildfire hazard reduction considerations in subdivision design.			
25	High	• New subdivisions should be developed with access points that are suitable for evacuation and the movement of emergency response equipment. The number of access points and their capacity should be determined during subdivision design and be based on threshold densities of houses and vehicles within the subdivision.	Within current operating costs
26	High	• Where forested lands border new subdivisions, consideration should be given to requiring roadways to be placed adjacent to those lands. If forested lands surround the subdivision, ring roads should be part of the subdivision design. These roads both improve access to the interface for emergency vehicles and provide a fuel break between the wildland and the subdivision.	Within current operating costs
27	High	• Proximity of hydrant locations to access points for forested parks should be a consideration during the design process for new subdivisions. The KFD should continue to review hydrant spacing and location for all new developments to ensure that water availability is sufficient for suppression purposes.	Within current operating costs

7.4.1.2 PARKS/ NATURAL LANDS ASSUMED BY THE CITY

Currently, forested and natural parcels of land are assumed by the City as part of the development process. These areas are then held by the City as parks. The parks provide many ecosystem services (wildlife corridors, stormwater retention, carbon sequestration, etc.) and benefits (aesthetics, sense of place, recreational opportunities, etc.) to City residents; these values should not be understated. However, the current process is

creating a situation where the City is assuming liability for high wildfire hazard lands, with potentially disastrous consequences should a wildfire occur, due to their proximity to, and location in relation to, values at risk. The liability these lands represent must be recognized and lands should be managed accordingly; the 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 land turned over as 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, future maintenance activities, and for fuel breaks and control lines.

Initially, the City should ensure that the lands represent an acceptable level of risk prior to taking possession of them. Field observations showed that areas assumed by City were observed to be 100 – 600 stems per hectare (20 – 60%+ crown closure) and with some suppressed trees remaining, contributing to ladder fuel loading and current threat ratings of moderate or high. Thick, long grasses provide flashy and continuous surface fuels. Much of the parks are situated on steep slopes with values at risk adjacent upslope. Prescriptions and implementations were inconsistent. Some variation among treatments are to be expected based on site specifics and operational limitations, but it is recommended that a greater level of consistency, in both product and result be expected to limit short-term liability and reduce costs to the municipality in the mid and long-term.

The following considerations and recommendations are to achieve consistency in mitigation activities and ensure that the areas are currently at and able to be maintained at, an acceptable level of threat.

- The City developed a wildfire hazard assessment checklist to provide clear and concise guidance and to set expectations. This important first step resulted in marked improvements in reports received and ability to evaluate results on the ground according to the assessment. By providing further guidance to the developers and QPs, in the form of a Wildfire Hazard Assessment-specific Terms of Reference, more consistent results could be achieved and the evaluation process could be streamlined. Specifically, it is recommended that formalized terms of reference include:
    - Set minimum levels of qualifications for foresters developing plans. The Association of B.C. Forest Professional's (ABCFP) practice guidelines on Fire and Fuel Management outline an RPF's required experience, training and education needed in order to competently carry out wildfire hazard assessments.
    - Provide developers with a shortlist of those contractors from which the City can expect high quality work and a high level of knowledge, experience, and professionalism. This can be achieved through a contractor pre-qualification process (Expression of Interest) or through other mechanisms.
    - All the required elements of the basic wildfire hazard assessment report, as outlined above in recommendation 21. Additional assessment elements should include: access and egress for residents, access plan for natural areas to be assumed by the City, water availability/ hydrants, and mitigative actions/ fuel treatment prescription to ensure that the sub-division is within an acceptable range of wildfire risk.

- To allow the City review and input into sub-division and parkland design, reports could be required in two phases: a preliminary report submitted early in the development process, assessing general wildfire threat, proposed parks locations, etc. The detailed report could be submitted at a later date, which would outline specific mitigative actions and fuel treatment prescription.

- Reference to standards expected, such as the NFPA 1144 and 1141, the FireSmart manuals (Protecting Your Community from Wildfire, the Site and Structure Hazard Assessment System, The Home Owners FireSmart Manual), the most recent Wildland Urban Interface Threat Assessment Forms and guidebook.

- Require use of the SWPI Fuel Management Prescription Template (include link to Notes to Assist Form Completion) to encourage consideration of multiple values and ensure that treatment activities will meet intent of the prescription (or develop equivalent Kelowna-specific template).

- State required mapping elements (scale, north arrow, lot-lines, current and planned roads and other access, treatment areas, structure locations/ footprints, hydrants, contours, etc). The map(s) should provide a visual display of all the components assessed.

- Provide guidance regarding post-treatment target stand conditions (TSCs), using the 2011 CWPP's guidance regarding TSCs based upon ecology and site exposure as a basis point from which target ranges can be adapted.[35] See Section 7.5.1.1 for more details.

- Require sign-off by QP at the completion of development or treatment. Sign-offs should be accompanied by photographs to ensure that treatment results meet the prescription objective(s).

Access to, and through, the natural areas is necessary for crew access for fire suppression; can be used for fuel breaks, control lines, or sprinkler line locations; and for access for crews and equipment for future mitigation activities. In order to maintain the natural areas in a moderate threat state in the long-term, fuel treatments at regular intervals (approximately 7 – 15 years, depending on site productivity) will be required to reduce the fuel loading. Treatments may include removal of conifer regeneration, reduction of surface fuel continuity (grasses), or removal of overstorey mortality (standing or surface fuels). Grass control is a priority in these areas, as the majority of polygons have grass surface fuel continuity which would support a rapidly spreading grass fire capable of spreading to adjacent structures.

Without access for maintenance fuel treatment activities, fuels will accumulate and create highly hazardous conditions adjacent to values at risk. It is recommended that an access plan for the natural lands is required as part of the wildfire hazard assessment and fuel treatment prescription. The access plan should be completed by a QP with a strong understanding of operational fuel treatments and fire behaviour in order to achieve all three objectives (fire suppression crew access, fuel breaks and control lines, crew and equipment access for fuel treatments).

[35] See pages 41 and 42 of the 2011 CWPP.

The location of lands turned over to the local government during development is a challenge, as park lands are usually the steepest slopes in the development area and in close proximity to, or intermixed with, the development. It is recommended that a forester with the Parks department is consulted in the planning stage and approves new park lands to ensure that the benefits of the park outweigh the costs. The City of Kelowna has surpassed its stated goal of 5% of total land area protected through public ownership, with more than 1,000 ha of protected natural areas and open spaces.[36] Parks which do not provide the City with ecological and social benefits which outweigh the long-term maintenance cost and liability should be identified early in the process to allow for Parks input and re-design; this includes parks which provide the majority of benefit to the adjacent homeowners or developers, or with exorbitant long-term maintenance costs. It is recommended that the City develop a decision matrix analysis or cost-benefit evaluation tool to allow for clear and transparent decisions regarding future parks status. [37]

Table 10. Summary of planning and development recommendations, specific to City parks obtained through the development process.

Planning and Development (City parks obtained through development process)			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: To reduce hazard and liability in the short and long term in City-owned natural parks obtained through development process.			
28	High	• Formalize the current checklist into a Terms of Reference document to be provided to the developers and QPs completing assessments. Recommended elements for assessment, above those already outlined in recommendation 21, are: minimum levels of experience for QPs, road access/ egress, water availability/ hydrant location, fuel treatment prescriptions, natural areas access plan, reference or links to standards, WUI threat plot forms and SWPI prescription templates, required mapping elements, and TSCs to help guide prescribed mitigation activities.	Cost included in recommendation #16
29	High	• The City should adopt a consistent standard for Registered Professional Forester wildfire hazard assessments and fuel treatment prescriptions required as part of the Development Permit process. This would help to ensure that hazard mitigation activities are consistent and appropriate within all subdivisions, that multiple values are considered in the prescription process, and help to streamline the evaluation process. The fuel treatment prescriptions should make use of the SWPI fuel management prescription template (or Kelowna-developed equivalent). Wildfire hazard assessment report standards can be adapted from the proposed standard contained in the Review of Policies, Procedures and Bylaws Relating to Wildland Fire, or adapting the proposed standard from the table of contents provided.	Cost included in recommendation #16
30	High	• Consult with purchasing regarding an approved contractor shortlist for QPs from which a high standard of work and professionalism can be expected. Solutions may include contractors submitting an Expression of Interest from which the City can evaluate their knowledge, skills, and experience.	Within current operating costs

[36] City of Kelowna website: Natural Parks: http://www.kelowna.ca/CM/Page291.aspx

[37] The City of Kelowna website: Urban Trees and Their Benefits: http://www.kelowna.ca/cm/page940.aspx

Planning and Development (City parks obtained through development process)			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
31	High	• Development Permit for sub-divisions should require an access plan for areas to be turned over to the City as parks. Access plans should be completed by a QP with experience in operational fuel treatment and with a strong understanding of fire behaviour. The plan should consider crew access for fire suppression, fuel breaks and control lines for suppression and future maintenance burns, and crew and equipment access for future maintenance activities. The access plan should be reviewed and approved by the Parks Department as part of the wildfire hazard assessment.	Within current operating costs (Costs borne by developer)
32	High	• The lands designated as future City parks should be reviewed and approved by the Parks Department, early in the DP process. This can be accomplished with a 'preliminary' development permit report with proposed park lands submitted early in the process which will allow for meaningful review and input from Parks. Review should include wildfire threat, location relative to slope and values at risk, access, and associated liability to the City.	Within current operating costs
33	High	• Ensure that bonds levied at the time of the development permit application are sufficient to cover wildfire mitigation activities. The bond should be returned upon post-treatment inspection of operational fuel treatment and threat rating of lands to be assumed by the City (along with any other non-wildfire related cost factors incorporated into the bond amount). The inspection is to be completed by a QP to ensure that the development meets the requirements in the wildfire hazard assessment report and fuel treatment prescription. Representative photographs should be included in the sign-off.	Within current operating costs
34	High	• Create a decision matrix analysis that allows the City to transparently and effectively evaluate multiple options (i.e. assume parkland as designed or request redesign of parkland) according to multiple weighted factors (social, environmental, and economic).	$2,000

7.4.2 OTHER POLICY

Table 11. Summary of other policy recommendations which would serve to reduce wildfire hazard on private land.

Municipal Policy			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: To reduce hazard and liability on private land.			
35	High	• The City should enforce Section 8.1.1 of Bylaw No. 10760 requiring owners to maintain their properties hazard free on all properties, with a focus on interface properties and properties in Wildland Fire Hazard Development Permit areas. Enforcement will serve to minimize fuel risks on problematic private properties which have allowed hazardous accumulation of fuels and provide improved protection to adjacent lands.	Increased costs dependent of extent of enforcement

Municipal Policy			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
36	High	• The City should alter the zoning bylaw to require that developers leave building set backs on private land consistent with FireSmart recommendations. This standard should be applied to housing bordering both City owned and forested private land within the Development Permit area.	Cost included in recommendation #16

7.5 FUEL MANAGEMENT

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

The City has completed extensive fuel management activities within and adjacent to the City (within the study area) (Figure 19). To complement the work completed to-date and to further reduce the wildfire risk in the study area, the objectives for fuel management are to:

- Reduce wildfire threat on private and public lands through fuel management; and
- Establish a monitoring program and maintenance schedule for those areas that have been treated.

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

As discussed above, fuel treatments are designed to reduce the possibility of uncontrollable crown fire through the reduction of surface fuels, ladder fuels and crown fuels. This threshold of reduction varies by ecosystem type, current fuel type, fire weather, slope and other variables. Additionally, fuel management can be an effective method of reducing fire behaviour; however, it is important to note that it does not stop wildfire. The purpose of altering vegetation for fire protection must be evaluated against the other key CWPP elements (outlined above) to determine its necessity.

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

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

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

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

Based on recommendations from the 2011 CWPP, fuel treatments activities were completed within the study area and on all the high priority polygons and many of the moderate priority polygons. The total area treated within the study area since 1998 exceeds 600 ha. Because treatment has been completed so extensively over the study area, few new eligible (Crown or municipal land) treatment areas remain. Treatments have been completed by the City, Regional District, and developers who are required to complete fuel treatments in order to reduce the hazard of new sub-divisions within wildfire development permit areas. Ongoing maintenance of the treated areas to retain them in a state such that they continue to function as effective fuel treatments is of very high priority for the City of Kelowna, as they represent a significant liability to the City if left to accumulate fuels. Ongoing maintenance activities and scheduling will be discussed in Section 7.5.2.

To assess risk on treated and untreated polygons, the *Provincial WUI Wildfire Threat Rating Worksheets* (worksheet) were used, as required by UBCM[38], in addition to professional judgment (WUI summaries are provided as a separate document). The worksheet provides point ratings for four components that contribute to wildfire risk. These components include fuels, weather, topography and structural values at risk. Proposed projects to reduce the wildfire hazard to the study area through fuel modification are summarized in Table 7 and locations are illustrated in Figure 20.

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

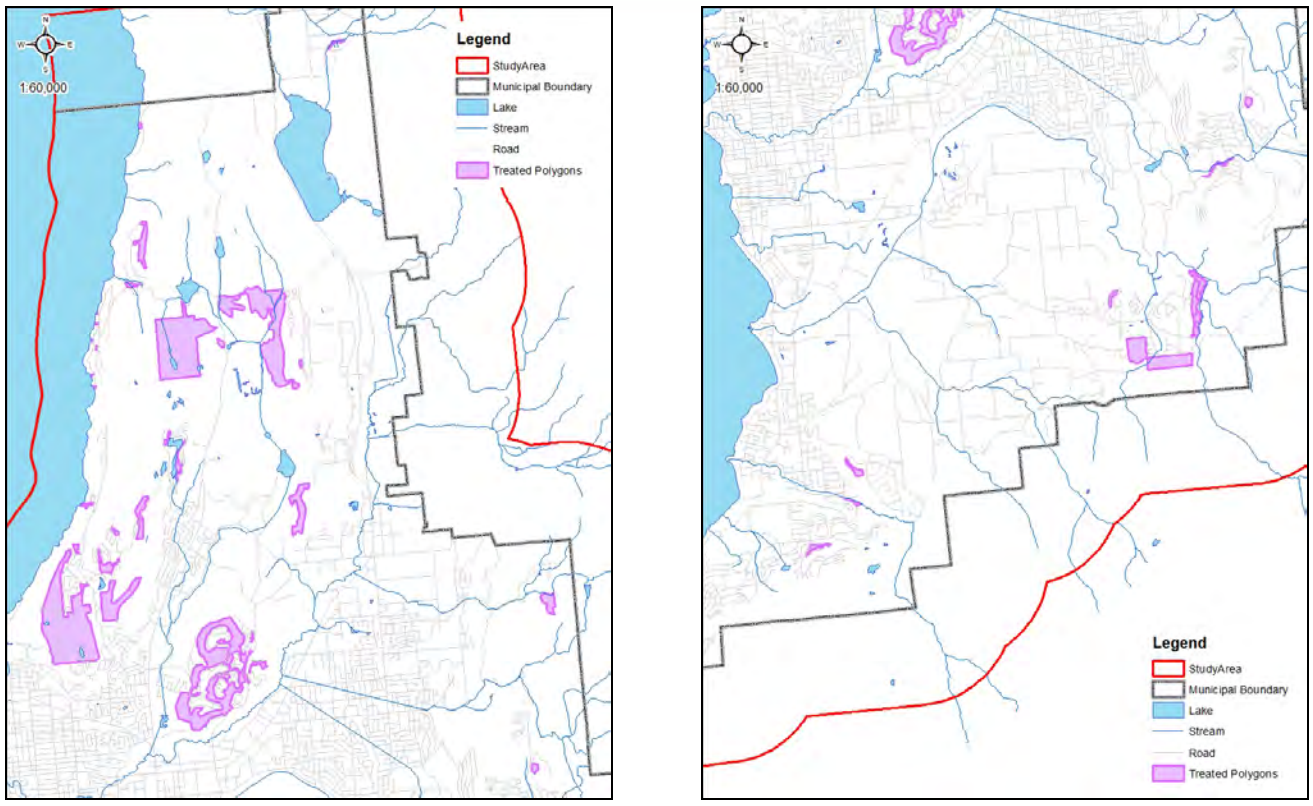


Figure 19. Previously treated polygons within the study area. The map on the left displays the north half of the study area, the map on the right displays the south half.

7.5.1 NEW TREATMENT POLYGONS

As noted above, the majority of eligible fuel treatment areas within the study area have been completed. Although fuel treatment/ vegetation modification is integral to the City's risk profile, it should be noted that higher priorities for action include: engaging with other stakeholders to encourage or facilitate fuel management on non-eligible lands and maintenance activities on previously treated polygons.

Eight polygons are recommended for initial fuel management activities (Figure 20, Table 7). Four proposed fuel treatment maintenance polygons are located in the southern section of the City (SK-1, SK-2, Mission Creek Regional Park, SK-4, SK-5), one area under RDCO jurisdiction is located more centrally in the City (Mission Creek), two polygons, both currently on private land, but which are expected to convert to City-owned property have been identified in the east interface (Black Mountain and Kirschner), and one proposed polygon is in the north of the City: NK-4. Proposed treatment polygons are general; exact polygon boundaries must be determined by a qualified professional at the time of prescription development.

SK-1, SK-2, and NK-4 are eligible for UBCM fuel treatment prescription and operational fuel treatment funding. SK-4 and SK-5 are in Myra Bellevue Provincial Park and will require facilitation with BC Parks in order to complete fuel modification. Mission Creek Regional Park is under RDCO management. It is recognized that the RDCO has been actively working on fire mitigation throughout the Regional District and on RDCO-managed land within the City

boundary. This polygon was identified because it represents a high threat area within the study area; the City's role in treatment will be limited. Kirschner and Black Mountain are currently privately held lands which will be assumed by the City. Fuel treatments on these lands will require engagement with private land holders to ensure that they are received in a moderate threat rating.

7.5.1.1 RECOMMENDED TREATMENTS

The primary objectives and key elements of interface fuel treatments prescriptions are well documented in the 2011 CWPP: to prevent occurrence of crown fire, to reduce surface fire intensity, and to improve fire suppression capabilities. In order to achieve the objectives, the report recommends that prescriptions aim to achieve target stand conditions (TSC). TSCs were proposed in the 2011 CWPP and can be found in APPENDIX L: 2011 CWPP TARGET STAND CONDITIONS. The TSCs from that document are based upon ecology and site exposure.

The TSCs as described in the 2011 CWPP are a good starting point for further refinement at the individual site level. Although the overall vision for the TSCs is appropriate, they are not global or flexible enough to realize all phases of stand succession. For example, city foresters have noticed that in some fuel treatments where density was reduced to 300 – 400 sph in immature stands, retained trees 'sagged', likely from drought caused by increased exposure and wind into the stand, and increasing transpiration. In immature stands, fuel treatments may need to be completed in multiple phases, to achieve a healthy and resilient stand and reduce the risk of crown fire. Additionally, grassy fuels in open canopy stands pose a serious fire hazard in the study area and the hazard is generally underestimated; thick, continuous flashy fuels (grasses) are one of the biggest fire hazards and operational challenges facing the City.

Grass fires, though not as spectacular as crown fires, when wind-driven can have very rapid rates of spread and considerable flame height (up to 4 m) and are capable of destroying structures. This was most recently demonstrated in the 2015 Sleepy Hollow fire in Wenatchee, WA, where a grass fire destroyed more than 24 homes. Embers, most likely released from the burning residential structures, then travelled in excess of 2 km downslope from the firefront, alighting on, and destroying, several commercial structures in the downtown core.[39, 40] Grass fires challenge the notion of rapid initial attack, as they have the capability to spread faster than the ability of crews to respond to the site, particularly when wind-driven.

It was noted that on all but the most freely draining, sandy-soiled south and west aspect slopes, grass continuity was at least 70%, usually greater, in treated areas where crown closure was less than 40%. Retaining higher crown closure, and thus higher density, in order to control understorey grass growth may be a preferred option, though it should not be done at the expense of increasing risk of a crown fire.

The challenge will be to implement treatments that delicately balance the trade-off between crown separation such that the stand is not capable of carrying a crown fire and control of grassy fuel height, density, and continuity

[39] Personal communication, Jim Duck, Assistant Manager, Central Washington Interagency Communications Center. May 18, 2016.

[40] http://www.cbc.ca/news/canada/british-columbia/sleepy-hollow-fire-in-washington-state-destroys-homes-and-forces-evacuations-1.3131739. Accessed 1 June, 2016.

such that surface fire intensity and rate of spread is reduced to an acceptable level. Use of prescribed fire, both at the time of initial treatment and in conjunction with thinning activities, as well as for maintenance of surface fuels, is the most effective option. See Section 7.5.1.2 for more details.

Further to that, it is recommended that the TSCs are refined and improved based on quantitative data and empirical evidence, rather than based solely upon professional opinion. It is clear that the proper balance between density, forest health, and grass hazard has not yet been established. To that end, monitoring plots in treatment and control areas should be established with resulting data used to inform and feedback into new or refined TSCs for the City. More details on a monitoring program can be found in Section 7.5.2.2.

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

There are many operational challenges with surface fuel continuity reduction and maintenance treatments, including, but not limited to: access limitations, steep slopes, air quality concerns, cost, and proximity to homes. There are few feasible methods of grass control, each with distinct risks and benefits. Broadcast burning is an effective measure at fine fuel reduction and can be implemented in conjunction with thinning operations at the time of initial treatment to control fine fuels, as well as used as a maintenance strategy. Other grass control measures are detailed in Section 7.5.2.1.

Site specific operational challenges exist in almost all treatment areas. Specifically, within the study area, debris disposal and management are constrained severely by access limitations, which consistently pose challenges to implementation and increase operational costs. Many polygons are located on steep slopes, which may not be accessible by machinery and limit operations to manual labour. Housing developments, or other structures, often surround treatment areas, or are adjacent on one or more sides, which can further limit debris removal. Oftentimes, the most cost effective debris disposal method is pile burning of woody waste materials.

In the future, maintenance burns using prescribed broadcast burning are recommended every five to seven years as a preferred option to maintain previously thinned and burned treatment areas (more details on maintenance can be found in Section 7.5.2). All maintenance burning should be conducted by trained staff in coordination with BCWS or with the direct assistance of the BCWS.

7.5.1.2 BURNING AND SMOKE MANAGEMENT

Prescribed burning is the deliberate use of fire in a specific area and within prescribed fuel and weather conditions. Prescribed fire, when used properly and in appropriate circumstances, is an extremely important, and effective, tool for mitigating wildfire hazard and reducing fuels. Piling and burning and prescribed broadcast burning are tools of fuel reduction/debris management that must be considered an option during fuel reduction activities. When implemented properly, prescribed burns can be completed with low emissions and little impact

on air quality; prescribed burns can be implemented with much less smoke and particulates released than during a wildfire event.

PILE BURNING

Pile burning is an effective use of fire in locations where access is limited making chipping or fuel removal impossible or too costly. Smoke management and control during pile burning has improved in recent years and there are a number of strategies which can be employed to reduce smoke emissions to an acceptable level. They include: checking local venting indices prior to burning; lighting a small test pile to check venting prior to starting larger operations; burning concurrently (lighting small piles and continually adding to the pile throughout the day, rather than accumulating large piles to burn); adding oxygen through the use of leaf blowers, or similar hand-held devices to encourage more complete combustion.

Prescribed burning is just one method of woody debris management and fuel reduction and can be used in combination with other methods, such as chipping, mulching, fuel utilization, or scattering fuels, in the same treatment unit to further reduce emissions.

PRESCRIBED BROADCAST BURNING

Low intensity surface fires are the most effective method to control fine and small fuels, help to maintain lower fuel loads, and to restore or maintain an ecosystem closer to its historically natural conditions. A study of fuel treatment effectiveness found that in lower elevation long-needle pine and mixed conifer forests, the most effective fuel treatments have occurred in grasslands and conifer forests that were thinned and subsequently burned.[41] This finding was consistent in northern and southern latitudes in the western United States, which suggests that it may be cautiously extrapolated to the study area.

Prescribed burning is not without risks and limitations:

- It has little effect on larger diameter fuels;
- Risk of fire escape and resultant damage or destruction;
- It does not allow for discriminatory fuel reduction (fire burns biomass available);
- Smoke can be a health hazard, particularly as fire prescriptions tend toward high relative humidity and low wind speed conditions often associated with stagnant air masses; and,
- Due to the risk of fire escape, fire managers often tend towards substantial fire personnel and equipment, which can result in higher implementation costs.[42]

[41] Martinson, Erik J.; Omi, Philip N. 2013. Fuel treatments and fire severity: A metaanalysis. Res. Pap. RMRS-RP-103WWW. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 38 p.

[42] Bracmort, K. 2013. Congressional Research Service Report 7-5700.

On the other hand, the costs and impacts of an uncontrolled wildfire should be weighed against the risks and limitations of prescribed burning. For example, proper prescribed burning methods and timing can minimize emissions. Additionally, the timing of smoke emission is known, which allows for accommodation for those most seriously affected by smoke. Whereas smoke emissions from uncontrolled wildfires are considerable, uncontrollable, untimed, and the protection of health and public safety of all in the community becomes paramount. Concerns regarding health impacts from smoke emissions can become secondary when loss of life and property is at risk.

Other mechanisms to control fine surface fuels, such as grasses and needles, are targeted grazing, chemical, and mechanical methods. The benefits, challenges, and limitations of these other methods are discussed in detail in Section 7.5.2.1.

SMOKE MANAGEMENT

Smoke management is integral to the success of any burning operation. Site, or area specific, smoke management plans should be in place to ensure that emissions are minimized and operations are compliant with all relevant legislation. Strategies to minimize impacts of smoke include:

- burn under acceptable venting, wind and weather conditions only;
- light a test pile before burning to ensure that local conditions match published venting conditions;
- practice concurrent burning, also called hot-fed piles (piling and burning at the same time to achieve a moderate level of fuel compaction and a good mixture of small and large diameter wood);
- utilize tools, such as leaf blowers, to maintain a hotter fire with more complete combustion;
- stop burns immediately should venting, weather, or wind conditions become undesirable;
- utilize trained and knowledgeable personnel;
- time burns when the least amount of people will be impacted (e.g. during school holidays); and
- notify the public and offer alternatives for those with serious health concerns

Burning completed by knowledgeable and competent personnel, guided by a smoke management plan, and directed by an experienced professional can often be completed with minimal impacts to public health or air quality. It is recognized that the City does not allow burning activities on City-land or City-funded projects. Burning pilot projects may allow the City to take first steps towards re-introduction of this useful wildfire mitigation tool.

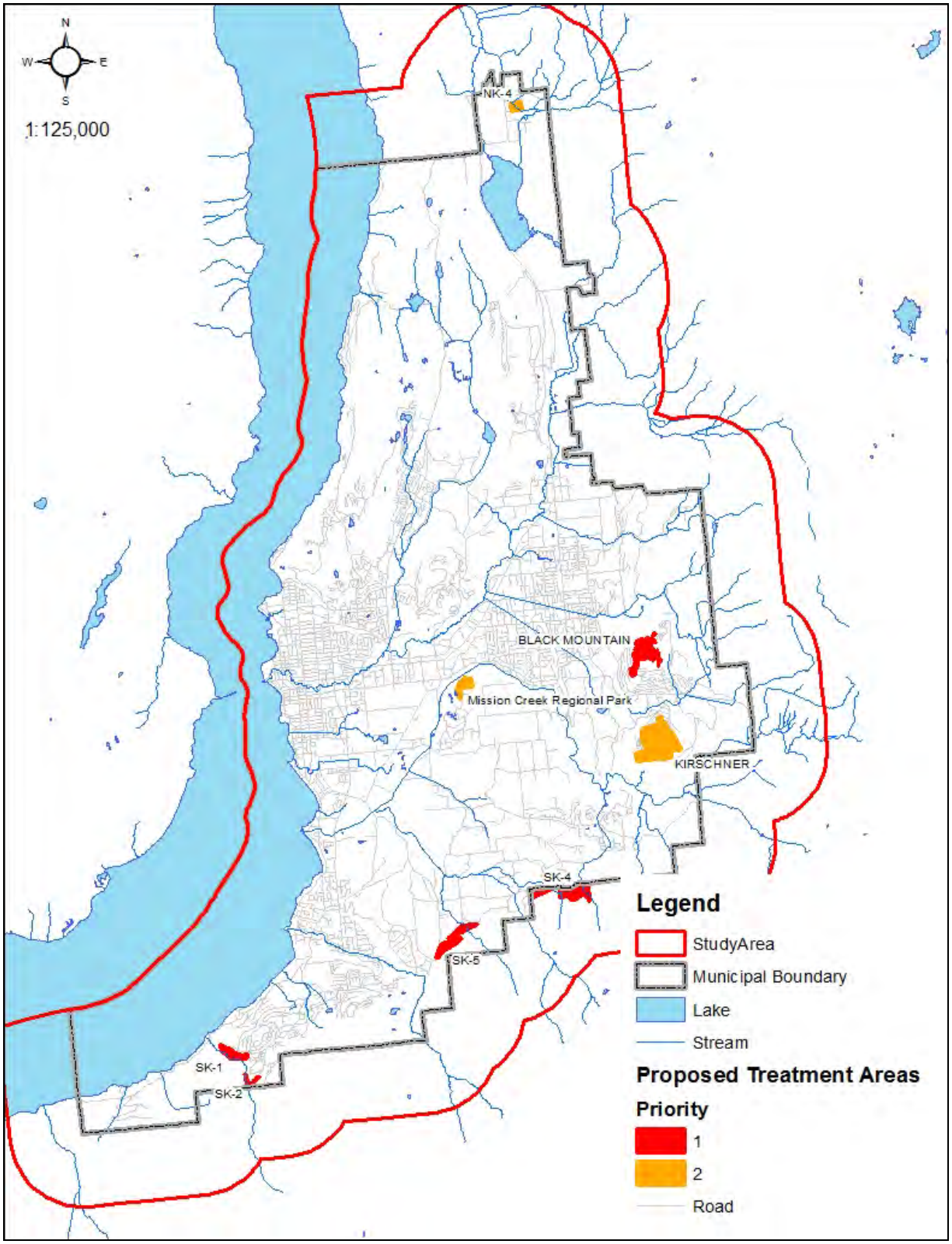


Figure 20. Proposed treatment polygons within the study area.

Table 12. Priority fuel treatment areas.

Treatment Polygon	WUI Threat Plot	Priority	Fuel Type	Approximate Area (ha)	Recommended Treatment Type	Comments
Fuel Treatments						
SK-1	24	1	C7	12	Recommended Treatment: • Prune trees up to 2 m; • Reduce woody surface fuels; • Remove standing dead; • Thin dense patches; and • Burn surface grass cover (40-60% coverage).	Polygon is on municipal land and located on a steep slope below homes and above intermix structures. Previous fire caused mortality and has resulted in moderate to high woody surface fuels. Grass cover is high. Complete treatment to reduce rapidly spreading surface fires and surface fires moving into tree crowns or igniting homes at top of slope. Operational constraints include steep slope and associated lack of access.
SK-2	26	1	C7	3	Recommended Treatment: • Prune trees up to 2 m; • Reduce woody surface fuels; • Remove standing dead; • Create fuel break and access trail between homes and continuous forested land to south and east; and • Burn surface grass cover (40-60% coverage).	Polygon is on municipal land and located on a steep slope above and side slope from a new development (currently under development). Mortality has resulted in moderate to high woody surface fuels and standing dead. Grass cover is high. Complete treatment to reduce rapidly spreading surface fires and surface fires moving into tree crowns or igniting nearby homes. Operational constraints include steep slopes and associated lack of access. Fuel break / access could serve as a sprinkler line location, crew access, as well as access for future danger tree removals and fuel treatment maintenance activities.
Mission Creek Regional Park	11.5	2	C7	33	Recommended Treatment: • Prune trees up to 2 m; • Thin dense patches to 25% crown closure; • Remove/ reduce conifer regeneration (isolate patches to reduce ladder fuels); and • Burn surface grass cover (40-60% coverage).	Polygon is part of Mission Creek Regional Park. Coordinate treatment with RDCO.
SK-4	34	1	C3/ C7	35	Recommended Treatment: • Thin overstorey to 30% crown closure; • Prune trees up to 2 m; • Reduce coarse and fine woody surface fuels; and • Burn surface grass cover (40-60% coverage) every 5-7 years.	Polygon is dense, ingrown C7/ C3 fuel type on both BC Parks and Crown land. It is recommended that a public education campaign for the adjacent private homeowners is undertaken simultaneously to spur action on adjacent private land and ensure the greatest efficiency of expenditure. The polygon is a high-use recreational area (horseback riding, biking, hiking, and running).

Treatment Polygon	WUI Threat Plot	Priority	Fuel Type	Approximate Area (ha)	Recommended Treatment Type	Comments
Fuel Treatments						
SK-5	32	1	C3/ C7	20	Recommended Treatment: • Thin overstorey to 30% crown closure; • Prune trees up to 2 m (where needed); • Reduce coarse and fine woody surface fuels; and • Encourage understory deciduous shrub community.	Polygon is dense, ingrown C7/ C3 fuel type on both BC Parks land within the municipal boundary. It is recommended that a public education campaign for the adjacent private homeowners is undertaken simultaneously to spur action on adjacent private land and ensure the greatest efficiency of expenditure. The polygon is a high-use recreational area (horseback riding, biking, hiking, and running).
NK-4	105	2	C7	7	Recommended Treatment: • Prune trees up to 2 m; • Remove/ reduce conifer regeneration (isolate patches to reduce ladder fuels); • Thin dense patches to 40% crown closure; and • Burn surface grass cover (40-60% coverage) every 5-7 years.	Polygon is on provincial land located adjacent to the industrial/ commercial area. No access to land due to high fence. Estimate of hazard from outside fence line. Polygon is adjacent to industrial and commercial structures.
Kirschner	50	2	C7	87	Recommended Treatment: • Prune trees up to 2 m; • Thin dense patches to 30% crown closure; and • Provide permanent municipal access to the treatment area.	Polygon is on what is currently private land adjacent to the new Kirschner development. Portions of the polygon are to be turned over to the City as natural park area. The polygon has been partially treated by the developer in multiple phases. Areas of the polygon are acceptably treated, though pockets of very dense coniferous crown closure remain, as does high surface fuels continuity. It is recommended that an ATV-access/ trail network be created to facilitate access for suppression crews, provide a fire break and possible sprinkler line location, and provide access for future maintenance activities that will be required (danger tree removal, maintenance fuel treatments).

Treatment Polygon	WUI Threat Plot	Priority	Fuel Type	Approximate Area (ha)	Recommended Treatment Type	Comments
Fuel Treatments						
Black Mountain	37, 51	1	C7	34	Recommended Treatment: • Thin overstorey to 30% crown closure, or less; • Prune trees up to 2 m; • Burn surface grass cover (40-60% coverage); and • Create ATV access to the polygon/ fuel break.	Polygon is on what is currently private land adjacent to the new Prospect at Black Mountain development. Portions of the polygon are to be turned over to the City as natural park area. The polygon is very steep and has been partially treated by the developer, but the threat rating remains high, mostly due to high crown closure and surface fuels type and continuity. It is recommended that an ATV-access/ trail network be created to facilitate access for suppression crews, provide a fire break between lot boundaries and forested polygon, possible sprinkler line location, and provide access for future maintenance activities that will be required (danger tree removal, maintenance fuel treatments).

7.5.2 MAINTENANCE TREATMENTS

The City of Kelowna has shown leadership in completing fuel management projects within the study area to reduce the associated hazard. These activities started as early as 1998 and have been implemented on over 600 ha of land. These polygons are in various states of hazard, many of which require additional fuel management activities in order to maintain or to re-attain moderate threat ratings. Previously treated areas were found to range from 100 – 600 sph and 20% - 60% crown closure and have moderate or high WUI threat ratings. Surface fuel continuity (grasses) generally depended on site exposure and crown closure.

The 2011 CWPP identified areas where additional treatment of thinned stands is recommended to reduce the risk of crown fire (additional thinning and/or pruning). Field observations supported the findings of the 2011 CWPP, many of the previously treated polygons could be thinned further and less uniformly. Additional thinning should be focused on areas within 200 m of structures.

Maintenance activities may include additional thinning, conifer regeneration reduction, or surface fuel continuity reduction (grass control).

In many of the previously treated areas, grass cover (bunch or pine grass) is 70 – 90% cover and, when cured in the fire season, would be capable of supporting a rapidly spreading grass fire. Within the study area, surface fuel height and continuity (*e.g.*, of grasses) is a considerable concern, particularly for those developments built on slopes with an intermixed matrix of developments, oftentimes at the bottom, mid-slope, and/or top of slope, such as Dilworth Mountain, Magic Estates and Wilden (Figure 21, Figure 22).

Figure 21. Homes at top of conifer and grass slope in the Dilworth Mountain neighbourhood.

Figure 22. Homes at top of conifer and grass slope in the Dilworth Mountain neighbourhood.

7.5.2.1 GRASS HAZARD/ SURFACE FUEL CONTINUITY REDUCTION

Fire hazard associated with grass is arguably the biggest maintenance challenge facing the City of Kelowna. The majority of the previously treated areas has greater than 60% grass surface cover and often is in excess of 80% surface cover. Grasses include bunch grass, pine grass, and invasive cheat grass. South aspects and treatment areas on sandy, freely draining soils are generally less productive and have less continuous cover and shorter grasses, one such example is Mission Ridge Park and the adjacent slope to the west and northwest (Figure 23). Sites on northern and eastern aspects, and with higher site productivity, such as the Upper Canyon Open Space by the Wilden neighbourhood and parts of Dilworth Mountain, have thick, continuous, tall standing grasses which pose considerable hazard and could support a rapidly spreading surface fire capable of destroying nearby

structures (Figure 18). Those areas that were disturbed during development and subsequently re-seeded represent considerably higher grass hazard; these areas are generally 100% grass cover of thick, matted, non-native grass species often more than 1 m in height.

Broadcast burning, grazing, chemical and mechanical strategies can be employed to control the grass hazard. Broadcast burning was detailed in the previous Section 7.5.1.2; the costs, benefits, and major considerations of the other strategies are outlined below.

Figure 23. West aspect slope in Mission Ridge Park. Surface fuel continuity from grass is approximately 50%; the ground is clearly visible.

TARGETED GRAZING

Targeted grazing by goats, sheep, cattle, and horses may be an effective surface fuels control under some conditions. Success of a grazing treatment depends on a great deal of variables, including, but not limited to: availability of livestock species appropriate for the target vegetation; availability of qualified personnel to herd and manage the livestock to achieve desired results; and timing of both livestock and personnel availability with

the appropriate timing for surface fuel control for the target vegetation. [43] When applied effectively, target grazing can reduce the overall fine fuel loading and limit fire spread through reduction of fine fuels continuity, accumulation and height.

Variables such as type and composition of vegetation available in the area (both target and non-target vegetation), stocking rate (number of animals), and season of grazing (for both livestock and target vegetation) will impact treatment effectiveness. Furthermore, unique site and weather conditions affect the vegetative response to grazing and can make the results of grazing difficult to anticipate.[44] Grazing requires patience; it can take three to five years of targeted grazing to see visible fuel reduction results. Site-specific grazing management plans should be developed and include detailed stocking levels, length of grazing periods, number of seasons required to achieve objectives, and quantifiable criteria to measure effectiveness. Other operational considerations should include water sources and salt block locations, exclusion from riparian areas, invasive plant avoidance strategies, and strategies to avoid overgrazing and soil disturbance.[45] Prescriptions should focus on plant succession and should consider the myriad of possible consequences and results of grazing, such as susceptibility to invasive plants, transition to a different plant community/ vegetative association, and environmental quality of plant, land and water resources.[46]

Cost and funding availability for grazing programs are difficult to estimate, as grazing for fuel treatment is not a common practice in BC. It is recommended the City consult with UBCM regarding eligibility of grazing for the SWPI program. Due to the proximity of polygons to houses, implementation will be more complex than in large polygons in more conventional rangeland, likely adding to the project cost. For example, temporary exclusion fencing for non-target areas (yards), additional personnel, sheep transportation frequency, and personnel housing during the project are items which may increase project cost and compromise feasibility. Targeted grazing has been successfully implemented in interface areas in the southwestern United States; consultation with land managers of successful programs may allow for the City to sidestep some common pitfalls.[47] For example, in the East Bay of California, goats are utilized for targeted grass grazing in urban areas. The herding contractor sets up

[43] Jain, Theresa B.; Battaglia, Mike A.; Han, Han-Sup; Graham, Russell T.; Keyes, Christopher R.; Fried, Jeremy S.; Sandquist, Jonathan E. 2014. A comprehensive guide to fuel management practices for dry mixed conifer forests in the northwestern United States: Mechanical, chemical, and biological fuel treatment methods. Res. Note RMRS-RN-61. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 2 p.

[44] Taylor, C. 2006. Chapter 12: Targeted Grazing to Manage Fire Risk. In Karen Launchbaugh (Ed.), *Targeted Grazing: A natural approach to vegetation management and landscape enhancement* (pp. 107 - 114).

[45] LSA Associates, Inc. 2009. *East Bay Regional Park District Draft Wildfire Hazard Reduction and Resource Management Plan*.

[46] Daines, R. 2006. Reader's Guide: To the Targeted Grazing Handbook. In Karen Launchbaugh (Ed.), *Targeted Grazing: A natural approach to vegetation management and landscape enhancement* (pp. iv - vii).

[47] City of Boise, ID. East Bay Regional Park District, CA. County of Los Angeles Fire Department, CA. Carson Ranger District, Carson City, NV. Pacific Gas and Electric, Central Valley, CA.

temporary plastic exclusion fencing and moves the herd and fencing daily. The herder stays on site in a motorhome. Residents adjacent to the grazing noted no complaints with noise or feces.[48]

The ultimate success of a targeted grazing treatment depends on a number of variables which are beyond the scope and expertise of the authors of this report. It is recommended that grazing consultation and prescriptions be developed by a qualified professional, specializing in rangeland management, plant ecology, and/or associated range sciences. Consultation with jurisdictions who have implemented grazing projects to manage fire risk is recommended.

HERBICIDES/ CHEMICAL TREATMENT

Herbicides may be an effective an acceptable treatment option for aggressively invasive species or fast-growing vegetation which requires frequent re-treatment. Success of implementation depends on accessibility to the treatment area, treatment area size, soil types, ecosystem sensitivity, proximity to water and other values at risk, and effectiveness of herbicide on the target vegetation. Water quality concerns and other environmental and societal impacts that may occur with widespread or prolonged use of herbicides as a treatment option to reduce surface fuel continuity makes chemical treatment an unfeasible option for most circumstances in the study area. Additionally, herbicides do not reduce the fuel load, so in the short and medium term, fire hazard may not be reduced or may actually increase after herbicidal treatment, if other fuel treatment options are not employed in conjunction with the herbicide treatment. Further exploration of herbicidal maintenance is not recommended at this time.

MECHANICAL TREATMENT

Mechanical treatment of grass (mowing) is most effective along roadways or other similar and linear corridors accessible by mowers. Paired burns, comparing standing to mowed grass, shows significant decrease in fire behaviour (flame length and rate of spread) in the mowed grass plots.[49]

The City's Parks Department completes roadside mowing and hazard tree identification and removal annually as part of their current wildfire management program as recommended in the 2011 CWPP. This program should continue in order to maintain roadsides in a moderate or lower threat rating.

Regrowth should be monitored; additional mowing may be required as determined by seasonal variations. The mowing program should also consider times when grass hazard is the highest: after snow melt, before green up and after curing.

Due to the amount of road-side areas within the City, mowing is completed from spring to fall to complete all the areas. Because mowing introduces an ignition risk (sparks from mower blades hitting rocks can ignite fires in dry grass), prioritized scheduling is implemented. High threat areas (areas near to continuous forest fuels) should only be done in times of high humidity or after recent moisture to reduce the risk of fire ignition.

[48] Personal communication, Sabrina Lawrence. Resident adjacent to goat grazing in Berkeley, CA. June 28, 2016.

[49] Baxter, G. 2006. *Results of Experimental Burns on Grass Plots with Mowing Treatments Slave Lake, Alberta*. Wildland Fire Operations, Western Division, FERIC.

7.5.2.2 MAINTENANCE SCHEDULING

Maintenance of previously treated, City-owned parcels should be a high priority for the City. The areas previously treated have been assessed and polygons prioritized for maintenance activities, such as reducing surface fuels continuity and additional thinning (overstorey reduction and thinning suppressed conifers or conifer regeneration) (Table 8, Figure 24). It should be noted that almost all of the treatment polygons visited are in need of some maintenance activities, or will require maintenance activities in the near future. Currently, there is a back-log of areas which are in need of re-treatment in the next 1 – 3 years.

Moving forward, it is recommended that a comprehensive monitoring program be developed to assess treatment efficacy, grass hazard, and to help set best practices. The objectives of the program should include:

- Establishing and refining maintenance schedule for previously treated polygons;
- Improve understanding of the relationship between crown closure and grass cover, more specifically, identification of the optimal crown closure to reduce crown fire hazard and control grass growth; and,
- Providing empirical data to support, inform, and/ or improve future fuel management decisions, including evaluation and facilitation of wildfire hazard assessment prescriptions provided to the City by qualified professionals working for developers, as well as management of City-owned natural areas.

Grass maintenance should target 40 – 60% grass surface fuel continuity. Maintenance burns using prescribed broadcast burning are recommended every six to eight years as a preferred option to maintain previously thinned treatment areas. Less productive areas can likely withstand a longer frequency between maintenance activities, while more productive areas would require treatments more often. This method should be conducted by trained staff in coordination with BCWS or with the assistance of the BCWS. Results and observations of the monitoring program should be fed back into the above-recommended maintenance regime to improve efficacy and improve budgeting ability.

Table 13. Maintenance schedule for previously treated polygons within the study area.

Treatment Year	Name	Area (Ha)	Plot (Threat Rating – H/M/L)	Priority	Target Timeline	Comment
2010	Dilworth Mountain Park	59.5	3-9 (M/H)	1	2017 - 2020	Grass cover is high. Areas of high density. Focus additional thinning on denser areas within 100 m of homes. Homes upslope, sideslope and downslope.
2012	Dilworth Mountain Park	54.8	3-9 (M/H)	1	2017 - 2020	Grass cover is high. Areas of high density. Focus additional thinning on denser areas within 100 m of homes. Homes upslope, sideslope and downslope.

Treatment Year	Name	Area (Ha)	Plot (Threat Rating – H/M/L)	Priority	Target Timeline	Comment
2014	Dilworth Mountain Park	2.6	3-9 (M/H)	1	2017 - 2020	Complete Dilworth as one unit.
2015	Dilworth Mountain Park	0.3	3-9 (M/H)	1	2017 - 2020	Complete Dilworth as one unit.
2015	Dilworth Mountain Park	0.4	3-9 (M/H)	1	2017 - 2020	Complete Dilworth as one unit.
2007	Knox Mountain Park	137.2	14 (H)	1	2017 - 2020	Focus additional thinning in denser areas within 200 m of homes.
2008	Knox Mountain Park	1.4	-	1	2017 - 2020	Focus additional thinning in denser areas within 200 m of homes. Complete with 2007 Knox Mountain Park.
2009	Knox Mountain Park	26.8	-	1	2017 - 2020	Additional thinning in denser areas within 200 m of homes. Areas further from structures are lower priority.
2012	Mission Ridge Park	3.4	31 (H)	1	2017 - 2020	Grass cover is high, crown base height is low, additional thinning of understorey may be required.
2009	Quail Ridge	51.8	52-b (M)	1	2017/2018	Grass cover is high. Treatment recommended in conjunction with treatment of adjacent private land. Focus additional thinning in north area adjacent to homes.
2008	Still Pond Park	3.7	12 (H)	1	2017/2018	Steep, west aspect slope with homes adjacent above.
2010	Upper Canyon Open Space	6.1	13 (H)	1	2017/2018	Steep, east aspect slope with very high grass cover and patches of very high density and with moderate to high woody surface fuels. Homes directly adjacent above.
2012	Upper Canyon Open Space	9.2	13 (H)	1	2017/2018	Steep, east aspect slope with very high grass cover and patches of very high density and with moderate to high woody surface fuels. Homes directly adjacent above.

Treatment Year	Name	Area (Ha)	Plot (Threat Rating – H/M/L)	Priority	Target Timeline	Comment
2011	McKinley Mountain Park	10.5	-	2	2017 - 2020	West aspect. Monitor and maintain every 6 - 8 years.
2013	Skyland Open Space	1.2	-	2	2019-2022	Monitor and maintain every 6 - 8 years.
2009	Southridge Park	2.9	27 (M)	2	2019 - 2022	Grass continuity is patchy, ranging from 40 - 80%. Overstorey is acceptable density.
2010	Stockley Open Space	2.1	106 (H)	2	2017 - 2020	Fairly isolated patch. Complete when funds are available. Additional thinning would be required.
2012	Bellevue Creek Greenway	0.6	28 (M)	3	2022 - 2024	Additional thinning could be completed. Understory is grass, but with considerable component of deciduous shrubs. Riparian area, stream serves as break.
2013	Bellevue Creek Greenway	0.3	28 (M)	3	2019-2022	Additional thinning could be completed. Understory is grass, but with considerable component of deciduous shrubs. Riparian area, stream serves as break.
Unknown	Beqbie Park	1.3	-	3		Monitor and maintain every 6 - 8 years.
2013	Bredin Farm Property	41.8	-	3	2019-2022	Grass cover is continuous, surrounded by agricultural fields on three sides.
2013	Carney Park	0.8	-	3	2019-2022	Monitor and maintain every 5 - 8 years.
2014	Cassiar Park	0.7	-	3	2020-2023	Monitor and maintain every 6 - 8 years.
2014	Dewdney Road #1 Beach Access	0.4	-	3	2020-2023	Monitor and maintain every 6 - 8 years.
2008	Gopher Creek Linear Park	2.3	36-b (M)	3	2017 - 2020	Complete in conjunction with private land parcel adjacent to the south. The majority of the hazard to adjacent structures is on adjacent private land.

Treatment Year	Name	Area (Ha)	Plot (Threat Rating – H/M/L)	Priority	Target Timeline	Comment
2013	McCulloch Road/ Hydro Line	40.3	38 (M)	3	2019-2022	Maintain regularly to act as intended as landscape fuel break.
2014	North Glenmore Dog Park	1.5	-	3	2020-2023	Monitor and maintain every 6 - 8 years.
2013	Summerside Park	1.7	-	3	2019-2022	Monitor and maintain every 5 - 8 years.
2016	Tower Ranch Mountain Park	7.7	-	3	2022-2023	Monitor and maintain every 6 - 8 years.
2014	University South Park	16.9	-	3	2020-2023	Monitor and maintain every 6 - 8 years.
2013	McKinley Landing Park	0.2	-	4		Low hazard; mostly lawn.
2011	Vernon Creek	1.5	-	4	2021 - 2023	Thin, linear treatment area on either side of irrigation ditch. Initial treatment was forest-health related. Removed mortality.
2014	Dewdney Road #2 Beach Access	0.1	N/A	N/A	N/A	Private Land
2008	Dubbin Road North Beach Access	0.1	N/A	N/A	N/A	Private Land
2008	Dubbin Road South Beach Access	0.2	N/A	N/A	N/A	Private Land
2014	Finch Road Beach Access	0.7	N/A	N/A	N/A	Private Land
2013	Lochview Road Beach Access	1.1	N/A	N/A	N/A	Private Land

Treatment Year	Name	Area (Ha)	Plot (Threat Rating – H/M/L)	Priority	Target Timeline	Comment
2008	McKinley Road Beach Access	1.9	N/A	N/A	N/A	Private Land
2012	McKinley Road Beach Access	1.9	N/A	N/A	N/A	Private Land
2014	Scenic Canyon	18.9	35 (M)	N/A	N/A	RDCO Park
2012	Stephen Coyote Regional Park	111.8	-	N/A	N/A	RDCO Park

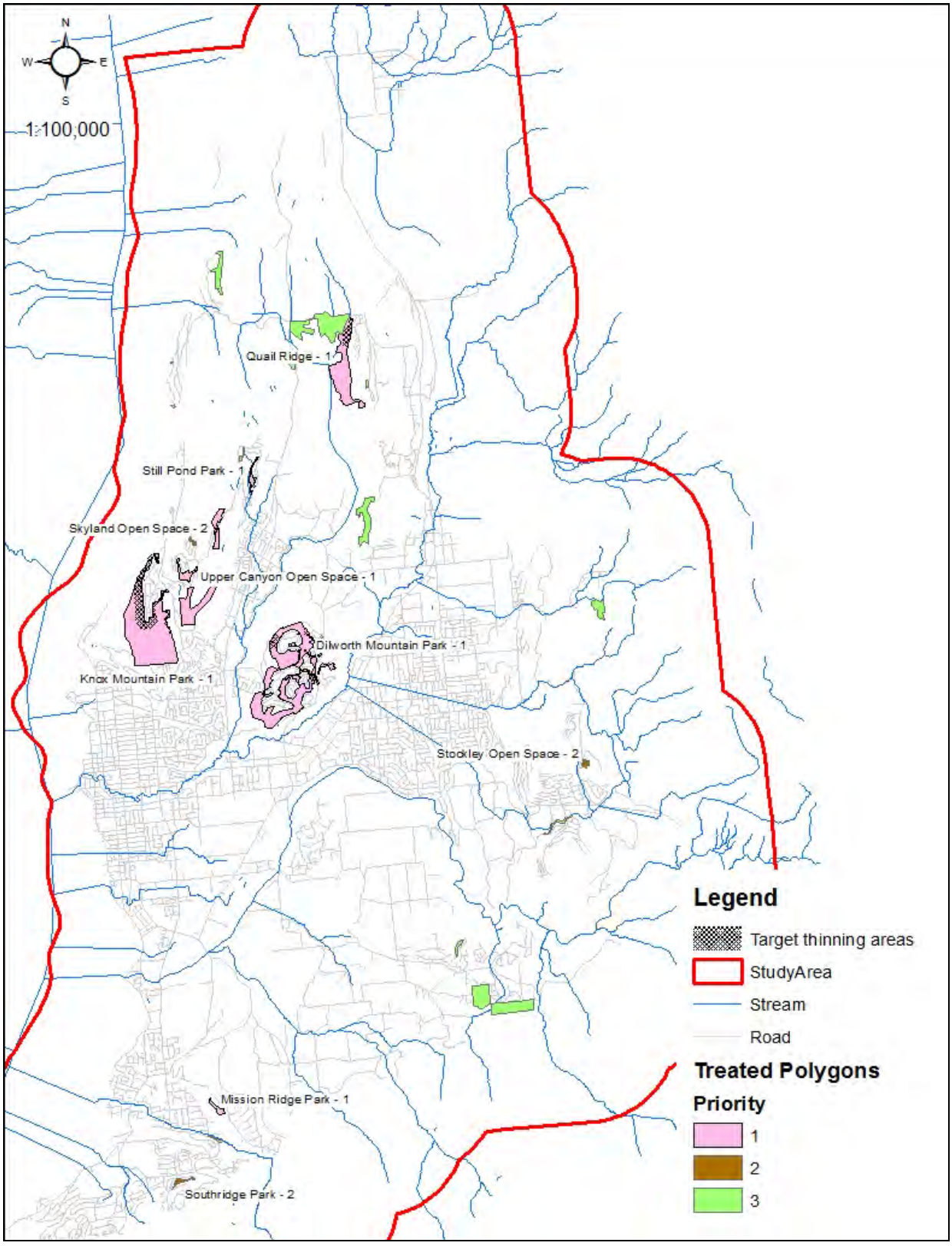


Figure 24. Previously treated polygons, displayed by maintenance priority.

7.5.3 LANDSCAPE LEVEL FUEL BREAKS

Fuelbreaks can be defined as strategically placed strips of low volume fuel where firefighters can make a stand against fire and provide safe access for fire crews in the vicinity of wildfires, commonly for the purpose of lighting backfires. Fuelbreaks act as staging areas where fire suppression crews can anchor their fire suppression efforts; hence increasing the likelihood that fire can be stopped or fire behaviour minimized so the potential for a fire to move fluidly through the interface into a developed area are substantially reduced. The principles of fuelbreak design are described in detail in APPENDIX M: LANDSCAPE LEVEL FUELBREAK MANAGEMENT.

The three main areas identified which may be appropriate for landscape level fuel breaks are: southeast of the study area through Myra Bellevue Provincial Park and Scenic Canyon, east of the study area in Joe Rich, and the ridge from Knox Mountain Park to the northern extent of the study area. Figure 25 broadly outlines potential areas for landscape level fuel breaks, identified due to their fuel type, fire behaviour threat class (assessed and extrapolated), values at risk, and predominant wind direction.

Due to predominant wind directions during the fire season, wildfire is most likely to enter the study area from the south or southeast. Much of the area to the south of the study area was previously burned in the 2003 Okanagan Mountain Park fire and has seen little regeneration since that time. The majority of the burned areas are a moderate fire threat at this time, though will likely increase with threat overtime as regeneration occurs. Pockets of very dense fuels near to homes in the south and southeast of the study area should be managed and are included in Section 7.5.1 as fuel treatment polygons. Of particular note are larger polygons of high fuel accumulation within the Myra Bellevue Provincial Park and surrounding areas.

As identified in the 2011 CWPP, continuous hazardous fuels occur east of the study area in Joe Rich. The Joe Rich area was also identified as an area of specific concern during consultation with BCWS zone staff[50]. Most of these natural areas are buffered from structures at risk within the study area by agricultural lands that provide effective fire breaks. There are significant values at risk outside the study area in the RDCO.

Landscape level fuel break opportunities in the east and northeast, as well as from Magic Estates (north of Knox Mountain Park) to the northern extent of the study area are severely constrained by private land.

To the east and southeast of the study area, there are areas of continuous forested land which may benefit from a landscape level fuel break. The land of interest is on Crown, BC Parks, and Federal land and would require consultation with multiple land owners, agencies, and stakeholders including, but not limited to: Westbank First Nation, BC Hydro, BCTS, Weyerhaeuser, RDCO, Gorman Brothers, Tolko, and private landowners. Though most of this area is outside the study area, and therefore is not part of the WUI threat assessment, the area is continuously forested with dense mixed coniferous forests and could be linked with areas identified as high threat within the study area, such as in Myra Bellevue Provincial Park.

Existing physical features and land ownership must be considered and further explored in establishing fuelbreak positions. These areas should be further examined for the opportunity for a landscape level fuel break in cooperation with the RDCO, BCWS, and MFLNRO. Further fire behaviour modeling and analysis is recommended

[50] Personal communication with Trevor Lees, Forest Protection Assistant, Penticton Fire Zone, BCWS.

in order to assess fuel break locations and their effectiveness at moderating fire behaviour and protecting values at risk. It is recommended that fuel breaks work towards managing for, or enhancing, multiple values, such as wildlife habitat, recreation, and fire risk reduction.

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

- Wildfire risk reduction activities, such as thinning, pruning, and surface fuel reduction to reduce wildfire risk in key areas;
- Forest rehabilitation, such as clearing and/or reforesting areas impacted by wildfire;
- Wildlife habitat restoration and ensuring that fuel management and rehabilitation activities also promote desired wildlife habitat characteristics, such as enhancing mule deer winter range; and,
- FireSmart program and raising awareness among both local governments and rural property owners regarding steps they can take to protect homes and property from wildfire.[51]

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

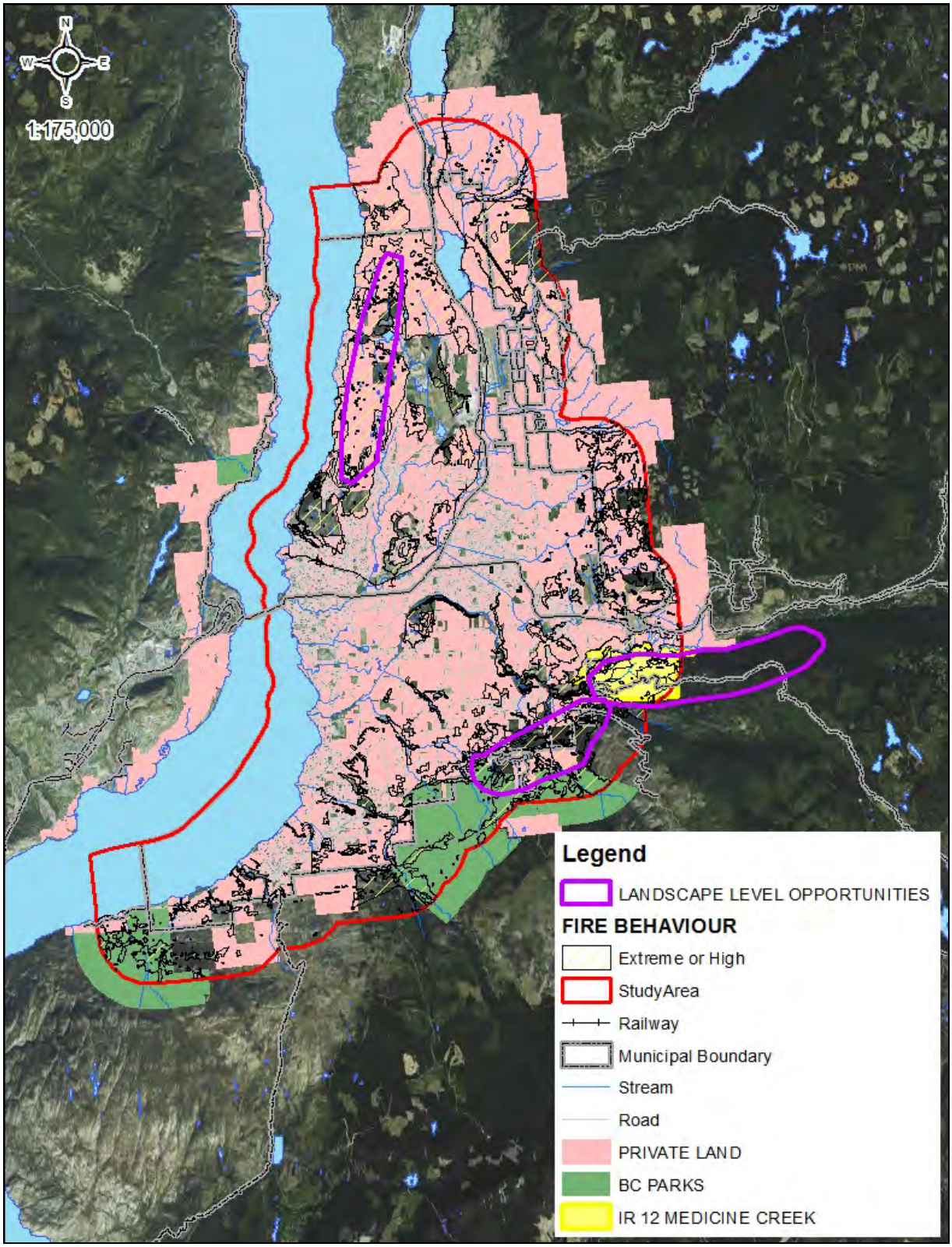


Figure 25. Potential landscape level fuel breaks areas. These areas should be further explored to assess feasibility and probably effectiveness.

Table 14. Summary of Fuel Management recommendations.

Fuel Management			
Item	**Priority**	**Recommendation**	**Estimated Cost ($)**
Objective: Reduce wildfire threat on private and public lands through fuel management.			
37	High	• Apply for funding to conduct maintenance for previously treated areas, starting with priority 1 areas.	UBCM SWPI Funding / Municipal Funding
38	Moderate	• Apply for funding to continue fuel management projects on lands identified for treatment which are eligible for UBCM SWPI funding.	UBCM SWPI Funding / Municipal Funding
39	Moderate	• Engage with BC Parks regarding hazardous fuels and fuel treatment implementation in identified polygons in Myra Bellevue Provincial Park.	Within current operating costs
40	High	• The City should work with developers to ensure that all lands turned over to the City as natural parks are in a moderate hazard state prior to taking ownership. This should include thinning, pruning, and/or burning. Priority areas are Kirschner and Black Mountain (currently privately held).	Within current operating costs
41	High	• Continue roadside mowing program to maintain grass and remove dense conifer regeneration along roadways.	Within current operating costs
42	N/A	• Prescribed fire (pile burning and broadcast burning) should be a tool available to land managers for fuel treatments and maintenance activities to improve cost efficiency and efficacy of fuel treatments. Any use of fire should strictly follow smoke management guidelines to limit the health impacts of smoke and be done in cooperation with the BCWFS.	Within current operating costs
43	Moderate	• The City should adopt a standard for fuel management in parks and green spaces.	$2,000
Objective: Maintain previously treated areas under an acceptable level of wildfire fire threat (moderate).			
44	Moderate	• Implement a 3 – 5 year grazing pilot program, including engagement of a grazing/ range specialist, consultation with jurisdictions with a similar program, and consultation regarding funding from UBCM.	UBCM SWPI Funding/ Municipal Funding
45	High	• Implement a prescribed burn pilot project, including a burn plan and smoke management plan and public relations plan. Post-burn analysis of results should include measuring treatment efficacy (fuels and ecological analysis), as well as efficacy of smoke management plan and public reaction/ support.	UBCM SWPI Funding/ Municipal Funding/ BCWFS Support
46	Low	• Establish a monitoring program for the previously treated areas. A formalized program can inform future maintenance schedules, help track natural areas newly acquired through the development process, and help to more effectively manage the City's rapidly expanding natural areas lands. Cost reduction options include recruiting a graduate student to undertake this project as a research opportunity.	$10,000 (explore graduate student opportunity to reduce costs)

Objective: Reduce the wildfire threat to the City and neighbouring jurisdictions with a cooperative regional approach.			
47	High	• Submit phase 1 application for FES funding for a landscape level fuel break in the southeast of the study area and to the east of the study area. Look for synergies with other funding sources, initiate engagement with other agencies, jurisdictions, and governments (MFLNRO, RDCO, licensees, Westbank First Nation), and identify opportunities to enhance/ satisfy multiple selection criteria, such as wildlife habitat enhancement/ ecosystem restoration, forest health salvage, and fiber recovery. Target the second intake deadline of November 2016.	FESBC funding

8.0 CONCLUSION

The City of Kelowna is situated in a fire-prone area; there have been significant wildfires in the past in the region and undoubtedly there will be more in the future. The risk of interface fires is expected to increase as development within the interface continues and inaction on private land, fire suppression, and forest health factors result in an increase in hazardous fuel types. Changing fire weather conditions from climate change is also expected. Although there are considerable wildfire challenges facing the City, the risk can be mitigated through the implementation of the recommendations in this document. The success of the plan, and reduction in wildfire threat to the study area, will require significant commitment and resources, as well as cooperation among agencies and neighbouring jurisdictions. The City has, to date, shown provincial leadership in many aspects of wildfire mitigation; implementation of this plan is the next step towards protecting the long-term health and safety of the City's citizens, structures, and infrastructure, as well as the many other ecological and social values at risk.

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APPENDIX A: STATUS OF 2011 CWPP RECOMMENDATIONS

#	Action Item	Priority	Status
Rec # 1	Review the *Vision Statement* at least every fire years to ensure that it continues to represent the community's principles and values.	B	2016
Rec # 2	Evaluate the City's performance every five years based upon accepted ecological, community and management based criteria.	B	2016
Rec # 3	This CWPP is a living document that should be reviewed and updated every five years.	B	2016
Rec # 4	The *Natural Features at Risk Map* should be reviewed and updated every five years.	B	2016
Rec # 5	The *Archaeological Features Map* should be reviewed and updated every five years.	B	2016
Rec # 6	Treat all City owned interface polygons that were identified as posing a risk of moderate or greater.	A	95% Complete
Rec # 7	Pursue opportunities for *Fuel Reduction Pilot Projects* through UBCM.	A	Ongoing
Rec # 8	All fuel treatments carried out in the wildland/urban interface should follow a "Fuel Treatment Prescription" developed and submitted to the City by a Professional Forester.	A	Ongoing
Rec # 9	Monitor the pine beetles and be proactive to remove all dead and dying pine in the urban/wildland interface.	A	Ongoing
Rec # 10	Develop recreation trails in strategic locations within the urban/wildland interface that act as surface fuel breaks and improve access for suppression resources.	B	Ongoing
Rec # 11	The City should acquire two smaller ATV/UTV suppression vehicles	B	Complete
Rec # 12	All City staff who work in the interface areas should receive basic level fire suppression training (S-100) at least once every two years.	B	Modified response
Rec # 13	Basic suppression equipment should be kept in strategic locations around the City.	A	Complete
Rec # 14	Interagency wildfire suppression training should be coordinated between the Wildfire Management Branch and the City Fire Department.	B	Ongoing

#	Action Item	Priority	Status
Rec # 15	Coordinate with the Ministry of Forest, Lands and Natural Resource Operations (MFLNRO) to ensure that any new policy and harvesting activities adjacent to the City are not contributing to the wildfire risk.	B	Ongoing
Rec # 16	Ensure that all forest licensees address the fuel hazard associated with any harvesting in interface areas.	A	n/a
Rec # 17	Ensure that BC Hydro and FortisBC abate fuel hazards during their vegetation management operations along their transmission right of way.	B	Ongoing
Rec # 18	Ensure that grass is maintained and that all tree cutting is cleaned up adequately along roadways.	A	Ongoing
Rec # 19	Ensure all roads constructed in interface areas meet standards required for suppression vehicles.	A	Ongoing
Rec # 20	Identify interface communities with one access route or cul-de-sac roads. Explore options to build alternative access to these areas.	C	Ongoing
Rec # 21	Encourage strategic recreation trail development in parks to a standard that supports ATV/UTVs.	B	Complete
Rec # 22	Gates should be installed on roads and trails that run through natural areas to minimize access by unauthorized users, especially those using motorized vehicles.	B	Ongoing
Rec # 23	Identify area with poor water availability and install hydrant systems or alternative water reservoirs.	B	Ongoing
Rec # 24	Identify and map alternative water sources including reservoirs, lakes and rivers.	C	Ongoing
Rec # 25	Fire hydrants should be located to serve all new developments and in existing interface areas that are deficient.	B	Ongoing
Rec # 26	Roadside ditches and medians that contain grasses should be mowed prior to the fire season.	B	Ongoing
Rec # 27	Wildfire awareness signs should be posted along major transportation corridors, camp sites, recreation areas and high use trail heads during the summer showing the fire danger rating and emphasizing the need to fully extinguish campfires and not discard cigarettes.	C	Ongoing
Rec # 28	Engage in public education programs to reduce human caused ignition focusing on private residents that live in the urban/wildland interface.	B	Ongoing
Rec # 29	Work with BC Hydro and FortisBC to ensure that distribution lines and transmission corridors are assessed regularly for tree risk and that the associated fuel hazards are abated.	B	Ongoing

#	Action Item	Priority	Status
Rec # 30	Recognize Wildland Fire Hazard Development Permit Areas (WFHDP) in the OCP and ensure all development in those areas submit and comply with a Wildfire Management Plan	B	Ongoing
Rec # 31	Inspect construction sites during the fire season and ensure construction contractors are aware of their responsibilities as described within the Wildfire Act.	C	Ongoing
Rec # 32	The *FireSmart* guidelines should be considered as the minimum standard any new development proposed within the Wildland Fire Hazard Development Permit Areas must adhere to.	A	Ongoing
Rec # 33	Develop and distribute neighbourhood evacuation plans for all high risk interface areas.	B	Ongoing
Rec # 34	Wildfire awareness signs should be posted along major transportation corridors, camp sites, recreation areas and high use trail heads that specify how to report a wildfire.	A	Ongoing
Rec # 35	The City should develop a public education and awareness program for wildfire management.	A	Ongoing
Rec # 36	Distribute educational material to all private land owners within 100 m of the Wildfire DP areas.	A	Needs attention
Rec # 37	Summaries of this report and associated maps should be posted at strategic public locations.	A	Complete
Rec # 38	A series of public presentations should be planned once this CWPP is adopted.	A	Complete
Rec # 39	A representative from the Parks Department and the Fire Department should be present at public events that take place in or near natural areas.	A	Ongoing
Rec # 40	Establish a school education program to engage youth in wildfire management	B	Ongoing
Rec # 41	Digital media including video and the City's website should be updated to include this plan.	A	Complete
Rec # 42	Designate awards to individuals or groups that demonstrate commitment to wildfire management planning.	B	Ongoing
Rec # 43	In the event of a wildfire, a post-fire ecosystem impact assessment and rehabilitation plan should be completed.	B	When required
Rec # 44	Pursue funding sources to undertake pilot projects to treat the City owned interface polygons recommended in Appendix B.	A	Complete

APPENDIX B: SPECIES AT RISK WITHIN STUDY AREA

Table 15. Publicly available occurrences of Blue and Red-listed species recorded within the study area. Data current as of date accessed: 1 April, 2016.

Species	Scientific Name	Category	BC List
Alkali saltgrass	*Distichlis spicata* var. *stricta*	Vascular Plant	Red
American badger	*Taxidea taxus*	Vertebrate Animal-mammal	Red
Cup clover	*Trifolium cyathiferum*	Vascular Plant	Red
Engelmann's spike-rush	*Eleocharis engelmannii*	Vascular Plant	Red
Hairy water-clover	*Marsilea vestita*	Vascular Plant	Red
Peach-leaf willow	*Salix amygdaloides*	Vascular Plant	Red
Western Screech-owl, Macfarlanei Subspecies	*Megascops kennicottii macfarlanei*	Vertebrate Animal - bird	Red
Yellowseed False Pimpernel	*Lindernia dubia* var. *dubia*	Vascular Plant	Red
American avocet	*Recurvirostra americana*	Vertebrate Animal - bird	Blue
Columbia Plateau pocket mouse	*Perognathus parvus*	Vertebrate Animal-mammal	Blue
Gopher snake, deserticola subspecies	*Pituophis catenifer deserticola*	Vertebrate Animal-reptile	Blue
Great Basin spadefoot	*Spea intermontana*	Vertebrate Animal-amphibian	Blue
Great blue heron	*Ardea herodias Herodias*	Vertebrate Animal - bird	Blue
Lewis's woodpecker	*Melanerpes lewis*	Vertebrate Animal - bird	Blue
North American racer	*Coluber constrictor*	Vertebrate Animal-reptile	Blue
Ovate spike-rush	*Eleocharis ovata*	Vascular Plant	Blue
Painted Turtle - Intermountain - Rocky Mountain Population	*Chrysemys picta* pop. 2	Vertebrate Animal-turtle	Blue
red-rooted cyperus	*Cyperus erythrorhizos*	Vascular Plant	Blue
Scalepod	*Idahoa scapigera*	Vascular Plant	Blue
Three-flowered waterwort	*Elatine rubella*	Vascular Plant	Blue

APPENDIX C: BEC ZONES WITHIN THE STUDY AREA

The Biogeoclimatic Ecosystem Classification (BEC) system describes zones by vegetation, soils, and climate. Regional subzones are derived from relative precipitation and temperature. See Table 11 for a summary of the BEC Zones within the study area, and the area of each.

The Coastal Mountains create a rain shadow effect over the Okanagan region and the City of Kelowna. The general climate in the summer fire season is warm and dry, to which the ecological communities in the area are well-adapted (DHC 2011). The majority of the study area is characterized by two main subzones: the Very Dry Hot Ponderosa Pine subzone (PPxh1 and PPxh1a) and the Okanagan Very Dry Hot Interior Douglas-fir subzone (IDF xh1 and IDF xh1a). Both subzones are characterized by very warm and dry summers with growing season moisture deficits. The IDF xh subzone generally has a slightly milder climate, experiencing somewhat cooler temperatures and more precipitation. The PP xh subzone covers the vast majority of the study area, with the IDF xh subzone limited to the eastern and southern-most extents of the study area.

Table 16. BEC zones within the study area.

BEC Zone	Area (ha) of Study area	% of Study area[52]
PPxh1 and PPxh1a (Very Dry Hot Ponderosa Pine)	23,259	70%
IDF xh1 and IDF xh1a (Okanagan Very Dry Hot Interior Douglas-fir)	8,138	25%
IDF mw1 (Shuswap Moist Warm Interior Douglas-fir)	1,045	3%
IDFdm1 (Kettle Dry Mild Interior Douglas –fir)	612	2%

[52] Includes terrestrial portion of study area only.

APPENDIX D: NATURAL DISTURBANCE TYPES

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 (Province of British Columbia, 1995).

The PP xh and IDF xh (as well as the IDF dm1 and IDF mw1) are characterized as NDT4 – ecosystems with frequent stand-maintaining fires. The forested portions of these ecosystems would normally experience frequent, low-intensity fires that remove understory vegetation and maintain larger, fire resistant trees. Variable intensity and frequency of these types of fires across the landscape create mosaics of uneven-aged forests and grassy or shrubby openings.

Exclusion of fire, combined with other variables such as forest health factors, grazing, and logging, in these areas has altered the fuel composition and ecosystems within the study area and the Southern Interior Plateau. The challenges posed by changing forest structure and fuel quantity and composition were identified in the 2011 CWPP and remain the same today. They write,

> "*Forests have become denser and more uniform with a greater abundance of younger trees established in the understory (Arno 1988). Additionally, fire exclusion has resulted in a build-up of surface and ladder fuels and has contributed to the establishment of invasive species (Steele et al. 1986, McIver et al. 2001). These changes to the forest structure have increased the probability of large, high intensity, stand-initiating fires (Weatherspoon and Skinner 1996).*"

APPENDIX E: WUI THREAT PLOT DETAILS

Table 12 displays a summary of all WUI threat plots completed during CWPP field work. The original WUI threat plot forms have been submitted as a separate document.

Table 17. Summary of WUI Threat Assessment Worksheets.

WUI Plot #[53]	Geographic Location	WUI Threat Worksheet Components				Wildfire Behaviour Threat Class (/240)	WUI Threat Class (/55)
		Fuel	Weather	Topography	Structural		
#1	McKinley Landing	46	25	46	46	High (117)	Extreme (45)
#2	Academy Way and Mustang Ct	49	25	20	37	Moderate (94)	High (37)
#3	Cassiar Rd and Rifle Rd (Dilworth)	40	25	28	42	Moderate (93)	Extreme (42)
#5	Denali and Breckinridge (Dilworth)	39	25	33	50	High (97)	Extreme (50)
#6	Denali and Breckinridge (Dilworth)	54	25	44	50	High (123)	Extreme (50)
#7	Selkirk and Fairmont (Dilworth)	35	25	10	50	Moderate (70)	Extreme (50)
#8	Selkirk and Cassiar (Dilworth)	29	25	24	50	Moderate (78)	Extreme (50)
#9	Selkirk, Denali and Breckinridge (Dilworth)	33	25	37	42	Moderate (95)	Extreme (42)
#9-b	Dilworth (north aspect)	34	25	10	47	Moderate (69)	Extreme (47)
#10	Summit and Purcell (Dilworth)	42	25	12	47	Moderate (79)	Extreme (47)
#11	N of Begbie Road	67	25	26	35	High (118)	High (35)
#12	Below Long Ridge Dr	48	25	39	50	High (112)	Extreme (50)
#13	Wilden/ Upper Canyon	55	25	19	50	High (99)	Extreme (50)
#14	Knox Mt Park	43	25	35	42	High (103)	Extreme (42)
#20	Okanagan Mt Park/ Lakeshore Rd	49	25	19	11	Moderate (93)	Low (11)
#21	Timberline Rd	31	25	19	45	Moderate (75)	Extreme (45)
#22	Okanagan Mt Park	32	25	15	45	Moderate (72)	Extreme (45)
#23	Lakeshore Rd/ Aspen Rd	44	25	34	42	High (103)	Extreme (42)
#24	Tanager Dr	43	25	52	50	High (120)	Extreme (50)
#25	Mountain Side Dr	32	25	14	48	Moderate (71)	Extreme (48)

[53] Plot numbers are not necessarily continuous or sequential. Discontinuous numbering does not imply missing plots.

WUI Plot #[53]	Geographic Location	WUI Threat Worksheet Components				Wildfire Behaviour Threat Class (/240)	WUI Threat Class (/55)
		Fuel	Weather	Topography	Structural		
#26	Jasper Way	73	25	39	35	High (137)	High (35)
#27	Southcrest Dr/ Cantina Ct	37	25	29	45	Moderate (91)	Extreme (45)
#28	Gordon Dr	40	25	22	38	Moderate (87)	High (38)
#29	Lakeshore Rd/ Vintage Terrace Rd	42	25	12	38	Moderate (79)	High (38)
#30	Raymer Rd/ Bullock Rd	46	25	44	43	High (115)	Extreme (43)
#31	Mission Ridge Park	46	25	28	33	High (99)	High (33)
#32	Myra Bellevue	56	25	24	38	High (105)	High (38)
#33	Myra Bellevue	59	25	10	28	Moderate (98)	High (28)
#34	Myra Bellevue	61	25	12	48	High (97)	Extreme (48)
#81	Spiers Rd	39	25	32	43	Moderate (96)	Extreme (43)
#35	Gallagher Canyon	41	25	26	48	Moderate (92)	Extreme (48)
#36-a	Dunster Rd/ Woodland Cr	57	25	24	40	High (106)	Extreme (40)
#36-b	Loseth Rd	44	25	14	45	Moderate (83)	Extreme (45)
#37[54]	Mine Hill Dr/ Prospect Black Mt	42	25	44	48	High (111)	Extreme (48)
#38	Gallagher Canyon	42	25	4	35	Moderate (71)	High (35)
#39	Academy Hill	31	25	12	48	Moderate (68)	Extreme (48)
#40	Quail Ridge	49	25	31	50	High (105)	Extreme (50)
#41	Glenmore Rd	60	25	17	43	High (102)	Extreme (43)
#42	Glenmore Rd	57	25	35	43	High (117)	Extreme (43)
#43	McKinley Rd	54	25	10	30	Moderate (89)	High (30)
#50	Kirschner	38	25	12	35	Moderate (75)	High (35)
#51[54]	Mine Hill Dr/ Prospect Black Mt	52	25	47	48	High (124)	Extreme (48)
#52-b	Quail Ridge	41	25	24	50	Moderate (90)	Extreme (50)
#53	Kirschner (west)	38	25	34	35	High (97)	High (35)
#105[55]	Hall Road	51	25	22	33	High (98)	High (33)
#106	Stockley Open Space	43	25	29	40	High (97)	Extreme (40)

[54] Plot 37 and plot 51 were completed for the same polygon, in two slightly different locations, by two different qualified professionals.

[55] Access to polygon was not available due to fencing. Threat rating was assessed using best visual estimates from outside fencing.

APPENDIX F: WUI THREAT ASSESSMENT METHODOLOGY

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

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

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

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

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

FIELD DATA COLLECTION

The primary goals of field data collection are to confirm or correct the provincial fuel type, complete WUI Threat Assessment Plots, and assess other features of interest to the development of the CWPP. This is accomplished by traversing as much of the study area as possible (within time, budget and access constraints). Threat Assessment plots are completed on the latest version (2013) form, and as per the Wildland Urban Interface Threat Assessment Guide.

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

1. Update fuel-typing using orthophotography provided by the client and field verification.
2. Update structural data using critical infrastructure information provided by the client, field visits to confirm structure additions or deletions, and orthophotography
3. Complete field work to ground-truth fuel typing and threat ratings (completed 46 WUI threat plots on a variety of fuel types, aspects, and slopes and an additional 120 field stops with qualitative notes, fuel type verification, and/or photographs)
4. Threat assessment analysis using field data collected and rating results of WUI threat plots – see next section.

SPATIAL ANALYSIS

Not all attributes on the WUI Threat Assessment form can be determined using a GIS analysis on a landscape/polygon level. To emulate as closely as possible the threat categorization that would be determined using the Threat Assessment form, the variables in Table 13 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.

Table 18. Details regarding analytical model used in WUI threat assessment.

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

Forest health	No	
Continuous forest/slash cover within 2km	No	
WEATHER SUBCOMPONENT		
BEC zone	Yes	
Historical weather fire occurrence	Yes	
TOPOGRAPHY SUBCOMPONENT		
Aspect	Yes	
Slope	Yes	Elevation model was used to determine slope.
Terrain	No	
Landscape/ topographic limitations to wildfire spread	No	
STRUCTURAL SUBCOMPONENT		
Position of structure/ community on slope	No	
Type of development	No	
Position of assessment area relative to values	Yes	Distance to structure is used in analysis; position on slope relative to values at risk is too difficult to analyze spatially.

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

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

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

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

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

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

APPENDIX G: FIRE WEATHER DATA

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

Fire Danger Classes provide a relative index of how easy it is to ignite a fire and how difficult control is likely to be. The BC *Wildfire Act* [BC 2004] and *Wildfire Regulation* [BC Reg. 38/2005], which specify responsibilities and obligations with respect to fire use, prevention, control and rehabilitation, uses Danger Classes to restrict high risk activities 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. Fires are easily contained by ground crews with pumps and hand tools.
- **Class 3 (Moderate)**: Moderate to vigorous surface fires with intermittent crown involvement. They are challenging for ground crews to handle; heavy equipment (bulldozers, tanker trucks, and aircraft) are often required to contain these fires.
- **Class 4 (High)**: High-intensity fires with partial to full crown involvement. Head fire conditions are beyond the ability of ground crews; air attack with retardant is required to effectively attack the fire's head.
- **Class 5 (Extreme)**: Fires with fast-spreading, high-intensity crown fire. These fires are very difficult to control. Suppression actions are limited to flanks, with only indirect actions possible against the fire's head.

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 study area and it is worthy to note that fire danger in the study area can vary from season to season. Considering fire danger varies from year to year, historical weather data can provide information on the number and distribution of days when the study area is typically subject to high fire danger conditions, which is useful information in assessing fire risk.

Danger Class days for the study area are illustrated in Figure 26. Data was provided from the BCWFS, Kamloops Fire Centre and comes from the two weather stations closest to, and most representative of the weather conditions of, the study area: Fintry and Penticton. Twenty-six years of data (1989 – 2015) from the Fintry weather station and forty-five years of data from the Penticton weather station was used to summarize fire weather for the study area.

Generally, during the May and June, fire danger classes are moderate or higher approximately half of the time. On average, the greatest numbers of High Danger Class (DC IV) days generally occurs during July and August. Although in September the probability of high or extreme ratings declines, more than half of the days are likely to be moderate danger class (Class 3) or higher. The data supports the assertions from the 2011 CWPP: for about four months of the year in the summer, there is a high risk of a significant wildfire event (June, July, August, September).

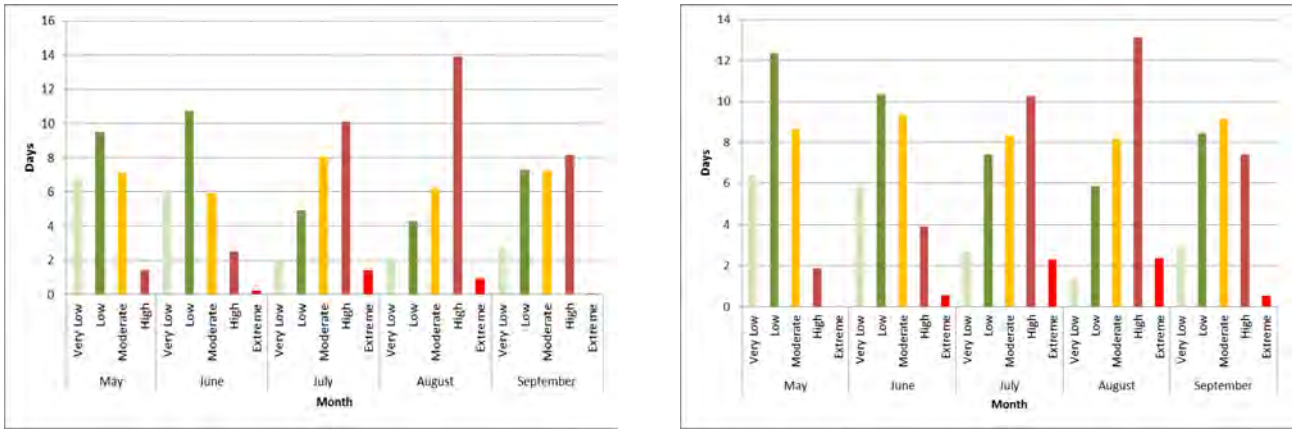

Figure 26. Left: Probability of Fire Danger Class ratings averaged by month over a 26-year period (1989 – 2015) from the Fintry weather station. Right: Probability of Fire Danger Class ratings averaged by month over a 45-year period (1970 – 2015) from the Penticton weather station.

APPENDIX H: FIRESMART CONSTRUCTION AND LANDSCAPING

FIRESMART CONSTRUCTION

Roofing Material:

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

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

Building Exterior - Siding Material:

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

Balconies and Decking:

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

Combustible Materials:

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

FIRESMART LANDSCAPING

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

Decorative bark mulch, often used in home landscapes is easily ignitable from wildfire embers or errant cigarettes and can convey fire to the home. Alternatives to bark mulch include gravel, decorative rock, or a combination of wood bark and decorative rock.[56]

LANDSCAPING ALTERNATIVES

The landscaping challenges faced by many homeowners pertain to limited space, privacy and the desire to create visually explicit edge treatments to demarcate property ownership from adjacent lots with evergreen vegetation screens. Ornamental plant characteristics fulfilling these criteria have an upright branching habit, compact form, dense foliage, as well as a moderate growth rate. Dwarf and ornamental conifers such as juniper and Arborvitae hedging are popular choices and grow well in the study area. Yet conifers such as these which have needle or scale-like foliage are highly flammable and not compliant with FireSmart principles and should be omitted from the 10 m Fire Priority Zone of the planned home footprint.

There are a number of broadleaved deciduous and evergreen plants with low flammability which can be used for landscaping within FireSmart PZ 1 (within 10 m of structures). Landscaping should be selected for the appropriate Canadian Plant Hardiness Zone (Zone 7a). Hedge and shrub examples which thrive in Zone 7 and are low flammability include, but are not limited to: boxwood, wolf willow, Oregon grape, mock orange, euonymus, cranberry contoneaster, firethorn, Cheyenne privet, and rose. Table 14 displays a list of low flammability or fire resistant landscaping options for the Kelowna area. This list is not comprehensive, but instead should be seen as a starting point or example for landscaping standards.

Table 19. Low flammability landscaping options for the Okanagan area.

Zone	Latin Name	Common name
Ornamental species		
4	*Berberis thunbergii*	Japanese Barberry
5	*Euonymus japonicus 'Green Spire'*	Green Spire Euonymus
5	*Leucothoe fontanesiana 'Rainbow'*	Rainbow Leucothoe
4	*Ligustrum vulgare 'Cheyenne'*	Cheyenne Privet
5	*Pieris japonicum cultivars*	Japanese Pieris
5a	*Pyracantha coccinea 'Teton'*	Firethorn
4	*Rosa rugosa 'Hansa' or 'Mediland'*	Rose
Species native to the Okanagan		
3	*Ceanothus sanguineus*	Red-stemmed ceanothus
4	*Elaeagnus commutata*	Wolf willow
3	*Mahonia aquifolium*	Oregon grape
2	*Sorbus sitchensis*	Mountain ash

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

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

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

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

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

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

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

The Canadian Plant Hardiness Zone for Kelowna is 7a.
http://www.planthardiness.gc.ca/?m=22&lang=en&prov=BritishColumbia&val=K.

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

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

The Okanagan Native Plant Society provides resources on plant choices, nursery resources and maintenance tips appropriate to the Okanagan Region through their Plant Database accessed online at:
http://okanaganxeriscape.org/db/

APPENDIX I: FIRESMART FUEL TREATMENTS

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

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

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

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

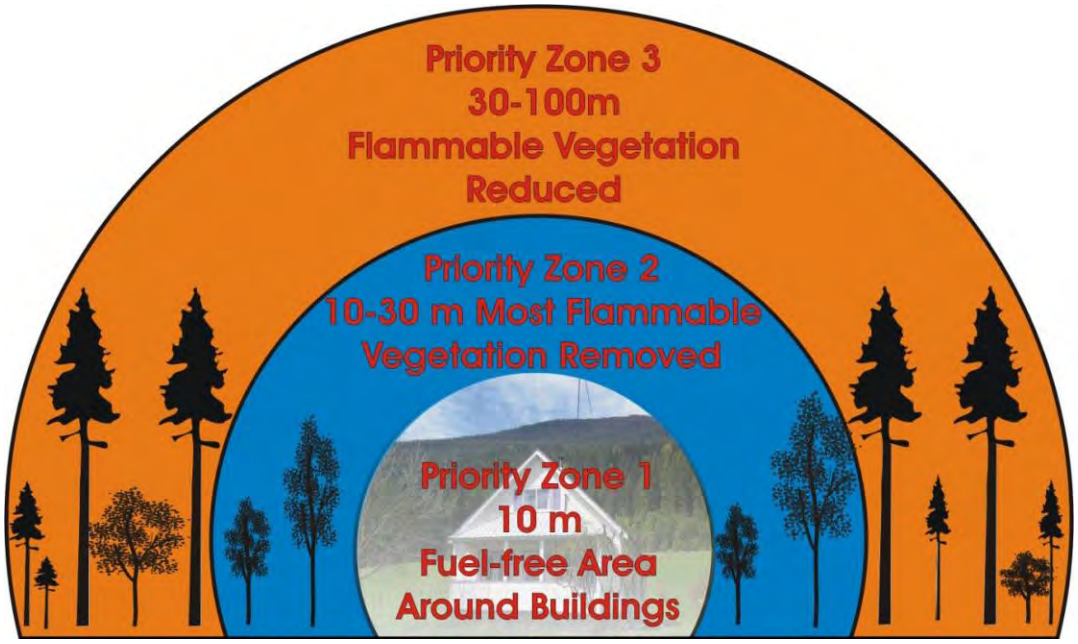

Figure 27. Illustration of FireSmart zones. (Figure adapted from FireSmart)

APPENDIX J: FIRE HAZARD ASSESSMENT STANDARD

SIMPLE ASSESSMENT: TABLE OF CONTENTS

Preliminary Wildfire Hazard Assessment Report

XX HERE ST

PID

Submitted By:	Submitted To:
CONSULTANT	CLIENT

DATE OF LAST AMENDMENT/ REVISION

B.A. Blackwell
& Associates Ltd.

B.A. Blackwell & Associates Ltd.

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B.A. Blackwell & Associates Ltd.

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APPENDIX K: PRINCIPLES OF FUEL MANAGEMENT

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

What is fuel management?

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

Fire Triangle:

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

Forest Fuels:

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

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

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

Surface Fuels:

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

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

Aerial Fuels:

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

Two measures that describe crown fire potential of aerial fuels are the height to live crown and crown closure (Figure 28 and Figure 29). The height to live crown describes fuel continuity between the ground surface and the lower limit of the upper tree canopy. Crown closure describes the inter-tree crown continuity and reflects how easily fire can be propagated from tree to tree. In addition to crown closure, tree density is an important measure of the distribution of aerial fuels and has significant influence on the overall crown and surface fire conditions (Figure 30). Higher stand density is associated with lower inter tree spacing, which increases overall crown continuity. While high density stands may increase the potential for fire spread in the upper canopy, a combination of high crown closure and high stand density usually results in a reduction in light levels associated with these stand types. Reduced light levels accelerate self-tree pruning, inhibit the growth of lower branches, and decrease the cover and biomass of understory vegetation.

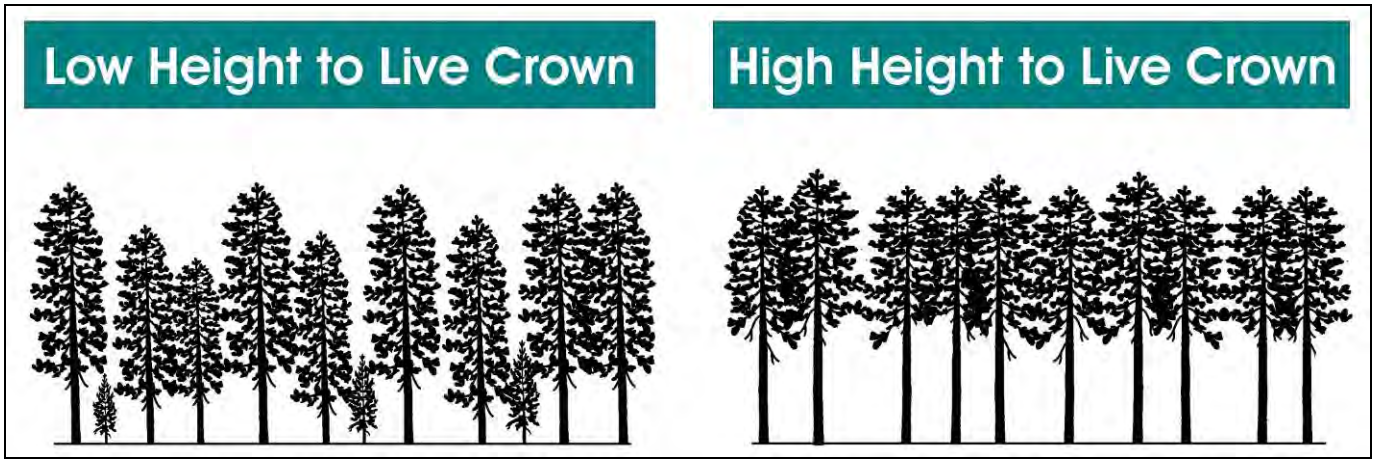

Figure 28. Comparison of stand level differences in height-to-live crown in an interior forest, where low height to live crown is more hazardous than high height to live crown.

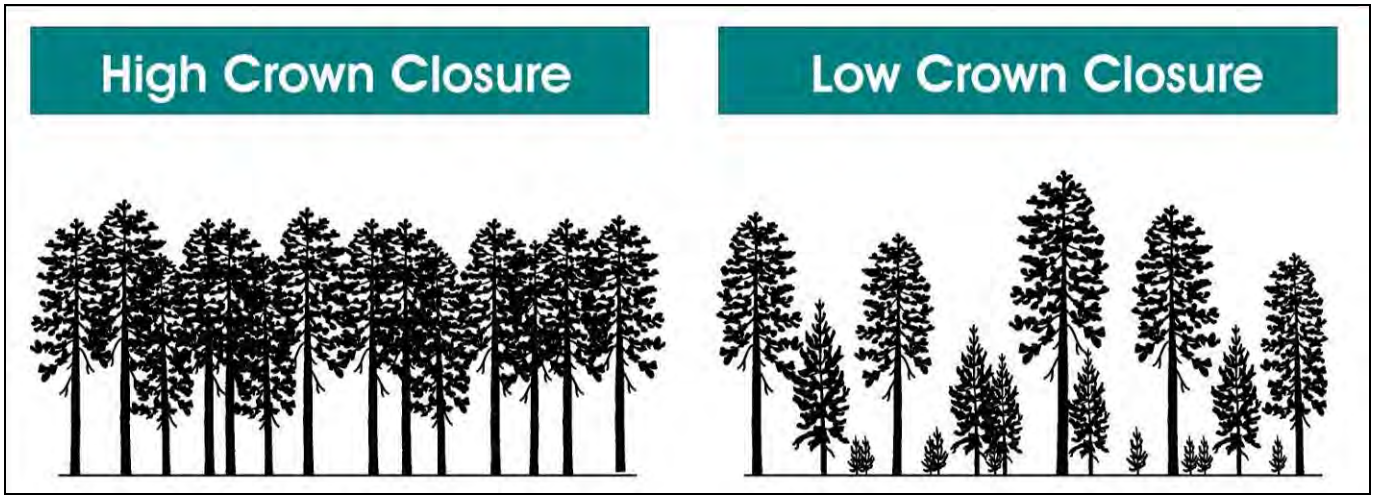

Figure 29. Comparison of stand level differences in crown closure, where high crown closure/continuity contributes to crown fire spread, while low crown closure reduces crown fire potential.

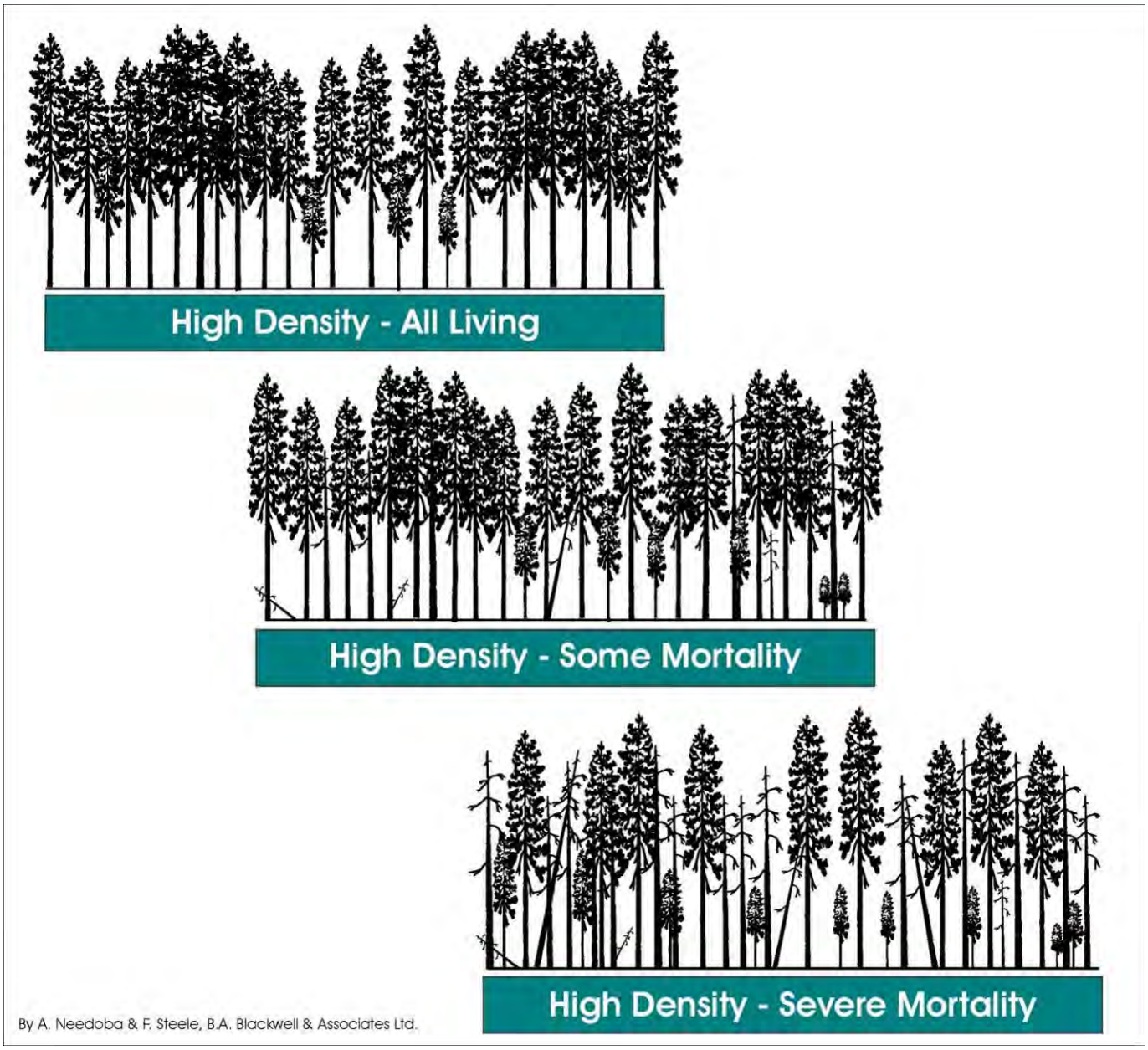

Figure 30. Comparison of stand level differences in density and mortality, and the distribution of live and dead fuels in these types of stands.

Thinning is a preferred approach to fuel treatment (Figure 32.) and offers several advantages compared to other methods:

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

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

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

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

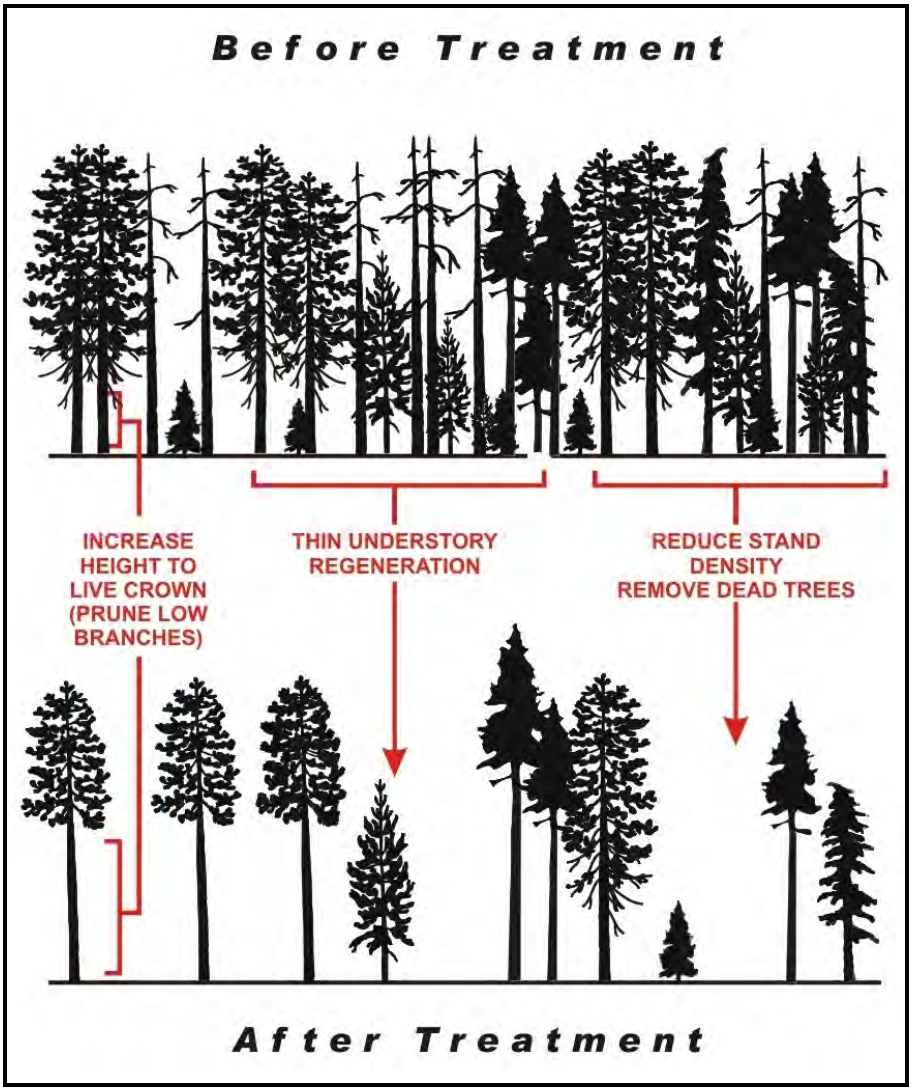

Figure 31. Illustration of the principles of thinning to reduce the stand level wildfire hazard.

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

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

APPENDIX L: 2011 CWPP TARGET STAND CONDITIONS

Ecosystem Type	Target Stand Conditions	Stand Density*	Canopy Gap Size Distribution	Surface Fuel Load Distribution kg/m²
TSC #1 Ponderosa Pine Zone on hot, dry south and west facing slopes	Grassland and open forest communities	< 100 st/ha dominated by ponderosa pine with a crown closure of <10%	Open grasslands with scattered individual trees or small groups of trees.	Small fuels <0.2 Large fuels < 1
TSC #2 Ponderosa Pine Zone on cooler north and east facing slopes	Low to moderate density forest communities with associated grassland communitites	50-300 dominated by ponderosa pine with a crown closure of 15-35%	Scattered irregular shaped, medium sized openings (25 to 50% of landscape are openings 0.1 to 0.5 ha in size).	Small fuels <0.5 Large fuels < 2
TSC #3 Interior Douglas-fir Zone on hot, dry south and west facing slopes	Low density, open forest communities with associated grassland communitites	50-150 of both ponderosa pine and Douglas-fir with a crown closure of 10-25%	Scattered irregular shaped, small to medium sized openings (25 to 50% of land-scape are openings 0.5 to 1 ha in size)	Small fuels <0.5 Large fuels < 2
TSC #4 Interior Douglas-fir Zone on cooler north and east facing slopes	Moderate density forest communities with associated small grassland communitites	200-400 of both ponderosa pine and Douglas-fir with a crown closure of 15-35%	Scattered irregular shaped, small sized openings (< 30% of landscape are openings < 0.1 ha in size)	Small fuels <0.5 Large fuels < 3

Figure 32. Summary of target stand conditions (TSCs) by site ecology and exposure developed by Diamondhead Consulting Ltd (2011). Further details can be found in the 2011 City of Kelowna CWPP.

APPENDIX M: LANDSCAPE LEVEL FUELBREAK MANAGEMENT

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

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

Surface Fire Behaviour:

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

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

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

Conditions That Initiate Crown Fire:

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

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

Table 20. Flame lengths associated with critical levels of fireline intensity that are associated with initiating crown fire, using Byram's (1959) equation.

Foliar Moisture Content (%)	Height of Crown Base Separation			
	2 meters	6 meters	12 meters	20 meters
	6 feet	20 feet	40 feet	66 feet
	M ft	M ft	M ft	M ft
70	1.1 4	2.3 8	3.7 12	5.3 17
80	1.2 4	2.5 8	4.0 13	5.7 19
90	1.3 4	2.7 9	4.3 14	6.1 20
100	1.3 4	2.8 9	4.6 15	6.5 21
120	1.5 5	3.2 10	5.1 17	7.3 24

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

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

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

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

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

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

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

Fuelbreak Effectiveness:

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

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

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

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