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CORPORATE REPORT

NO: **R064** COUNCIL DATE: **April 8, 2013**

REGULAR COUNCIL

TO: **Mayor & Council** DATE: **March 26, 2013**

FROM: **General Manager, Parks, Recreation and Culture**
Fire Chief FILE: **5000-01**

SUBJECT: **Community Wildfire Protection Plan**

RECOMMENDATION

The Parks, Recreation and Culture Department and the Fire Department recommend that Council receive this report as information.

BACKGROUND

Wildfires that have occurred in Kelowna and elsewhere in British Columbia caused the Provincial Government to introduce a Strategic Wildfire Prevention Initiative that provides funding to local governments for the purpose of developing a Community Wildfire Protection Plan (a "Plan"). Given that the City of Surrey has relatively extensive tracts of forested land within its boundaries, many of which are immediately adjacent to homes and other structures the Parks, Recreation and Culture Department and Fire Services Department submitted an application in 2012 to the Provincial Government for a grant under the referenced Provincial Initiative. The application was for $15,000 to complete a Plan for the City. The application was successful with a grant of $15,000 being provided to the City.

Using the grant funding, a consulting company (Diamond Head Consulting Ltd.) was engaged by staff to assist in developing the Surrey Community Wildfire Protection Plan.

DISCUSSION

The Plan, a copy of which is attached as Appendix "A" to this report, has now been completed. It identifies the level of wildfire risk associated with the various forested areas of the City and provides treatment prescriptions and recommendations to reduce the risk of wildfires. The wildfire risk analysis evaluates probability (fire behaviour potential) and consequence (risk to human life, structures and natural features). The analysis also identifies interface areas that are more sensitive. Preliminary ground assessments were completed in relation to wildfire fuel treatment.

In general the Plan recognizes that there is relatively low risk of wildfires in the City. Recommendations related to the planning and design of future development along interfaces with forested areas are incorporated into the Plan, including treatment of adjacent vegetation, water sources and standards for fire-safe landscaping. The Plan also includes recommendations related to emergency pre-planning, public education and inter-agency cooperation.

A completion of detailed ground assessments is the next step. An application to the Provincial Government is being made to seek additional financial assistance to allow for full ground assessments to be completed that will guide the City in implementing site specific preventative measures to reduce the risk of wildfire. The ground assessments will also enable the Fire Services Department to target education and information distribution efforts in relation to private land owners.

SUSTAINABILITY CONSIDERATIONS

The Community Wildfire Protection Plan will assist in achieving the objectives of the City's Sustainability Charter; more particularly the following objectives:

1. E12: "*Enhancement and Protection of Natural Areas, Fish Habitat and Wildlife Habitat"; and*
2. SC11: "*Improve Public Safety and Security"*

CONCLUSION

The Parks, Recreation and Culture Department and the Fire Department have collaborated on the development of a Community Wildfire Protection Plan with financial assistance from the Province. The Plan concludes that there is a relatively low overall risk of wildfire in the City; however, there are some areas that require treatment to manage the risks effectively. An application is being made to the Province for additional financial assistance to address site specific risks.

Laurie Cavan
General Manager
Parks, Recreation and Culture

Len Garis
Fire Chief
Fire Services Department

Appendix "A" - City of Surrey Community Wildfire Protection Plan

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City of Surrey Community Wildfire Protection Plan

March 2013

Submitted to:

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Acknowledgements

Diamond Head Consulting Ltd. thanks the City of Surrey for its generous and ongoing support to prepare this Community Wildfire Protection Plan. City staff provided valuable review and comments during preparation of draft reports, much of which has been integral to developing the final Plan and recommendations. Special thanks to Greg Ward (City of Surrey Urban Forestry Operations Manager) and Dan Barnscher (City of Surrey Deputy Fire Chief).

Executive Summary

The threat of wildfire to BC communities is a growing concern. The Firestorm 2003 Provincial Overview (Filman 2003) emphasized the need to recognize this threat and focus efforts to reduce wildfire risk in the wildland-urban interface.

This report provides a background review of the fire environment in the City of Surrey. It identifies the level of wildfire risk and provides treatment prescriptions and priority recommendations to reduce risk. A wildfire risk analysis evaluates probability (fire behaviour potential) and consequence (risk to human life, structures and natural features). This analysis identified interface areas that pose a significant risk. Ground assessments were completed on public land to prioritize areas for fuel treatment.

Results from the landscape level analysis show that there is relatively low risk of wildfire in and adjacent to the City of Surrey. These findings were confirmed through field assessments. Recommendations for future community planning and design are incorporated into the report. This includes treatment of adjacent vegetation and water sources, construction standards and landscaping. Recommendations to reduce wildfire risk through preparedness (i.e. emergency pre-planning), public education and interagency co-operation are also included.

The City's infrastructure and wildfire environment is continually changing. This report should be updated every five (5) years to reflect these changes. Adaptive management should be adopted to incorporate new scientific knowledge to monitor, evaluate and improve the inventories and recommendations contained in this report

Summary of Key Recommendations

Key recommendations have been prioritized in the following table for implementation in the next 20 years. Priority A recommendations are to be implemented with the short-term (1–5 years), Priority B in the mid-term (6-10 years) and Priority C in the long-term (10-20 years).

Table 1 Summary of Key Recommendations

Number	Action Item	Priority
Rec # 1	Evaluate the City's performance every five years based upon accepted ecological, community and management based criteria.	A
Rec # 2	This CWPP is a living document that should be reviewed and updated every 5 years	A
Rec # 3	Treat all City owned interface polygons that were identified as posing a risk of moderate to high	A
Rec # 4	Pursue opportunities for Fuel Reduction Pilot Projects through the UBCM	A
Rec # 5	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
Rec # 6	Enhance recreation trails in strategic locations in the urban/wildland interface that act as surface fuel breaks and improve access for suppression resources	B
Rec # 7	All Fire Department staff who work in the interface areas should receive basic level fire suppression training (S-100) at least once every two years	B
Rec # 8	Basic suppression equipment should be kept in strategic locations around large urban forests and parks.	A
Rec # 9	Interagency wildfire suppression training should be coordinated between the Wildfire Management Branch and the City Fire Department	B
Rec # 10	Ensure that BC Hydro and FortisBC abate fuel hazards during their vegetation management operations along their transmission right of way	B
Rec # 11	Ensure that grass is maintained and that all tree cutting is cleaned up adequately along roadways	A
Rec # 12	Ensure all roads constructed in interface areas meet standards required for suppression vehicles	A
Rec # 13	Identify interface communities with one access route or cul-de-sac roads. Explore options to build alternative access to these areas.	C
Rec # 14	Encourage strategic recreation trail development in parks to a standard that supports ATV/UTVs.	B
Rec # 15	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
Rec # 16	Identify areas with poor water availability and install hydrant systems or alternative water reservoirs	B
Rec # 17	Identify and map alternative water sources including reservoirs, lakes and rivers.	B
Rec # 18	Install fire hydrants to serve all new developments and existing interface areas that are deficient	B
Rec # 19	Road side ditches and medians that contain grasses should be mowed prior to the fire season	B
Rec # 20	Engage in public education programs to reduce human caused ignition focusing on private residents that live in the urban/wildland interface	B
Rec # 21	Work with BC Hydro to ensure that distribution lines and transmission corridors are assessed regularly for tree risk and that the associated fuel hazards are abated	B

Number	Action Item	Priority
Rec # 22	Enforce FireSmart principles for all development that takes place within 100m of areas with a moderate to high wildfire risk.	B
Rec # 23	Inspect construction sites during the fire season and ensure construction contractors are aware of their responsibilities as described within the Wildfire Act	C
Rec # 24	The FireSmart guidelines should be considered as the minimum standard any new development proposed within 100m of areas with a moderate to high wildfire risk.	A
Rec # 25	Wildfire awareness signs should be posted along major transportation corridors, at camp sites, recreation areas and high use trail heads that specify how to report a wildfire	A
Rec # 26	The City should develop a public education and awareness program for wildfire management	B
Rec # 27	Distribute educational material to all private land owners within 100 m of moderate to high risk areas	A
Rec # 28	Summaries of this report and associated maps should be posted at strategic public locations.	A
Rec # 29	A series of public presentations should be planned once this CWPP is adopted	A
Rec # 30	A representative from the Cities Parks Department and the Fire Department should be present at public events that take place in or near natural areas	A
Rec # 31	Establish a school education program to engage youth in wildfire management	B
Rec # 32	Digital media including video and the City's website should be updated to include this plan	A
Rec # 33	In the event of a wildfire, a post-fire ecosystem impact assessment and rehabilitation plan should be completed	B
Rec # 34	Pursue funding sources to undertake pilot projects to treat the City owned interface polygons recommended in Appendix C.	A

* Key recommendations are highlighted throughout this report. These have been prioritised into three categories. "Priority A" recommendations are to be implemented with the short-term (1–5 years), "Priority B" in the mid-term (6-10 years) and "Priority C" in the long-term (10-20 years).

Introduction

The City of Surrey (City) is one of the fastest growing communities in British Columbia. Population has increased over 100,000 people from 2001 to 2011, growing to approximately 483,000 residents. The City is expected to grow by almost 300,000 more people by 2041. Growth and densification place significant pressure on remaining land, particularly undeveloped forested areas in suburban and rural zones. Wildfire risk is expected to increase in coming decades due to continued development in interface areas and the influences of climate change.

While wildfire risk cannot be eliminated entirely, we can effectively prepare for wildland fires by reducing wildfire behaviour potential in fire-prone areas. This Community Wildfire Protection Plan (CWPP) was developed to address the threat of wildfires in the City's wildland-urban interface zone (WUI). The CWPP is a guiding document that provides a clear vision for long-term wildfire risk management in the City of Surrey. Clear, meaningful and achievable management goals are provided. This CWPP is an adaptive plan designed to evolve over time and provide a sense of community stewardship for residents.

Project History

The City has completed several planning studies over past 15 years that address the risk of wildfire. These include:

- "Natural Areas: Fire Management Strategy" (2005);
- "Sunnyside Acres Urban Forest Fire Management Plan" (2001);
- "Green Timbers Urban Forest Wildfire Management Plan" (2002); and
- "Natural Areas Management Plan – Fire Management Strategy (2011).

The wildfire environment in the City has dramatically changed since these reports were completed. Extensive residential development has occurred in the wildland-urban interface, increasing risk of wildfire ignition. The City recognizes that these wildfire planning documents require periodic updating as the wildfire environment changes.

This CWPP was developed with financial support from the Union of BC Municipalities. It follows standards and methodologies adopted and endorsed by the Wildfire Management Branch of the Ministry of Forests, Lands and Natural Resource Operations. Wildfire risk has been assessed on a landscape level and in the urban interface. Recommendations aim to reduce risk to human life, structures and ensure adequate preparedness and the availability of proper resources for wildland fire suppression.

A Vision for Wildfire Management Planning

A long-term, sustainable vision for wildfire management in the City of Surrey is a prerequisite to develop supporting policies, guidelines, and short and long-term management plans. The vision should exemplify an inspired concept for wildfire management, considering the City's present state and future perspective. The vision should respond to the community's needs while recognizing the management challenges associated with future population growth, fiscal constraints, land use and environmental change.

> "The City of Surrey recognizes the need to support sustainable and safe development while protecting the integrity of its natural areas. It is committed to becoming a "FireSmart" community, leading by example to ensure the safety of its citizens, buildings and infrastructure."

Guiding Principles

Table 2 Guiding principles adopted by the City

Guiding Principles	
Public Health and Safety	Public safety is the foremost priority. All wildfire management activities must reflect this commitment.
Protection of infrastructure	The City will implement measures to protect community infrastructure from wildfire including private property, public structures and facilities.
Sustainable Planning	The City of Surrey supports a unique diversity of natural features which help to define the character of the City. Protection of these features requires a framework for growth that supports a harmonious balance between long term social, economic and environmental values.
Environmental Protection and Enhancement	The ecosystems found within the City support a high level of biodiversity and environmentally sensitive features. This plan recognizes the importance of protecting and enhancing these environmental values.
Interagency Co-operation and Policy	Wildfire management planning, preparedness, prevention, suppression, ecosystem rehabilitation, and education will be conducted in co-operation between the City, the City Fire Department, the Ministry of Forests, Lands and Natural Resource Operations and First Nations.
Public Awareness, Education and Advocacy	Public awareness, education and advocacy are integral to fostering respect for the risk that exists from wildfire. Agencies will enhance understanding and support of wildfire management policies and practices through internal and external communication and education programs.
Adaptive Management	There are significant challenges in establishing a "FireSmart" community during a period of rapid growth and changing environmental climate. An adaptive management approach must be adopted that includes a monitoring function to evaluate the effectiveness of initiatives, modify actions as required, and incorporate new approaches and decision-making processes.
Financial Responsibility	The plan recognizes that many of the recommendations to be adopted are costly and will be implemented over time as budgets and funding sources allow. Limited budgets will require that a variety of initiatives be explored to implement all of the recommendations in the plan. Long term success of the plan depends on reliable and sustainable funding strategies within the context of developing innovative partnerships, priority setting and cost/benefit considerations.

Objectives, Assessment Criteria and Indicators

Successful implementation and long term monitoring of the CWPP requires that a foundation of objectives, assessment criteria and performance indicators be adopted. These are summarized in the following tables which correlate to specific ecological, community or management factors. Key objectives inform City managers, private industry stakeholders, and members of the community as to how the City intends to manage the risk from wildfire. Criteria and indicators were created to provide a roadmap to achieve an optimal state for wildlife preparedness. These tables are meant to help City managers direct and prioritize the recommendations made in this CWPP document. They also provide a measure of performance that can be reevaluated periodically.

Table 3 Objectives, Assessment Criteria and Performance Indicators - Ecological Factors

Key Objectives	Assessment Criteria	Performance Indicators			
		Low	Moderate	Good	Optimal
Minimize ecological impacts of fuel treatment activities	Ecological integrity of treatment areas	No consideration of ecological sensitivities during planning and operational activities; Impacts are high	General landscape considerations for ecological impacts; Impacts are evident but not high	Site specific ecological sensitivities identified and protected during operational activities; Impacts are low	Site specific ecological sensitivities identified and protected during operational activities; Impacts are insignificant
Minimize ecological impacts of suppression activities	Ecological integrity of areas impacted by suppression activities	No consideration of ecological sensitivities during suppression; Impacts including site degradation are high	General landscape considerations for ecological impacts; Ecological impacts are evident but not high	Site specific ecological sensitivities identified and protected during operational activities; Low impacts to site	Site specific ecological sensitivities considered during suppression; Site impacts are insignificant.
Restore all natural areas impacted by wildfire management activities	Implementation of restoration plans and programs	No restoration of impacted areas	Less than half of degraded areas restored within one year following disturbance	More than half but not all degraded areas restored within one year following disturbance	Restoration of all degraded areas within one year following disturbance

Table 4 Objectives, Assessment Criteria and Performance Indicators - Community Factors

Key Objectives	Assessment Criteria	Performance Indicators			
		Low	Moderate	Good	Optimal
Develop public education programs to support the goals of the Community Wildfire Protection Plan (CWPP)	Public understanding of wildfire planning and suppression	No education programs directed towards wildfire planning and suppression; little to no public awareness of wildfire issues	Public generally aware of CWPP. Some education and awareness programs initiated	Education initiatives targeted to priority recommendations in the CWPP	Proactive education initiatives in place to support CWPP; Public aware of and support the CWPP
Involve the public in the implementation of the CWPP	Public involvement and community stewardship	No public involvement or stewardship in CWPP initiatives	Limited public involvement in CWPP initiatives	Community engaged and participates in implementation of priority recommendations in CWPP	Community actively engaged and participates in implementation of all aspects of the CWPP

Table 5 Objectives, Assessment Criteria and Performance Indicators - Management Factors

Key Objectives	Criteria	Performance Indicators			
		Low	Moderate	Good	Optimal
Develop and implement a comprehensive CWPP	Implementation of a CWPP	No CWPP implemented	CWPP implemented with 50% of recommendations implemented	CWPP implemented with all recommendations implemented	CWPP implemented with all recommendations implemented; CWPP updated every 5 years
City departments cooperate to implement CWPP goals and objectives	Interdepartmental cooperation	No communication or consultation protocols between departments in place	Relevant departments have general awareness of CWPP management and planning activities	Relevant departments work together to implement the recommendations in the CWPP	Coordinated and cooperative management approach by relevant departments to implement the CWPP
CWPP goals and recommendations are recognized in municipal plans and policy	Integration of CWPP in municipal planning and development process	No recognition of CWPP in municipal planning process	Priority recommendations in CWPP recognized and supported by relevant municipal policy	All recommendations in CWPP recognized and supported by relevant municipal policy	CWPP goals and recommendations supported by relevant municipal policy and enforced in the development planning process
Secure annual funding to deliver comprehensive fire management program	Annual budget available to support the recommendations in the CWPP	No budget allocation to support the recommendations in the CWPP	Annual funding secured to deliver <50% of the recommendations in the CWPP.	Annual funding secured to deliver 50%-75% of the recommendations in the CWPP.	Secured, annual funding available to meet all recommendations in the CWPP

Key Objectives	Criteria	Performance Indicators			
		Low	Moderate	Good	Optimal
Employ adequate staff to deliver comprehensive fire management program	Ability of staff to deliver comprehensive program (number and qualifications of staff)	No qualified staff	Minimal staff provided with baseline training. Staff able to deliver <50% of the recommendations in the CWPP.	Qualified individuals on staff with regular professional development. Staff able to deliver 50%-75% of the recommendations in the CWPP.	Multi-disciplinary team; required resources available on demand. Staff able to deliver >75% of the recommendations in the CWPP.
Reduce wildfire risk in public owned interface areas	% of high risk public interface areas treated	<25% interface fuel treatment polygons treated and maintained	25-75% interface fuel treatment polygons treated and maintained	>75% interface fuel treatment polygons treated and maintained	All interface fuel treatment polygons treated and maintained
Reduce wildfire risk in private owned interface areas	% of high risk private interface areas treated	<25% interface fuel treatment polygons treated and maintained	25-75% interface fuel treatment polygons treated and maintained	>75% interface fuel treatment polygons treated and maintained	All interface fuel treatment polygons treated and maintained
Water supply is available for suppression to all structures within the wildland interface	Proximity of water source to structures within the wildland interface	Water sources available to less than 50% of structures within the wildland interface	Water sources available for 50-75% of structures within the wildland interface	Water sources available to greater than 75% of structures within the wildland interface	Water sources available to all structures within the wildland interface
Identify interface areas with a high risk of ignition	Extent of interface inventory	No knowledge or inventory of interface ignition sources	General understanding of the types of ignition sources; <50% spatial mapping of high risk areas in GIS	Comprehensive understanding of the risk of ignition within interface areas; 50% to 75% spatial mapping of high risk areas in GIS	Comprehensive understanding for the risk of ignition across the city; >75% spatial mapping of high risk areas in GIS
Ensure there are adequate access, ingress and egress routes to all communities within the interface	Presence of ingress/egress routes in all communities	<60% of communities have greater than one ingress/egress route	60-90% of communities have greater than one ingress/egress route	>90% of communities have greater than one ingress/egress route	All communities have greater than one ingress/egress routes
Implement a monitoring program for wildfire risk in interface areas	Frequency of monitoring	No monitoring program	Infrequent monitoring of high risk interface areas	Regular monitoring of high risk interface areas	Regular monitoring of all interface areas

Number	Action Item	Priority
Rec # 1	Evaluate the City's performance using the Criteria and Indicators tables every 5 years	A

A Living Document – Timelines and Adaptive Management

Developing an effective CWPP that considers natural ecosystem processes is challenging. Forest stand conditions are constantly changing due to growth, regeneration, pests and diseases. The City also has a rapidly increasing population and is developing to accommodate this growth. Development will continue to impact natural areas. In addition, future impacts to the landscape resulting from potential climate change scenarios will likely have a lasting, but as of yet, undetermined, impact on the natural forested communities.

An adaptive management approach is one of continual learning. Adaptive management integrates new management initiatives, scientific research, and community input. Specific management initiatives are monitored with the results used to better inform and strengthen the plan by making necessary adjustments where appropriate.

Recommendations in this CWPP are designed to be implemented over a 20 year time frame to lead the City of Surrey towards becoming a "FireSmart" community. The plan operates under the assumption that it will take some time before the City is operating at an optimal state of preparedness. Therefore, this plan is intended to be a living document that will be updated every five years.

Number	Action Item	Priority
Rec # 2	This CWPP is a living document that should be reviewed and updated every 5 years	A

Existing Policy and Guidelines

Following is a summary of some of the municipal and provincial policies and guidelines that relate to wildfire management and fuel treatments.

Table 6 Summary of wildfire related policy

Official Community Plan Bylaw #12900	The Official Community Plan (OCP) is a statement of objectives and policies that will guide City planning decisions over the next 5 to 20 years. It is developed to ensure orderly growth for complete sustainable communities with sensitivity to the environment.
Sustainability Charter	The charter was designed to help Surrey reach its sustainability goals. Environmental goals include demonstrating good stewardship of the land, water, air and built environments. Surrey also plans to protect, preserve and enhance natural areas and ecosystems for current and future generations while making nature accessible for all to enjoy.
Tree Protection Bylaw No. 16100.	This Bylaw regulates and prohibits cutting, removing and damaging of trees, setting of fees and issuance of permits and requirement for replacement trees and security for their provision and maintenance.
Outdoor Burning Regulations No. 10771	This bylaw regulates the burning of any solid fuels at any time within City limits. There is no burning of any solid fuels at any time unless compliant with the Bylaw. Burning permits may be issued for agricultural uses to residents not conducting an agricultural business on their property.
Air Quality Program	This program is a joint initiative between Metro Vancouver and the City of Surrey. Metro Vancouver monitors air quality in the region. It controls industrial, commercial and some residential emissions. The program also creates long-term plans and conducts emission inventories. Burning within City of Surrey limits is restricted to agricultural burning only and must be done with the required permits.

Methodology

This CWPP was developed in consultation with the City of Surrey and the City of Surrey Fire Department. A landscape level "Wildfire Risk Analysis" as well as interface field assessments were completed within the wildland-urban interface as part of this plan. The "Wildfire Risk Analysis" is a GIS based model that spatially quantifies and analyzes the relationships that exist between wildfire behaviour potential, values at risk and constraints to suppression capabilities. See Appendix A for a detailed explanation of the Wildfire Risk Analysis. This Analysis was used to highlight City wide concerns and to develop landscape level recommendations.

Detailed fuel hazard assessments were completed within the interface of City owned lands using the provincial assessment system, "Rating Interface Wildfire Threats in BC" (Morrow, Johnson, Davies, 2008). This ranking system was used to help determine where fuel treatments will effectively reduce wildfire threat and to prioritise these areas for treatment. This combination of landscape and site level risk assessments provides a foundation to develop treatment strategies at a broad landscape level and specific treatments to address structures at risk.

Funding used to develop this CWPP does not cover preparation of detailed fuel treatment prescriptions. However, a standardized approach has been recommended for their development. Recommendations for land development, planning, establishment of standards for wildfire preparation and public educations are provided.

Project Study Area

Population and Geography

The City of Surrey is located in the Lower Mainland on the west coast of British Columbia. Total land area is 31,900 hectares. Delta borders Surrey to the west; the City of Langley and Langley Township are to the east. The municipalities of New Westminster, Coquitlam, Port Coquitlam and Pitt Meadows are to the north, across the Fraser River. Surrey's southern border is shared with White Rock and the State of Washington, USA.

Surrey has a population of 483,690 (City of Surrey, 2011), which is projected to grow to 580,000 by the year 2016. The majority of City land is developed for residential, commercial or agriculture use. Approximately 8,692 ha is in the Agricultural Land Reserve (ALR). Many of the developed areas of Surrey lack extensive tracks of forested area, but do include some urban forests and parks. The largest and most forested City parks and urban forests include: Sunnyside Acres Urban Forest, Crescent Park, Green Timbers Urban Forest, Colebrook, Redwood, Latimer, Hi-Knoll, Invergarry, Hawthorn, Bear Creek, Fleetwood, and Surrey Lake. Large parks managed by Metro Vancouver include Surrey Bend and Tynehead Parks. Numerous smaller natural area parks are also found throughout the City

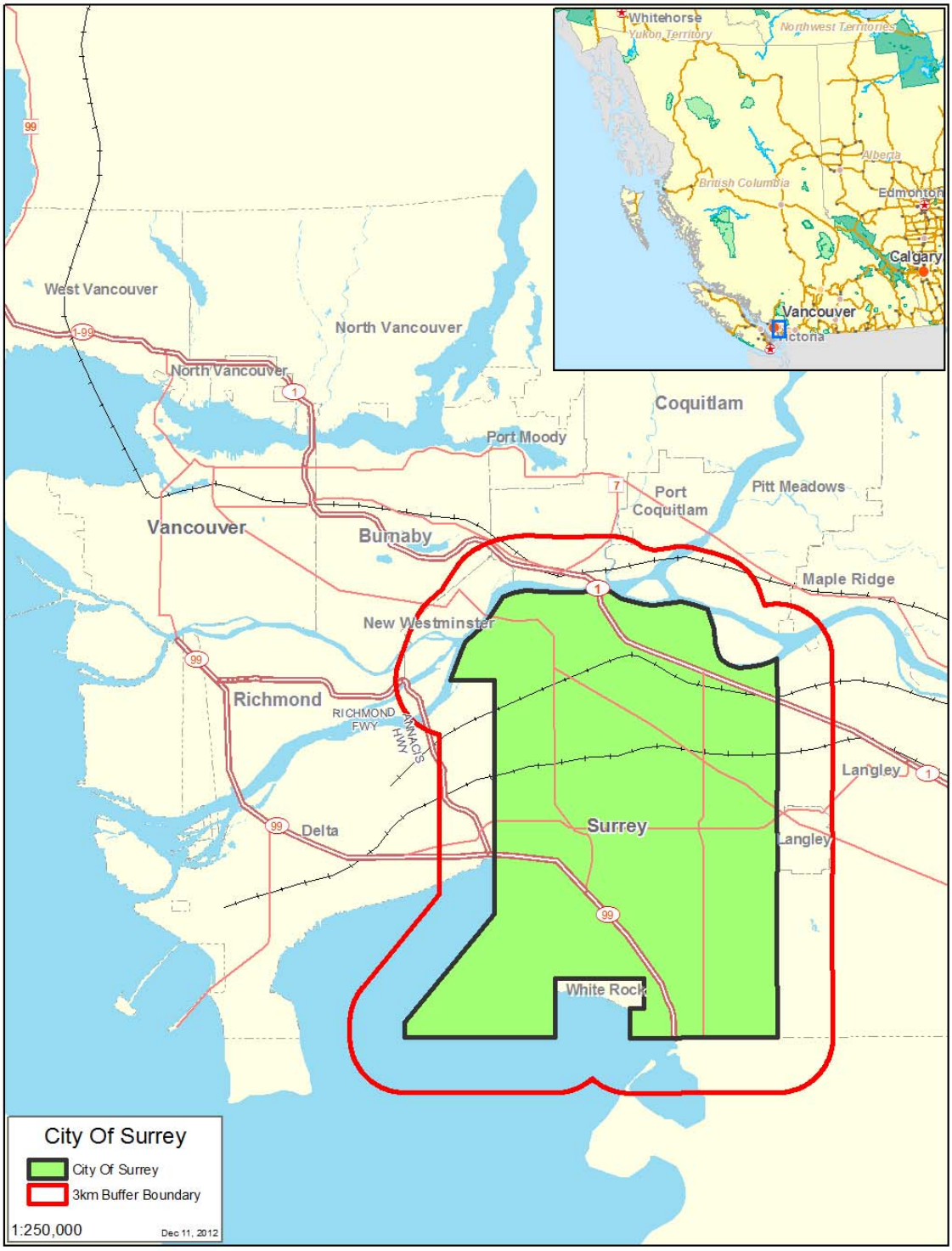

Figure 1 Project location and boundary

Natural Environment

Surrey is located on the Fraser River floodplain on British Columbia's west coast. The Coastal Mountains to the east and the Pacific Ocean to the west of Surrey create a mild, wet climate. Mild, sunny summers and cool, wet winters are typical of the region. The western portion of the City is the warmest and driest, being in the rain shadow of the Vancouver Island mountains. Climate is slightly wetter in the eastern and northern portions of the City. According to the Biogeoclimatic Ecosystem Classification (BEC), Surrey has three subzones: CDFmm, the CWHxm and the CWHdm.

Moist Maritime Coastal Douglas-fir Subzone (CDFmm)

The western edge of the City is classified as the CDFmm subzone. It is under the influence and in the rain shadow of the Vancouver Island mountains. This subzone is characterized by warm, dry summers and mild wet winters. There are long growing seasons with pronounced water deficits in the summer. This is the mildest subzone in BC.

Very Dry Maritime Coastal Western Hemlock Subzone (CWHxm)

The majority of the City is classified as the CWHxm. It occurs to the east and north of the CDFmm and is slightly cooler and wetter. This subzone is characterized by warm, dry summers and moist, mild winters.

Dry Maritime Coastal Western Hemlock Subzone (CWHdm)

The northwestern corner of the City is classified as the CWHdm. This subzone is wetter than the CWHxm as it is influenced by the North Shore mountains. This subzone is characterized by warm, relatively dry summers and moist mild winters. There are long growing seasons; however, water deficits are less frequent.

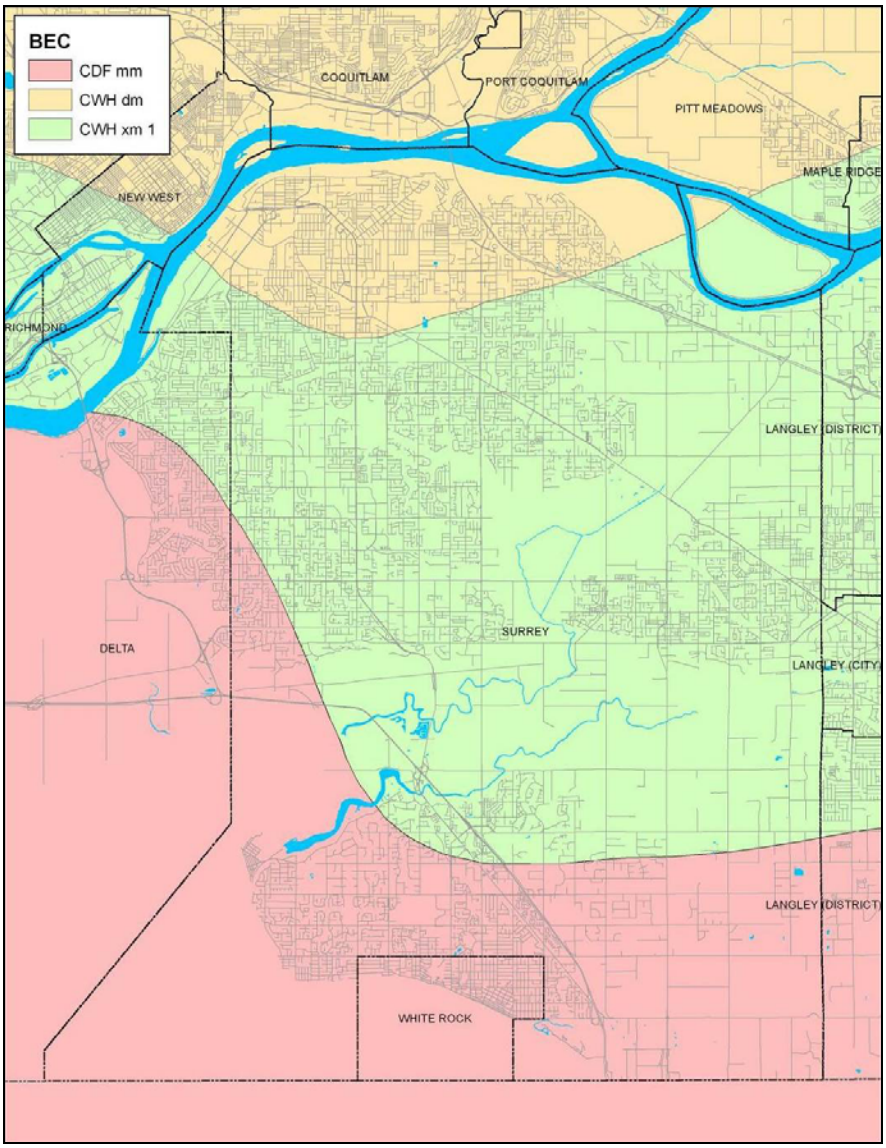

Figure 2 Biogeoclimatic subzones across Surrey and adjacent municipalities.

Table 7 Climatic characteristics of the CDF and the CWH Zones (Meidinger and Pojar 1991).

Biogeoclimatic Zone	Mean Annual Ppt. (mm)	Mean Summer Ppt (mm)	Annual Avg. Temp (C)
Coastal Douglas-fir (CDF)	873	141	9.5
Coastal Western Hemlock (CWH)	2140	467	9.2

Most terrestrial ecosystems in Surrey will naturally colonize with trees, with the exception of wetlands and intertidal areas. For this reason the majority of natural areas are forested plant communities. With the exception of the bog in Surrey Bend Regional Park, Surrey has no climax (old growth) plant communities. The forested stands range in age up to 120 years old. A large portion of the forested community is dominated by early and mid-seral forests of mostly deciduous tree species. Typically, these forest communities are composed of red alder with varying components of black cottonwood, bigleaf maple, paper birch and bitter cherry. Soils are generally rich supporting a well developed understory (i.e. shrub and herb layers). These types of forest are commonly found throughout the City on private and public land.

Figure 3 Typical young deciduous forest found throughout the City

Many of the original old growth forests on upland sites were harvested and broadcast burned at the turn of the century. Today, even-aged, mature conifer stands are found in these areas. Douglas-fir often acts as a pioneer species on these drier sites, quickly regenerating on the exposed mineral soils. Other common conifer species associated with these stands include western hemlock and western redcedar. There is scattered spruce and grand fir. These mature stands have intermixed components of younger deciduous tree species.

Figure 4 Typical mature second growth conifer stand found in the City

The City supports a large predominantly unforested lowland area associated with the floodplains of the Nikomekl and Serpentine Rivers. The majority of this area is converted for industrial agriculture. Those that are natural are characterized by tall graminoids or a variety of low and tall shrub communities. There are also a number of BC hydro right of ways that run through Surrey and are maintained as grass/shrub plant communities.

Figure 5 Typical lowland area converted to agriculture with scattered unmanaged herb and shrub communities

The lowland areas of the City support numerous freshwater wetland communities. Along the interface with the ocean (Mud Bay) there are intertidal brackish wetland communities.

Figure 6 Typical brackish intertidal wetland community

The City was mapped and divided into 20 broad land cover classes: forest, streams/lakes, wetlands, marine, shrub/herb/grass, agriculture and developed areas. These were used as a foundation to classify fuel types. Apart from developed areas, agriculture is the most abundant cover class in the City. The predominant forest types include young deciduous and mixed stands.

Table 8 Land cover class

Land Cover Class		Description	Area (ha)	Land Base (%)
Natural	Forest	Old Growth Forests (>240 yrs)	92	0.3%
		Mature Forest (80-240 yrs)	176	0.6%
		Young Mixed Forests (5-80 yrs)	1717	5.4%
		Young Deciduous Forests (5-80 yrs)	2357	7.4%
		Young Evergreen Forests (5-80 yrs)	723	2.3%
	Streams, Lakes	Freshwater River	172	0.5%
		Freshwater Lake	118	0.4%
	Wetlands	Marsh	143	0.4%
		Bog	48	0.2%
	Marine	Intertidal Flat/Salt Marsh	58	0.2%
		Marine Shallow Water	6	0.0%
		Estuarine Marsh	12	0.0%
	Shrub/Herb/Grass	Unmanaged Herb and Grass	648	2.0%
		Unmanaged Shrub	641	2.0%
Developed	Agriculture	Agricultural Herb and Grass	4803	15.1%
		Agricultural Row Crops	2615	8.2%
	Urban	Urban Trees	450	1.4%
		Turf Grass	1453	4.6%
		Urban Suburban/Low Density	3853	12.1%
		Urban Suburban/Moderate Density	7967	25.0%
		Urban Suburban/High Density	3827	12.0%

Natural Disturbance Regime

All ecosystems are influenced by periodic disturbances that vary in severity, frequency and extent. Disturbance events include: wildfire; windthrow; flooding; mass wasting (i.e. landslides); ice and freeze damage, insect or disease outbreaks; and human caused events such as logging. These disturbances influence the successional processes of an ecosystem. Historically, agents of disturbance were viewed as a threat to the integrity and value of the forest resource. Wildfire suppression and elimination of forest pests was a standard policy. As a result, many ecosystems that were dependent on natural disturbance events for renewal and habitat creation have been degraded. This has resulted in loss of biodiversity and reduction in early seral-stage vegetation (i.e shrub) communities. Many fire dependent ecosystems are accumulating hazardous fuel loads. Regular, low intensity ground fires that would normally burn small amounts of organic debris are suppressed. As a result, fuel loads build over time which can lead to large, uncontrollable wildfires that cause significant damage to ecosystems. Pest outbreaks can also be substantial, again often due to suppression of wildfire which would otherwise act as a natural biological check. .

Wildfire is often the most dramatic disturbance event and has the ability to immediately and significantly alter the physical and biological characteristics of an ecosystem. It can change the structure and species composition of a forest and significantly modify the composition of forest floor (including the organic layer and chemical properties of the soil). In ecosystems where natural wildfires are frequent, fire helps to prepare seed beds, recycle nutrients, alter plant succession, maintain a diversity of seral stages across the landscape, control insect and disease populations and reduce fuel accumulations. Many of the native plant species found in fire-dominated ecosystems depend on fire for renewal.

All biogeoclimatic subzones are categorised into five natural disturbance types (NDT) based on the size and frequency of natural disturbances that historically occur:

- NDT 1 - Ecosystems with rare stand-initiating events;
- NDT 2 - Ecosystems with infrequent stand-initiating events;
- NDT 3 - Ecosystems with frequent stand-initiating events;
- NDT 4 - Ecosystems with frequent stand-maintaining fires; and
- NDT 5 - Alpine Tundra and Sub-alpine Parkland ecosystems.

Subzones in the Lower Mainland are classified as NDT 2. These ecosystems have evolved with infrequent stand-initiating fires and have developed a multi-storey canopy. Wildfires that do occur are often smaller in size (20-1000 ha). Larger fires can occur after periods of extended drought (Forest Practices Code 1995).

Prior to European settlement, the major mode of disturbance in the region was wind storms. Combined with pathogens that weaken trees, small canopy gaps would often open up after wind storms. There are historical records of stand-replacing wind events, but these instances are uncommon. Other observed disturbances having a minor impact on forest regeneration in this area include floods, insect attacks, and wildfire (Dorner and Wong 2002).
It has been suggested that wildfires were set by local First Nations to manage coastal forests, especially within the drier CDF zones (Agee and Dunwiddie 1984). Evidence of low to moderate severity fires were set on an 80 year rotation with size ranging from 1 to 500 ha. A study within the CWHvm1 Biogeoclimatic Zone suggests that partial-replacement fires occurred at intervals of 200 to 450 years. Fires size ranged from 10 to 1048 ha (Green *et al.* 1999). The same study found that for Douglas-fir to be maintained on the landscape, fires must occur within the CWH zone on an interval of less than the 700 to 800 year lifespan of the tree. The same study found that wildfire must occur in our coastal ecosystem for Douglas-fir trees to regenerate.

The Fire Environment

Historic Fire Weather Analysis

Weather conditions used to calculate fire behaviour were derived from historic records dating back to 1981 for two Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) weather stations. These stations were selected as they best approximate typical climate and weather conditions found in Surrey.

Table 9 MFLNRO weather station data

Station #	Station Name	BEC zone	LATITUDE	LONGITUDE	ELEV_M_	Start Year	End Year
72	UBC research station	CWH dm	49.265	-122.573	98	1981	2011
45	Saltspring Island	CDF mm	48.774	-123.474	34	2001	2011

Historical weather data was statistically analyzed for the months of May to September. The 80th percentile indices were used to represent the worst-case scenario for the fire weather conditions (Table 8). This information, in addition to ground fuel plot data, was used to model fire behaviour characteristics.

Table 10 Average fire weather indicies between the months of May to September

	Fine Fuel Moisture Code	Duff Moisture Code	Drought Code	Initial Spread Index	Build Up Index	Fire Weather Index	Relative Humidity	Precip. (mm)	Temp.
#72 - UBC Research Station (1981-2011)									
80th Percentile	86.4	34.3	275.6	3.1	49.0	8.0	87.0	3.3	23.1
Average	62.3	21.1	166.7	41.7	29.6	4.1	69.0	3.0	18.7
Maximum	97.1	148.3	615.6	42.8	173.7	34.8	100.0	100.8	37.4
#45 - Saltspring Island (2001-2011)									
80th Percentile	87.0	92.2	554.2	5.8	99.2	20.1	71.0	0.5	21.8
Average	76.6	40.6	370.0	3.8	60.7	11.4	65.5	1.1	18.5
Maximum	94.9	153.0	802.1	16.2	203.4	42.0	100.0	34.2	35.0

Fire History

The Ministry of Forests maintains a record of all historic wildfires that have occurred in the province. There have been very few wildfires in and adjacent to the City since records have been kept. The majority of wildfires include lighting strikes that cause small spot fires. Fall of 2012 was one of the driest periods for the coast in recorded history. There were 265 wildfires that occurred in the Coastal region. A number of these started on the North Shore of Vancouver including a ground fire in Maplewood Conservation Area. This is a wet floodplain area that normally has low fire behaviour potential. The unusually dry period and resulting wildfire risk in typically low risk fuel types highlights the importance of long term planning and consideration of climate change.

Local Fuel Types

Sixteen national benchmark fuel types are used by the Canadian Fire Behaviour Prediction System (CFBPS). This system classifies fuels into five major groups and 16 more specific fuel types. Classification is according to stand structure, species composition, surface and ladder fuels and the organic (duff) layer. Fuel types were derived using field reconnaissance and air photo interpretation. Each fuel type represents a different fire behaviour pattern. They may not necessarily match the fuel types described in the CFBPS; however, they are the closest profiles available

Table 11 Fuel type classification and representative areas found within the City of Surrey

Fuel Type Classification	Total Area (ha)	% of Total Area	% of Natural Area
O-1b (Open grass)	5389	17.2%	37.9%
C-2 (Multi-canopy coniferous)	92	0.3%	0.6%
C-3 (Dense multi-canopy coniferous)	768	2.5%	5.4%
C-5 (Mature coniferous)	176	0.6%	1.2%
C-7 (Open coniferous)	450	1.4%	3.2%
M-2 (Mixed coniferous/ deciduous)	1713	5.5%	12.0%
D-1 (Deciduous dominated stands and shrub)	5640	18.0%	39.6%
N (Non fuel areas)	17080	54.6%	
Total	31306		

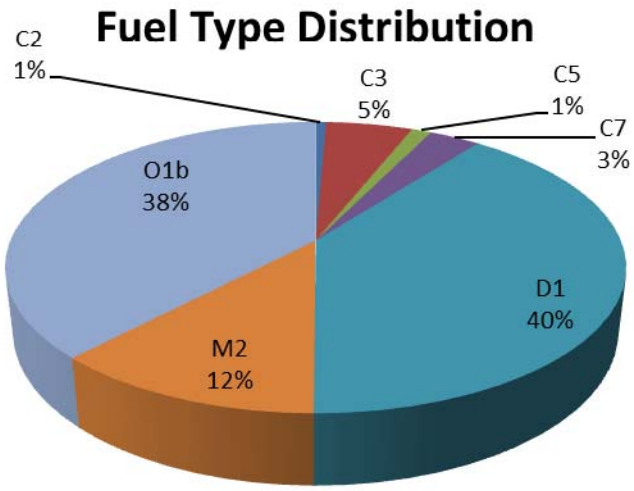

Figure 7 Fuel type distribution of natural areas in the City

One half of the City's area is not classified as a natural fuel type. These areas include mostly developed areas and water. The most common natural forest areas found in the City are deciduous dominated stands (40% of natural fuels). These stand types generally pose a low wildfire risk. Fuel types that pose the greatest risk include the closed coniferous stands classified as C2, C3 and C5. Together, these stand types represent 3.3% of the land area and 7.2% of natural areas. These fuel types are the focus for wildfire risk mitigation.

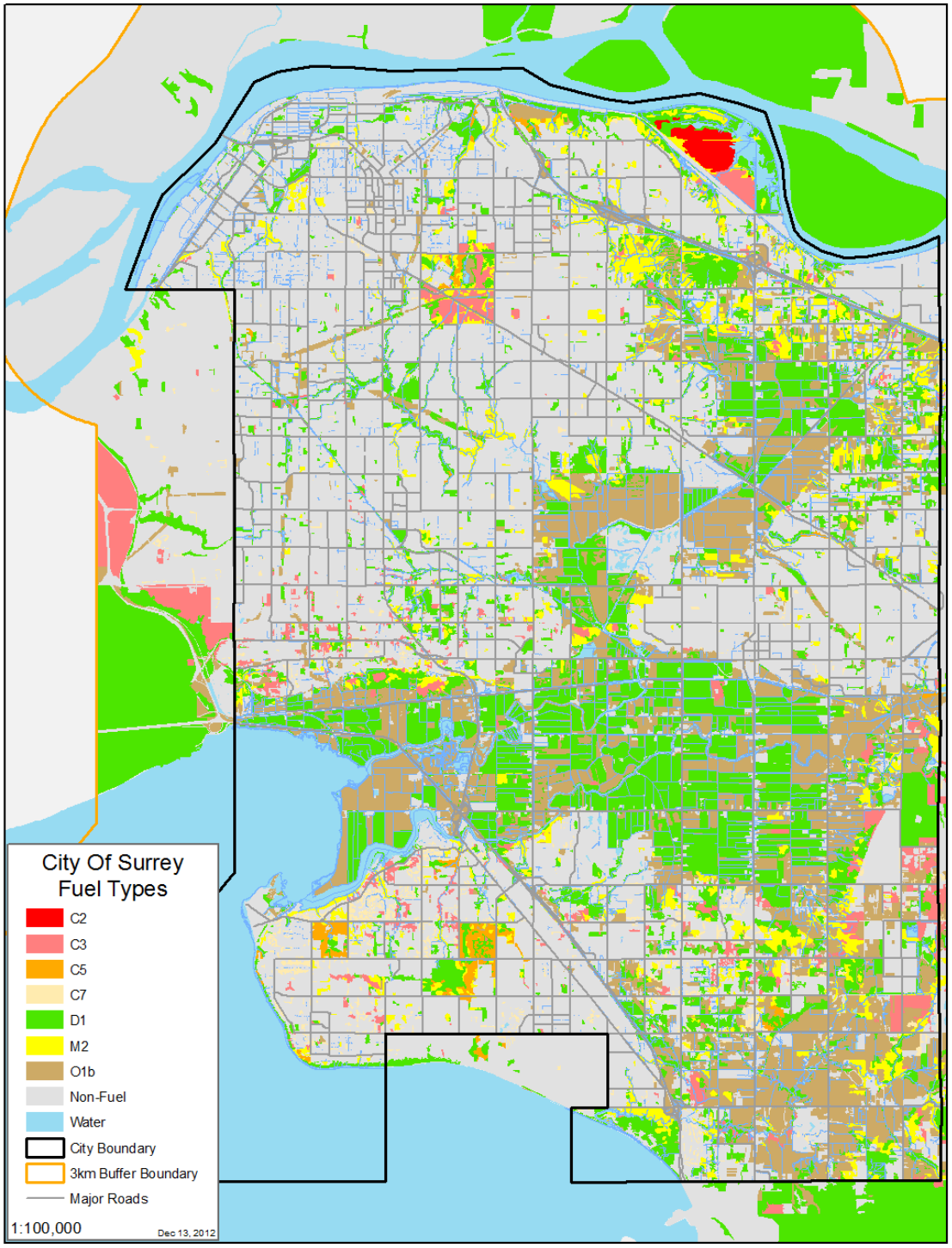

Figure 8 Map of fuel types in and adjacent to the City

Fuel Type C-2 – Multi-canopied coniferous stands

These fuel types are characterized by moderately dense coniferous stands. Most trees have crowns that extend to, or near, the ground. These stands have high ladder fuel loading that provides conditions for a moderate to high intensity crown fires. Moderate volumes of downed, woody material are often present.

Fuel Type C-3 – Dense multi-canopied coniferous stands

These coniferous stands are generally dense with closed canopies. Stands tend to be dominated by a mix of mature Douglas-fir, western hemlock, and western redcedar. There are intermediate and suppressed conifers that create a multi storied canopy. The height to the main canopy is generally greater than five meters, but the presence of understory conifers or tall shrubs can contribute to ladder fuels. Low to moderate volumes of downed, woody material are often present.

Fuel type C-5 – Mature dense conifer stands

This fuel type is characterized by older even aged second growth Douglas-fir, western hemlock and western redcedar trees. These stands have a moderate number of stems per hectare (<500 ha) and are generally tall (>30 m). Natural shedding of lower branches (usually due to lack of light) on these large trees has created an open understory. Height to live crown is often greater than ten metres. Shrubs predominate in the understory. Fire potential is generally moderate in these areas due to difficulty of ground fire spreading into the crown of conifer trees.

Fuel type C-7 –Open coniferous

This fuel type is characterized by open stands of coniferous trees. Crowns of individual or small groups of trees are separated by canopy gaps. In the City, these include mostly mature trees growing as clusters among low density residential development. There is generally low ground fuel loading. Dense pockets of conifers associated with this fuel type have a high fire behaviour potential, but fuels are discontinuous.

Fuel Type D-1 – Deciduous dominated stands and shrubs

These stands consist mostly of deciduous species including red alder, bigleaf maple, paper birch, cherry and black cottonwood. Deciduous species are not as flammable as conifer species; therefore, they do not contribute to high fire behaviour potential, particularly in wetter ecosystems. Understory vegetation can be lush and rich with a high moisture regime throughout the year. These stands pose a low fire behaviour potential and have proven to be effective canopy fuel breaks due to their low volatility and their association with wetter understory environments. All shrub communities and row crops have also been classified as a D-1 fuel type, since crops are well irrigated.

Fuel Type M-2 – Mixed deciduous/conifer stands

These fuel types are characterized by stands consisting of a mix of native conifer and deciduous trees. Coniferous trees in these stands are generally discontinuous and there are scattered canopy gaps which breaks horizontal fuel continuity. Pockets of ladders fuels are present consisting mainly of suppressed conifers and the lower branches of mature conifer trees.

Ground fuels are generally moderate and discontinuous. Fire behavior potential in these stands is moderate and is dependent on the distribution of coniferous species.

Fuel type 01b – Grassland

This fuel type is characterized by non forested areas dominated by non managed grasses and herbs. In Surrey many of these areas include agricultural pastures and old fields. Many are located in lowland areas or along BC Hydro Right of Ways.

Fuel Type C7

Fuel Type C3

Fuel Type M2

Fuel Type C5

Fuel Type O1b

Fuel Type D1

Figure 9 Photos representing fuel types in the City

Landscape Level Wildfire Risk Analysis

The "Wildfire Risk Analysis" (WRA) is a GIS based decision-making tool that spatially identifies the severity of wildfire threat on a landscape level. The overall risk ranking is a cumulative 'score', based on four key components (Appendix A provides a detailed methodology). Each component is weighted according to its contribution to the final ranking:

1. Fire behaviour characteristics (40%);
2. Risk of ignition (10%);
3. Threat to structures, natural features and cultural features of significance (25%); and
4. Suppression constraints (25%).

The WRA provides a landscape level overview of the risk posed by a potential wildfire. It provides valuable direction for land use planning on a broad scale. However, due to the coarse scale of the input data, its application to site specific treatments is often limited. The WRA can be used to identify high risk areas and to highlight factors that are contributing to this risk. All areas within a three kilometer buffer around the City have been included in this analysis

Fire Behaviour Potential

Results from this fire behaviour modeling are illustrated in Figure 11. These values are calculated using a Canadian software model (Canadian Forest Fire Behaviour Prediction System) which accounts for fuel classification, slope, aspect and high risk weather conditions typical of the area. The fire behaviour map can be used in three ways: to determine the location of high fire behaviour areas that require treatment, to assist in the safe development of future neighbourhoods and to demonstrate to public and private landowners where fire risk and fuel hazards exist.

Fire behaviour potential is quite low across most of the City. The 80 percentile fire weather indices which represent the driest periods on record are relatively low compared to many other areas of the province. This is due to the moderate temperatures and high rain fall that the coast experiences. A majority of forested communities have a high deciduous tree component which does not readily support wildfires. Also terrain is generally flat with few steep slopes.

91% of natural areas analysed have low fire behaviour potential. This includes mostly deciduous forest, grasslands and shrub communities. The remainder of natural areas have a moderate to high wildfire risk. Only 1.6% of natural areas pose a high risk.

Table 12 Summary of fire behaviour potential for natural areas

Fire Behaviour	Total Area (ha)	% of total area
Low	12,999	91.4
Medium	104	7.1
High	221	1.6
Very high	0	0
Total	14,223	

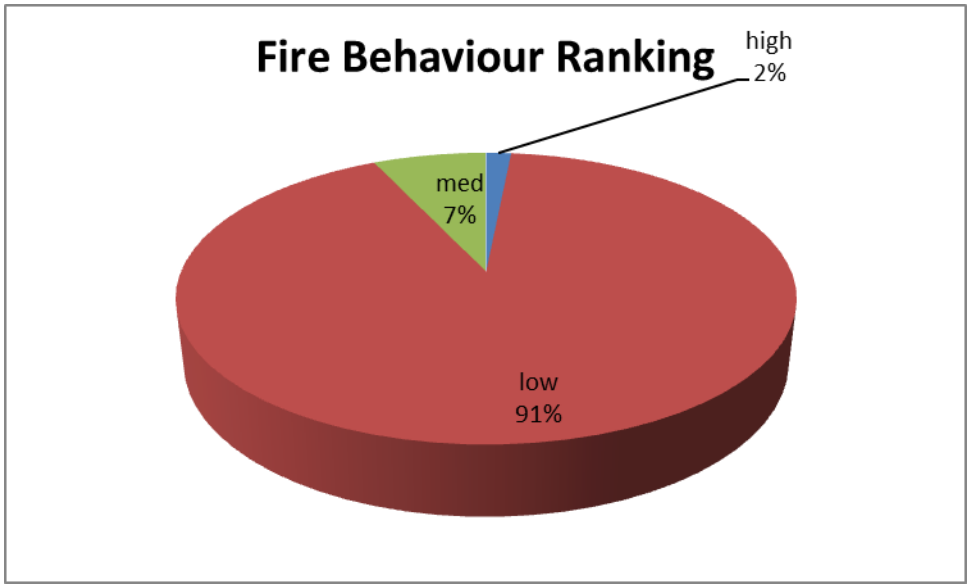

Figure 10 Distribution of fire behaviour potential of natural areas

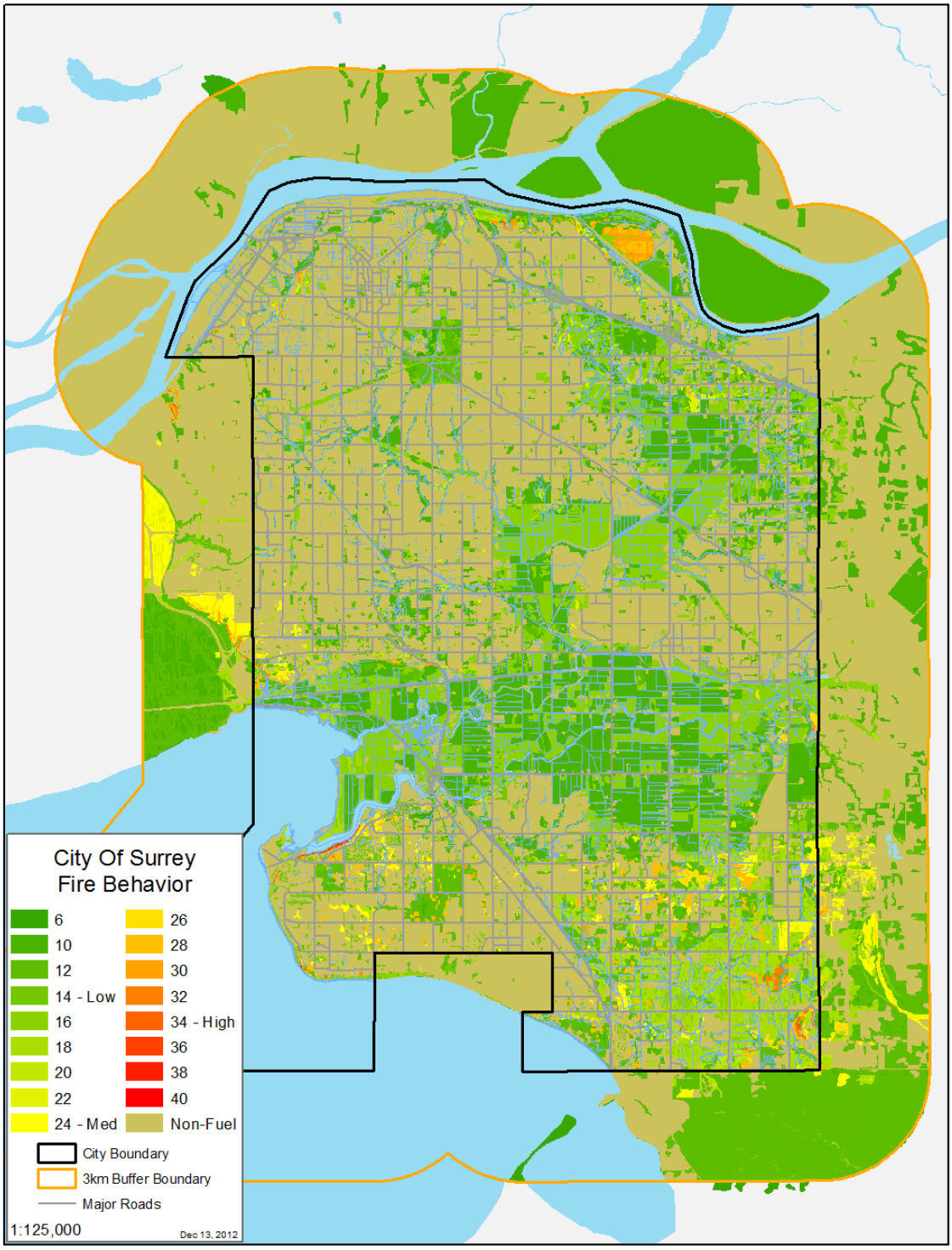

Figure 11 Wildfire Risk Analysis - Wildfire Behaviour Ranking

Values at Risk Component

The Values at Risk component incorporates significant man made structures, critical natural and archaeological features that would be detrimentally impacted by a wildfire. This component illustrates the concentration of values that are at risk in the interface areas. It defines what the potential consequence of a wildfire would be and helps to prioritise resources for reducing risk in the City. The results from this analysis are illustrated in Figure 14 and Figure 15.

Structures at Risk

There is very little natural forest area remaining in the City. Most land within City limits has been developed (~55%) or is being used for agricultural practices (~23%). The majority of structures in the interface areas are residential developments. Most of these developments have a defined perimeter (roads) between the forested area and structures.

A small percentage of structures are intermixed among high risk fuel types. These properties tend to have larger lot sizes with more forested areas between structures. Intermix areas are tactically more challenging to protect as ignitions can occur on all sides, from nearby adjacent structures and from spotting. Also, because the majority of the area is privately owned, ensuring the treatment of these areas is more challenging.

Figure 12 Photos illustrating structures intermixed among high risk fuel types

Creating effective fuel breaks and defensible space is critical to reduce risk of wildfire spread. Defined perimeters help protect interface structures from radiant heat, slow the rate of fire spread, and provide a safe and defensible space from which suppression personnel can fight fires.

All structures within the urban-wildland interface were inventoried as a part of this analysis. Natural areas within 100 metres of structures have been categorised by fire behaviour potential. 11% of the urban-wildland interface poses a moderate to very high fire behaviour risk.

Table 13 Summary of fire behaviour potential within the urban-wildland interface

Fire Behaviour	Total Area (ha)	% of total area
Low	6355	89.4%
Medium	632	8.9%
High	124	1.8%
Very high	0	0%
Total Area	7111	

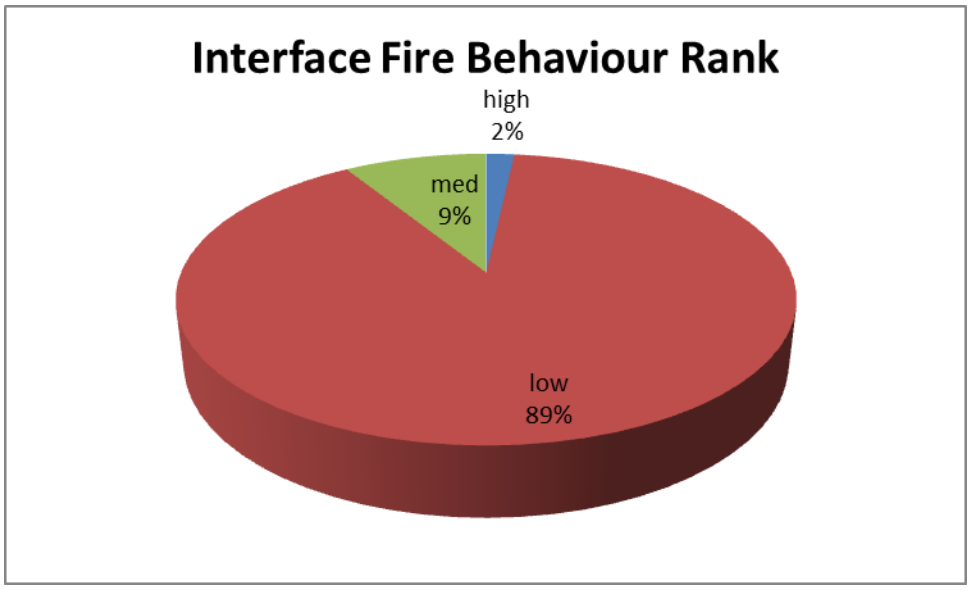

Figure 13 Distribution of fire behaviour potential in the wildland interface

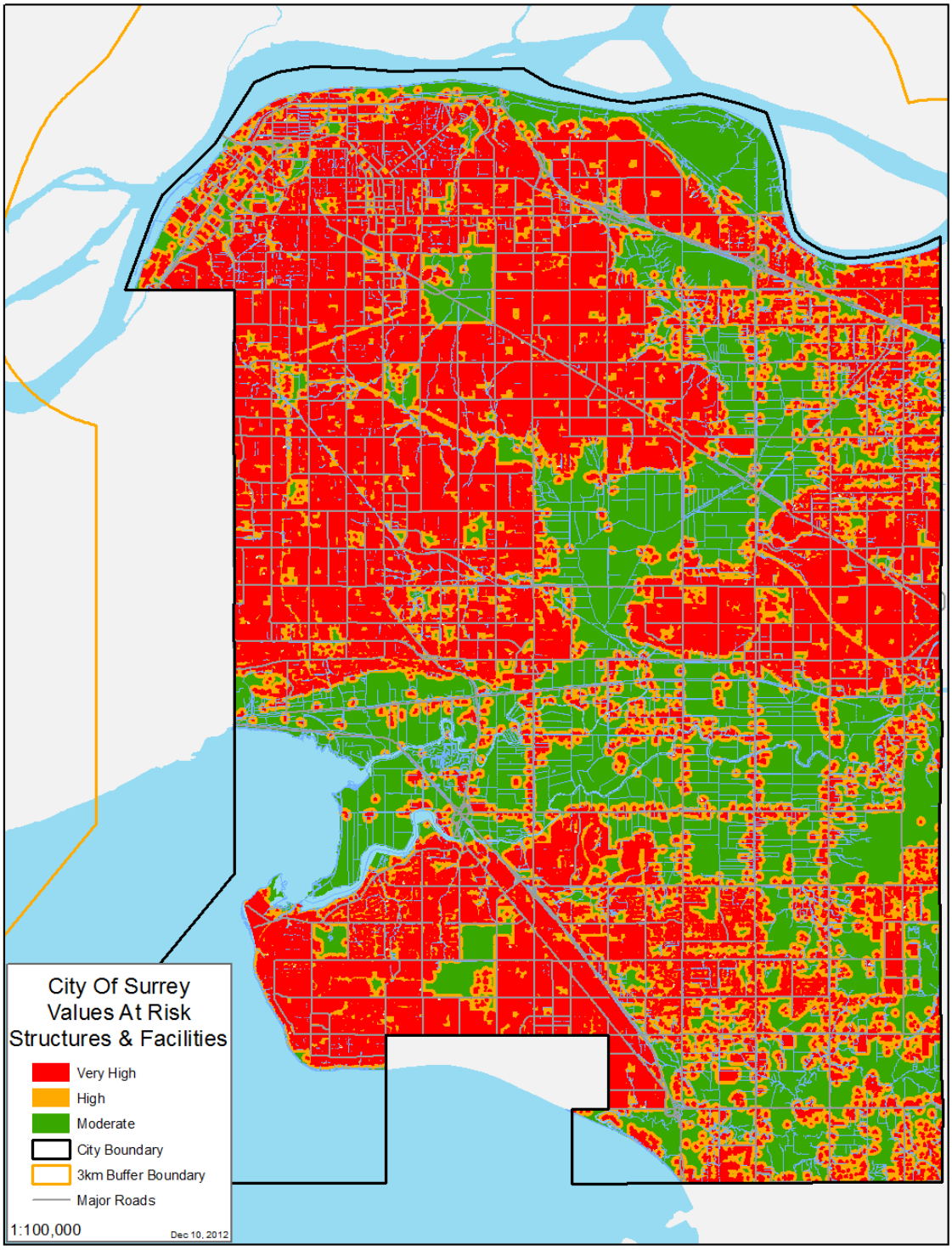

Figure 14 Wildfire Risk Analysis - Structures and Facilities at Risk Ranking

Natural and Cultural Features at Risk

Natural and cultural features were ranked according to their rarity and sensitivity to human impacts. Natural features include recorded rare and endangered species and their habitat, rare plant communities, mature forests, wetlands, riparian areas and raptors nests. These are found throughout the City concentrated in the existing large natural areas.

Archeological sites include those documented with the provincial government. It should be noted that First Nation values are often not available through the provincial government data bases due to the sensitive nature of the information; therefore, this information is not accounted for in this analysis. In the event there is a wildfire, the local First Nations should be contacted to ensure the local knowledge of cultural features is accounted for.

The protection of these features must be considered when planning any fuel mitigation or ecosystem restoration works. If planned works may negatively impact the natural features at risk, alternatives should be considered such as creating a fuel break around the area to protect it from an adjacent fire, reducing suppression constraints by improving access and increasing water availability or by mitigating the risk of ignition by reducing causes of ignition within and adjacent to the area.

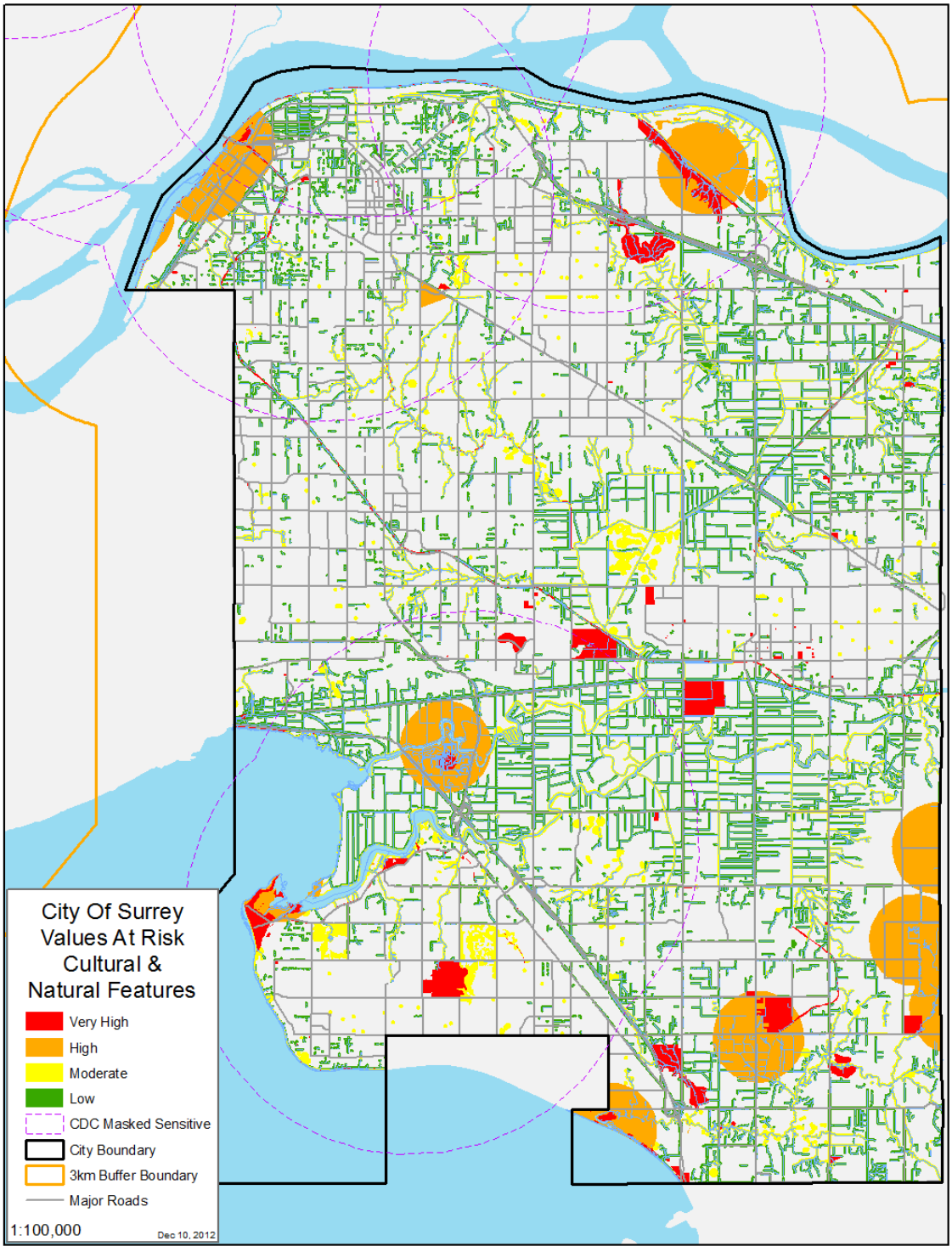

Figure 15 Wildfire Risk Analysis - Natural and Cultural Features Ranking

Risk of Ignition

The Risk of Ignition component accounts for both human and lightning caused ignitions. Results from this analysis are illustrated Figure 17. Lightning caused ignitions pose a low risk across most natural areas with tree cover. There have been relatively few lightning caused fires in the City due to infrequency of lighting and the predominance of the deciduous fuel type. However, there is an abundance of human caused ignition sources in densely populated urban areas, including:

- Heavy industry activity;
- Discarded cigarettes and matches;
- Vehicle traffic;
- House related fires;
- Power lines;
- Camp fires;
- Vandalism; and
- Railways.

The most common human caused sources of ignition is from machinery and discarded cigarettes along roads and recreation trails in forested areas. Also, development in the interface of natural areas poses a significant risk from sources such as house fires, BBQs and landscaping equipment.

Douglas-fir tree struck by lightning in 2012

Trees falling on power lines pose a risk of ignition

Figure 16 Photos illustrating risks of ignition

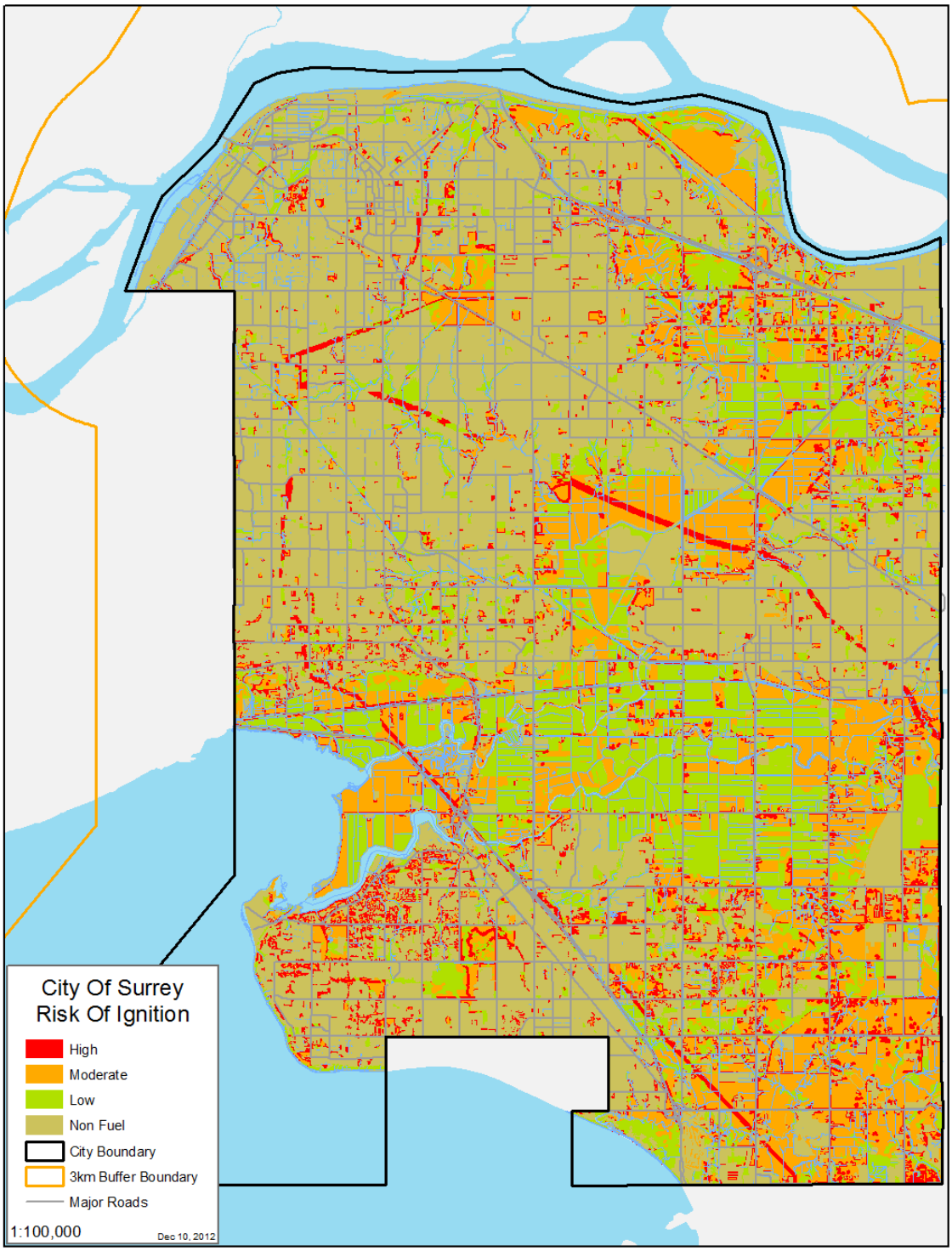

Figure 17 Risk of Ignition Map

Suppression Constraints

Suppression Constraints indicate areas where undertaking suppression activities may be difficult. These areas are generally associated with poor access, steep slopes or a lack of water sources. Overall, suppression constraints in the City are low in well developed areas which have an established water hydrant system and extensive road network. Results from this analysis are illustrated in Figure 18. Areas of concern include the interior forests of the large urban forests and parks.

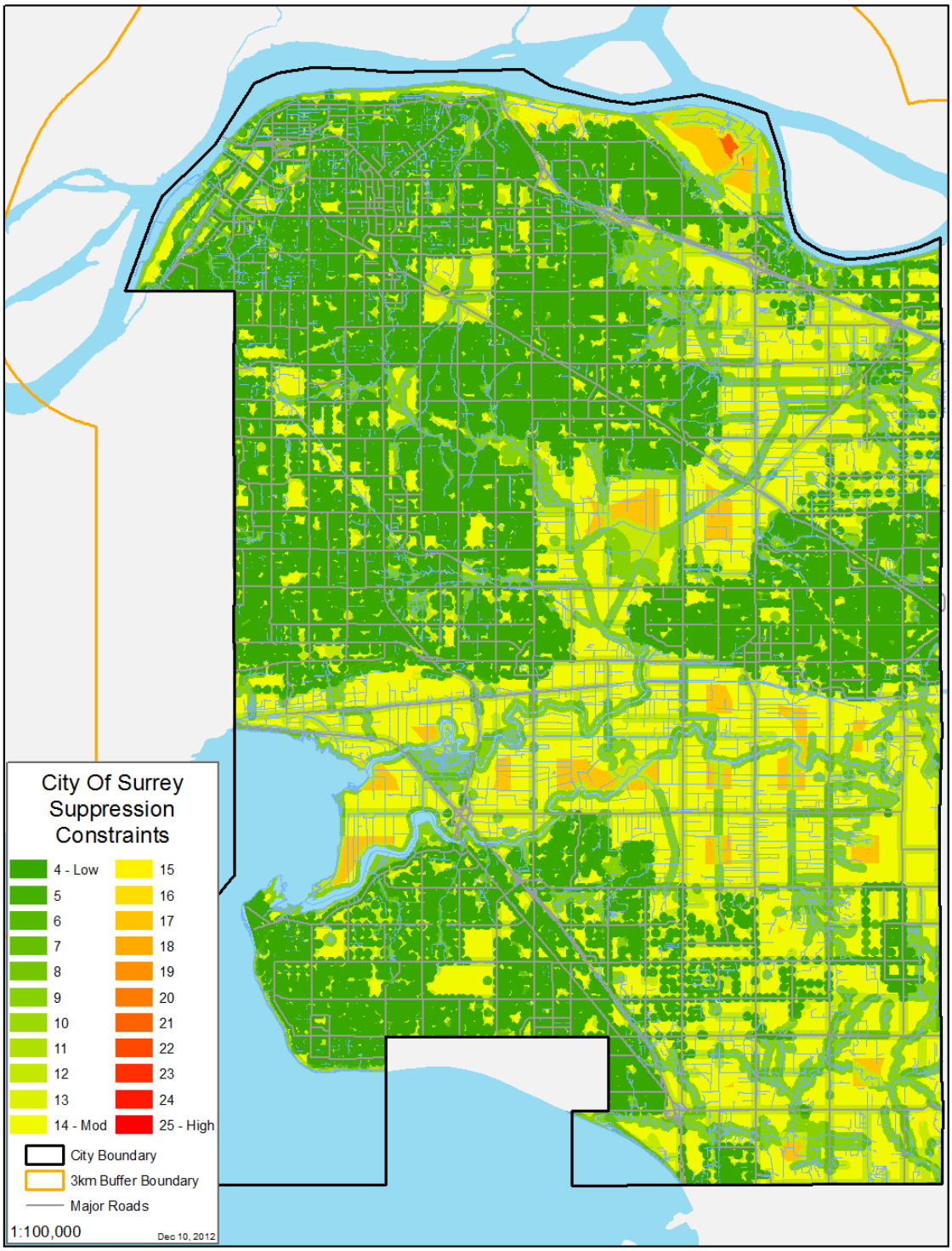

Figure 18 Suppression Constraints Map

Final Wildfire Risk Analysis

The final wildfire risk analysis is a cumulative ranking based on the four contributing components. Results from this analysis are illustrated in Figure 19. Forested areas with a conifer tree component growing within 100 metres of any structures are highlighted as high risk areas. This emphasizes the importance of managing interface fuels as new areas are developed. Risk is best mitigated through fuel treatments within this interface area. However, many of these areas are on private land. Public education, partnerships and support from the City will be required to successfully reduce the risk in these areas.

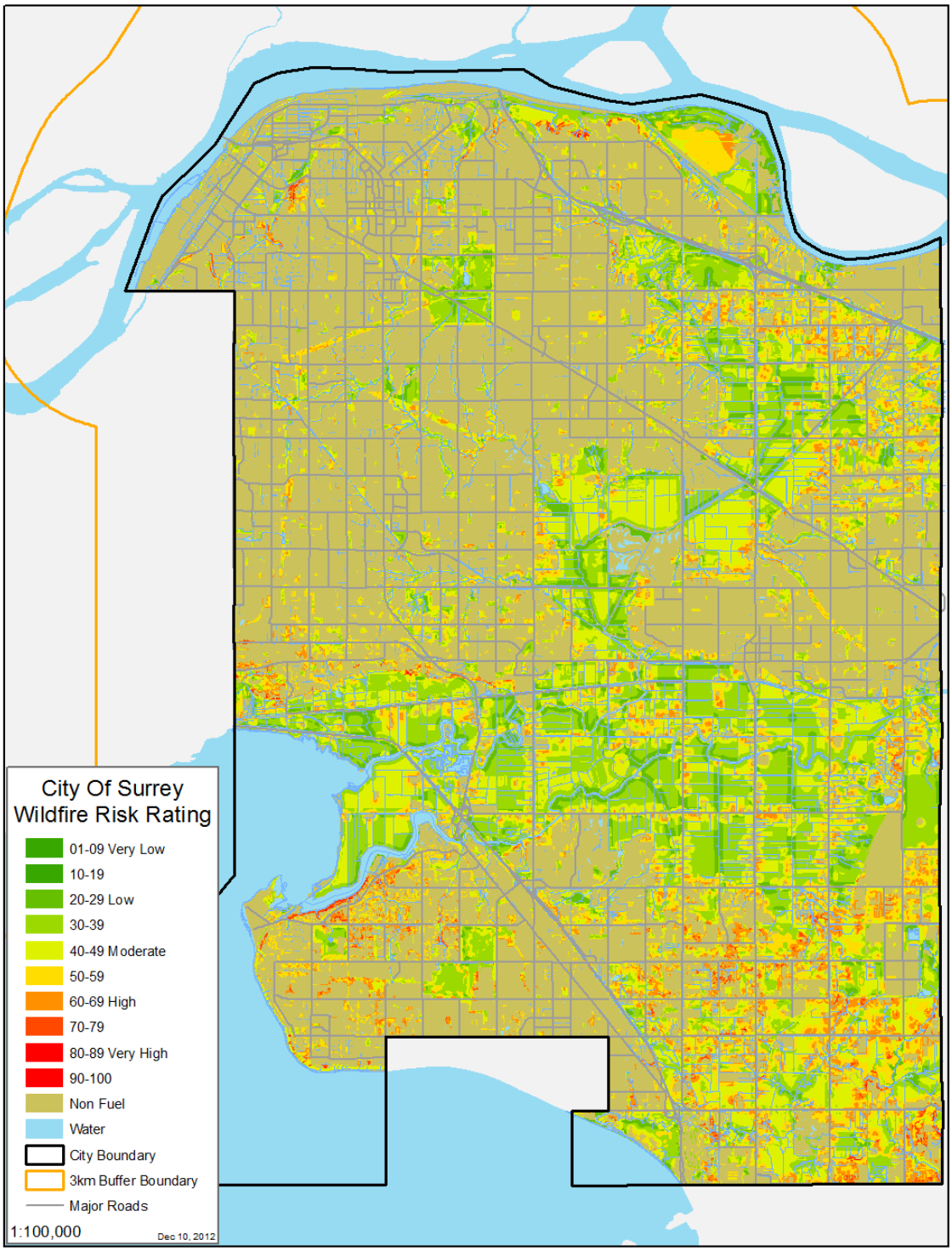

Figure 19 Wildfire Risk Analysis Map

Interface Fuel Hazard Assessments

All City-owned forested lands with a moderate to high wildfire behaviour risk and within 100m of any structures were identified as candidate polygons requiring an interface fuel hazard assessment. These areas were evaluated using the provincial assessment system outlined in the "Rating Wildfire Interface Threats in British Columbia" (MOFR 2008). Rankings from this assessment resulted in a prioritized list of areas for treatment. These treatment areas were then compiled along with their attributes into a GIS database and labelled according to their priority ranking. The results from these assessments are found in Appendix B. Priority areas recommended for treatments are illustrated in Figure 20.

Most of these interface areas are within protected parks and urban forests. However there are some large forested lots located in the southeast corner of the City that are owned by the City but are not protected as parkland. There is the potential that these lots will be cleared for development. Treatments options in these areas should only be implemented once land use has been decided.

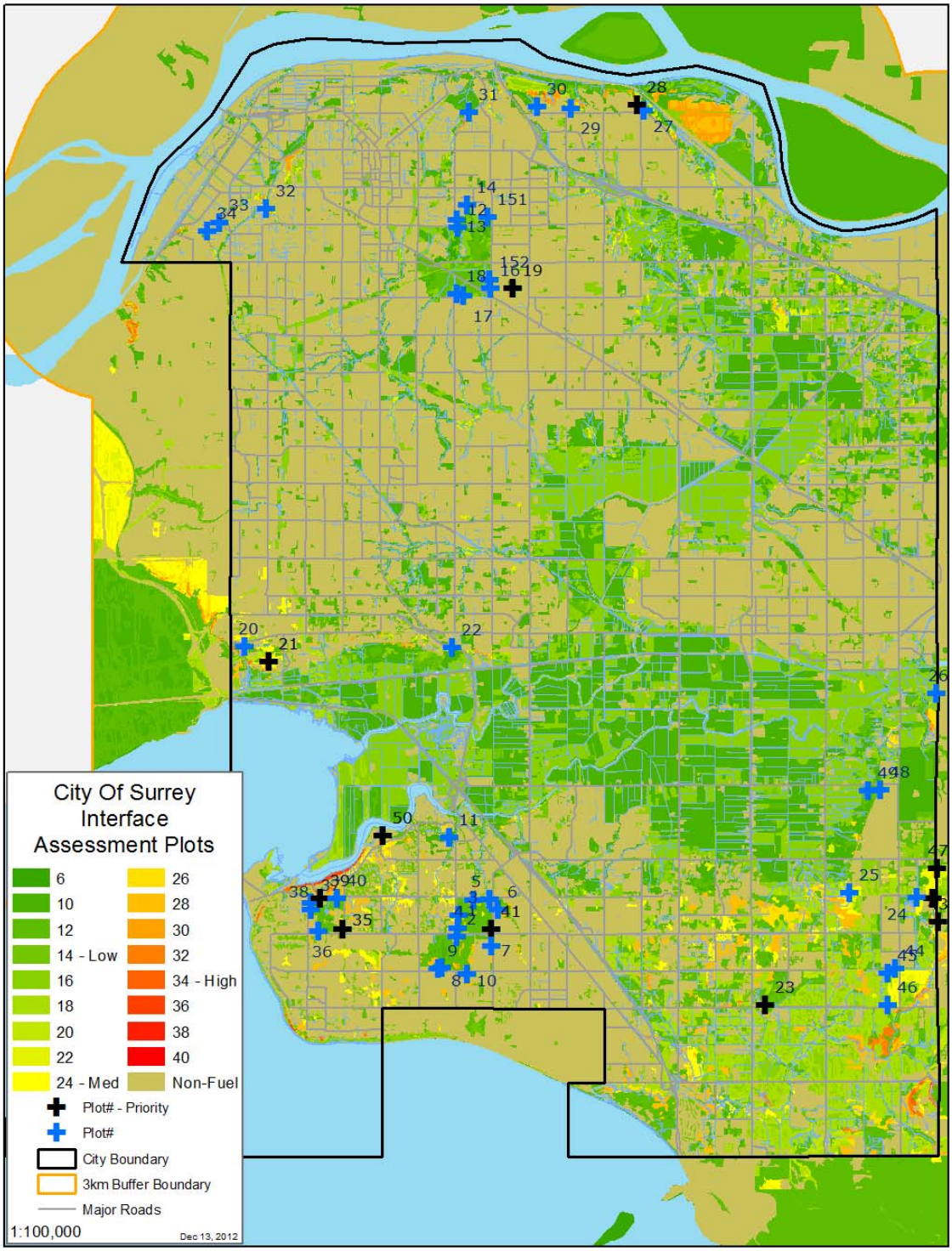

Figure 20 Wildland Interface Assessment Plot Locations

Strategies to Reduce Wildfire Risk

We have the ability to modify only certain factors that contribute to overall wildfire risk. Terrain, weather conditions, or the location of existing structures are difficult to alter. Land use planning strategies should focus on addressing those contributing factors that can be easily modified and will have significant impacts in terms of risk reduction to effectively mitigate wildfire risk. Strategies include changing fuel profiles, improving access, increasing water availability and reducing the number of ignition sources.

Modifying the Fuel Profile

Large, contiguous tracts of forested natural areas dominated by confers tree species in and adjacent to the City are the priority for risk mitigation. Wildfires in fragmented natural areas are easier to control and less likely to build up to a considerable size. Larger tracts of forested land have the potential to build quickly and have a higher spotting potential into the interface areas.

Within City limits, there are four areas with relatively contiguous natural forest that pose a significant risk on a landscape level. Green Timbers Urban Forest is located in north Surrey. It supports numerous mature coniferous dominated stands. The area has two major roads and one BC Hydro Right-of-Way running through it. These routes will act as fuel breaks and defence anchor points for fire fighters. However, there is still a risk of spotting (wind spread embers) across adjacent urban development. The urban forest has multiple walking paths throughout that would support ATV access. There is access to fire hydrants around the perimeter of the Park.

Figure 21 Air photo of Green Timber Urban Forest

Sunnyside Acres Urban Forest is a large natural area located in southwest Surrey. This area has one main road (24 Ave) running through the forest. There are mature coniferous dominated stands in this forest with pockets of deciduous stands which help to reduce the rate of wildfire spread. Phellinus root rot is common throughout Sunnyside. These historical root rot pockets have caused Douglas-fir mortality, which have been replaced by deciduous trees. Large woody debris has accumulated as a result of this disease. Numerous trails are already built throughout the site that allow for ATV access to aid suppression activities.

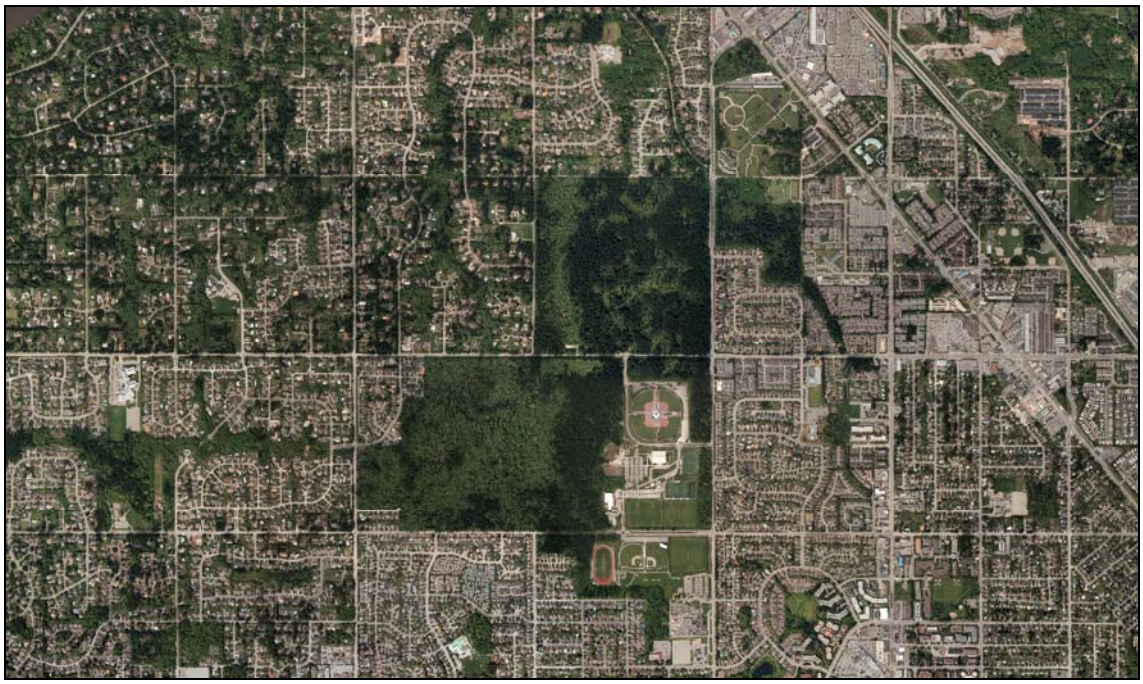

Figure 22 Air photo of Sunnyside Acres Urban Forest

Crescent Park is a large forested natural area located in southwest Surrey. Its coniferous stands are similar in nature to those in Sunnyside with tall mature trees and scattered incidences of Phellinus root rot. This park is smaller than the previous two urban forests and also has numerous trails located throughout the park. These trails are able to support ATV access and can act as fuel breaks and anchors for suppression activities. Crescent Park has two large deciduous stands and two landscaped fields that aide in breaking up the mature coniferous forest.

Figure 23 Air photo of Crescent Park

The forested natural area east of the Port Mann Bridge includes mature forest growing on a moderate to steep slope below residential development. These pose a risk due to the direct interface and steep slope. However, the forest in these areas is mixed with deciduous trees that break up the continuity of the stand.

Surrey Bend is located to the north east of the City and supports stands of conifers that pose a moderate to high fire behavior potential. Much of this area is classified as a bog. However a crown fire that established in this stand could spread and be difficult to suppress due to the isolation of the park. This area is separated from the adjacent residences by the Fraser perimeter road which provides an effective fuel break and defensible zone.

In addition to protected areas, there are a number of large coniferous dominated stands that are on private owned or City owned land that is not protected. The most significant include stands of trees in the Campbell Heights industrial neighbourhood. Some of these stands continue into the adjacent municipality of Langley.

Figure 24 Air photo of Campbell Heights neighbourhood

Interface Fuel Treatments

Fire behaviour potential can be effectively reduced by altering the fuel profile (the density, vertical and horizontal continuity) in high risk areas. This can be accomplished through fuel treatments such as harvesting, thinning, pruning and by reducing surface fuel loading (pile burning, prescribed burning, chipping/grinding, etc.).

Many of the interface areas that pose a high risk are not owned by the City. Treatment of these areas will require public education and consultation with private landowners. In these areas, a representative of the City and the Fire Department should meet with landowners in high risk areas and discuss in detail the recommended treatments to create a defensible space around their property.

While there is no fuel treatment that can produce a 'fire proof' forest stand, it is feasible to modify stands to a more 'fire safe' condition. This can be achieved by altering species composition, stand structure and the characteristics of fuel loads such that a crown fire is unlikely to occur. Fuel treatments general involve stand thinning and tree pruning. Thinning treatments should reduce the stand density enough that a crown fire cannot spread from crown to crown. Suppressed and intermediate trees are usually removed to reduce fuel loads in the lower canopy. Trees that are left should be pruned to remove live or dead branches that could act as ladder fuels. Pruning also increases the crown base height which reduces the chances of a ground fire reaching the canopy.

Residual material from treatments must be either chipped on site or removed and disposed of off site. Chipping should be managed so that the chips are discontinuous and do not reach a depth of greater than 5 cm. Controlled burning (e.g. prescribed fires and pile and burning) is not possible within the City boundaries due to risk management and air quality restrictions.

FireSmart recommends treatments around structures in three 'priority zones'. Treatments involve fuel removal, fuel reduction, and fuel conversion. Priority zones are based on distance from the structure, and the slope below the structure, and are defined as:

- Priority Zone 1 (within 10 m from structures): Establish a fuel-free zone immediately adjacent to all buildings. Remove all flammable fuels from this area;
- Priority Zone 2 (10-30 m from structures): Increase fuel modified area by reducing flammable vegetation through thinning and pruning and produce an environment that will only support low-intensity surface fires;
- Priority Zone 3 (30-100 m+ from structures): Eliminate the potential for a high-intensity crown fire through thinning and pruning, thereby slowing a fires approach towards structures.

The area within 30 meters of the structures (Priority Zones 1 and 2) should be treated aggressively to create a defensible space between the structures and the adjacent stand. Treatments in Priority Zone 3 should not be as intensive, but should still reduce the potential for a crown fire.

Slope of terrain has a strong influence on fire behaviour. The rate of spread (ROS) of a fire doubles for every 30% increase in slope up to 60%. Recommended treatment zone distances around structures should be adjusted accordingly. Steeper slopes should be treated to a further distance, thinning should be to a lower density and pruning height should be higher. Distance and extent of treatment should be determined by a fire behaviour specialist and clearly described in the fuels treatment prescription. Fuel treatments should not be implemented uniformly, but should mimic natural stand structure by producing canopy gaps to help break up the canopy fuel mass. Shape, size and distribution of these gaps should be strategic to slow and direct fire spread.

Fuel Treatment Prescriptions and Target Stand Conditions

The primary goals of interface fuel treatment are to prevent the occurrence of a crown fire, reduce surface fire intensity and to improve suppression capabilities. An objective-driven fuel treatment prescription should be carefully developed and followed to achieve these goals. A proper prescription includes a detailed description of the present stand, target stand conditions, and operational activities to be implemented.

Many of the areas that are recommended for mitigation in the City are within protected natural areas. The ecological integrity of these sites must be considered when prescribing fuel treatments. Removing mature trees in these natural areas will cause extensive ecological damage. In many of these areas the treatments should focus on mitigating ground and ladder fuels.

Specific target stand conditions (TSC) should be developed that will reduce fire behaviour sufficiently to minimize the potential of a crown fire under hazardous (90% percentile) fire weather conditions. Recommendations should also include a monitoring program to help determine the success of the project. These prescriptions should be developed by a Professional Forester with wildfire management experience.

Following are considerations and recommendations for future treatments on City owned lands.

- Create an effective defensible space within 10 meters from structures. The majority of standing fuels should be removed from within this area.
- Where feasible, surface firebreaks should be created within 30m of structures to stop the spread of surface fires.
- The height of pruning should be dependent on the slope of the terrain and the surface fuel loading. Generally, 3-5 m is usually adequate on flat ground; however, this should extend to 3-5m on steeper slopes. Target pruning heights refer to the lowest part of each branch.
- Thinning should generally be less uniform with scattered canopy gaps to create crown fuel breaks and to promote the establishment of small shrub/herb communities.
- Strategic firebreaks should be created to help stop the spread of potential ground fires.

Number	Action Item	Priority
Rec # 3	Treat all City owned interface polygons that were identified as posing a risk of moderate to high	A
Rec # 4	Pursue opportunities for Fuel Reduction Pilot Projects through the UBCM	A
Rec # 5	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
Rec # 6	Enhance recreation trails in strategic locations in the urban/wildland interface that act as surface fuel breaks and improve access for suppression resources	B

Wildfire Suppression

When a catastrophic wildfire occurs, lack of preparation can quickly lead to panic and disorganization. This greatly increases the risk to human lives, structures and natural resources. Planning to manage a wildfire involves a great deal of uncertainty as it is difficult to predict the behaviour of wildfire and the public. Decision-makers must be highly organized and prepared so that evacuation and suppression response can occur as quickly and efficiently as possible.

Wildfire Detection and Reporting

The BC Ministry of Forests, Lands and Natural Resource Operations is the agency that is responsible for wildfire detection. Fires are located using a lightning locator system, aerial patrols and public observation. In urban centers such as Surrey, a wildfire is most likely to be detected and reported quickly by the public. Wildfire awareness signs should be posted at strategic locations (major transportation corridors, recreation areas and high use trail heads) that specify how to report a wildfire in the City.

All wildfires should be reported to the Provincial Forest Fire Reporting Center in Victoria through their toll free number 1-800-663-5555 or *5555 on a cellular phone. The agent will then collect as much information as possible regarding the fire and its characteristics including:

- The exact location of the fire;
- Its estimated size;
- The type of fuel burning;
- How fast the fire is spreading and in what direction;
- The colour of the smoke; and
- The location of any structures or lives at risk from the fire.

Initial Attack Preparedness

The closest Forest Protection Fire Crew base is in Cultus Lake (~75km). This base includes one unit crew of 20 people. Crew response departure times can vary from 5 to 60 minutes depending on alert status and weather conditions.

Within the City of Surrey, City Fire Department and Staff are trained to respond and control a wildfire that starts in or close to the urban/wildland interface. The Department has 17 fire stations located strategically throughout the City. There are 342 full time personnel and 88 paid-on-call volunteers. Each station has a full complement of modern, up-to-date vehicles and equipment. The City has one wildland interface vehicle designed for fighting wildland fires. In addition, the parks department owns all terrain vehicles with portable tanks for travel along recreation trails. Based on the level of risk present, the existing interface suppression vehicles and equipment is considered sufficient.

Proper training, equipment and suppression protocol will ensure an efficient and effective response. All fire department staff working in interface areas should receive basic level fire suppression training at least once every two years. This training will ensure that if a staff member is the first on site, they will have the knowledge and ability to safely extinguish or

control the fire until more resources arrive. There are a number of training courses available through the BC Wildfire Management Branch. The required level of training is the S-100 "Basic Wildland Fire Suppression and Safety."

Standard suppression equipment should be kept in strategic locations in large urban forests and parks. This equipment should be inspected and maintained annually. At a minimum, strategic locations should include stands outlined in the "Wildfire Act" and equipment should include basic hand tools, fire extinguishers and communication devices.

Number	Action Item	Priority
Rec # 7	All Fire Department staff who work in the interface areas should receive basic level fire suppression training (S-100) at least once every two years	B
Rec # 8	Basic suppression equipment should be kept in strategic locations around large urban forests and parks.	A

Inter-Agency Cooperation

The Wildfire Management Branch (WMB) mandate is to fight forest fires throughout the province. Local municipal governments are mandated through the *Local Government Act* to establish fire departments that are responsible for fire prevention and suppression. Municipal fire departments are better equipped to fight structural fires, whereas the WMB is trained in wildland fire suppression and maintains equipment that is more suited to suppressing wildland fires. Interface fires, however, involve both wildland and structural fires. A large wildfire event will require the cooperation between both agencies. Therefore, ongoing interagency training should take place between the local WMB and the City Fire Department.

Vegetation adjacent to transportation corridors acts as an ignition source and a fuel hazard. This includes cured grass and woody material from tree removals. The City should ensure that grass is maintained and that all tree cutting is cleaned up adequately along roadways.

BC Hydro has numerous transmission lines in the City. These transmission lines represent potential ignition sources. With proper vegetation maintenance these right-of-ways can become effective fuel breaks. Vegetation management is required along all transmission right of ways. The City should ensure that BC Hydro abate this fuel hazard during their vegetation management operations.

Number	Action Item	Priority
Rec # 9	Interagency wildfire suppression training should be coordinated between the Wildfire Management Branch and the City Fire Department	B
Rec # 10	Ensure that BC Hydro and FortisBC abate fuel hazards during their vegetation	B

Number	Action Item	Priority
	management operations along their transmission right of way	
Rec # 11	Ensure that grass is maintained and that all tree cutting is cleaned up adequately along roadways	A

Improving Access

The road network serves several community needs including providing access for emergency vehicles, escape routes for residents and fuel breaks. Communities with narrow driveways and dead-end streets impede fire suppression efforts. Wildfire risk can be reduced by careful planning of access systems (road and trails) associated with development. Access roads can act as fuel breaks for surface and crown fires, and can also provide control lines for suppression efforts. Following is a list of required road standards that will facilitate suppression vehicles and public evacuation in the case of a wildfire:

- Roads should provide safe simultaneous access for emergency vehicles and public evacuation with a minimum width of 6.1 metres excluding parking;
- Road curvature radius should be at least 30 metres, measured from the centre line;
- Road gradient should not exceed 10 percent;
- Dead-end roads should have a turnaround at the terminus having no less than 36 metres outside diameter of traveled way;
- Surrey fire service personnel shall be provided with keys to any locking mechanism on any gate restricting access to any road.

Number	Action Item	Priority
Rec # 12	Ensure all roads constructed in interface areas meet standards required for suppression vehicles	A
Rec # 13	Identify interface communities with one access route or cul-de-sac roads. Explore options to build alternative access to these areas.	C
Rec # 14	Encourage strategic recreation trail development in parks to a standard that supports ATV/UTVs.	B
Rec # 15	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

Water Availability

Water is the single most important resource for suppression activities. Where hydrant coverage is limited, particularly in rural settings, alternative water sources such as reservoirs, lakes and rivers should be located, assessed and mapped. These provide sites for helicopter bucketing and pump sites for suppression crews.

In addition, when new areas are proposed for developments, an adequate number of fire hydrants should be established in strategic locations in the interface zones. If possible hydrants

should be installed along strategic recreation trails systems in high risk conifers stands in urban natural areas.

Number	Action Item	Priority
Rec # 16	Identify areas with poor water availability and install hydrant systems or alternative water reservoirs	B
Rec # 17	Identify and map alternative water sources including reservoirs, lakes and rivers.	B
Rec # 18	Install fire hydrants to serve all new developments and existing interface areas that are deficient	B

Reducing Sources of Ignition

Sources of ignition can be human and lightning caused. Lightning caused ignition is difficult to predict or manage. Human caused ignitions, however, can be prevented and are the source of about one half of all provincial wildfires. The most common sources of human caused fires are listed in

Table 14. Common sources of Ignition

• Campfires; • Industrial activity; • Discarded cigarettes and matches; • Vehicle traffic	• Railways; • House related fires; • Power lines; and • Vandalism

Predicting and preventing human caused ignitions is the most cost effective component of any fire prevention program. This is best achieved through ongoing public education campaigns to reduce risk. Road side ditches and medians that contain grasses should be mowed prior to the fire season. This will reduce fuel loading (standing cured grass) and reduce the ignition potential associated with vehicles, heavy machinery and cigarettes during the fire season. Signs should be posted at 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.

There is also ignition potential from the numerous residences that back up against the interface. Private residents adjacent to wildland (grass or forested) should be reminded (e.g. through public bulletins or media notices) of common risks of ignition in these forested landscapes.

Trees can potentially fall on power lines, which can pose a fire risk. Risk is managed primarily by utility companies with regular assessments and tree hazard mitigation programs. The City should continue dialogue with BC Hydro to ensure they are removing hazardous trees from forested natural areas that could strike the power lines.

Number	Action Item	Priority
Rec # 19	Road side ditches and medians that contain grasses should be mowed prior to the fire season	B
Rec # 20	Engage in public education programs to reduce human caused ignition focusing on private residents that live in the urban/wildland interface	B
Rec # 21	Work with BC Hydro to ensure that distribution lines and transmission corridors are assessed regularly for tree risk and that the associated fuel hazards are abated	B

Wildfire Legislation

Wildfire risk is relatively low across the City. This level of risk does not warrant the introduction of new planning policy (Wildfire Development Permit Areas). Instead, planners should consult the wildfire behaviour map when approving new developments. When projects occur within 100 meters of any moderate to high risk areas, the principles of "FireSmart" should be enforced. These are summarised in Appendix D.

The *Wildfire Act* places responsibility for preventing wildfires clearly on the public, construction operators, and/or developers and provides an avenue for the government to charge for suppression costs and damages caused by accidental ignition. The City could inspect construction sites that are in the wildland interface during the summer months to ensure contractors are complying with wildfire management plans and are managing the risk of ignition from their sites.

Number	Action Item	Priority
Rec # 22	Enforce FireSmart principles for all development that takes place within 100m of areas with a moderate to high wildfire risk.	B
Rec # 23	Inspect construction sites during the fire season and ensure construction contractors are aware of their responsibilities as described within the *Wildfire Act*	C

FireSmart Community Planning and Design

The FireSmart Wildland/Interface planner was developed to provide guidelines to individuals, communities and planners on how to reduce the risk of a wildfire. Guidelines describe interface hazards (structural and vegetative), provide mitigation strategies and techniques, and include regional planning solutions.

New developments have historically been designed and built with little consideration for the consequences of a wildfire. A responsible development plan should consider prevention of two types of wildfire interface scenarios. The first is that of a wildfire starting in the forest and spreading into the interface community. The second is that of a fire starting from human activity in the urban environment and spreading into the adjacent forest. Responsible development planning must consider the prevention of both scenarios in the short and long term. Short-term measures during the construction phases include prevention of potential ignition sources and ensuring suppression resources are available in case of a wildfire. Long-term planning includes the strategic placement of structures and roads within the development, treating interface fuels to reduce the fire behaviour potential and creating defensible spaces around structures within the interface.

Planners, architects and developers should consider the risk from wildfire during the planning and design phases of development. Factors such as the location of alternate water sources, road access and hydrant location may have a major influence on the overall design.

An overview of the general guidelines and recommendations within the FireSmart Planner is provided in Appendix D. The FireSmart guidelines should be considered as the minimum standard that any new development proposed within 100m of any areas with a moderate to high wildfire risk.

Number	Action Item	Priority
Rec # 24	The FireSmart guidelines should be considered as the minimum standard any new development proposed within 100m of areas with a moderate to high wildfire risk.	A

Evacuation Planning

The primary concern when dealing with a wildfire is public safety. The objective of an evacuation plan is to ensure all people can be evacuated safely and to facilitate effective wildfire control measures. After a wildfire is detected, the threat that it poses to the public should be quickly evaluated. The location, direction and rate of spread of the fire will indicate where the greatest risk is to public safety. The Protection Branch and the Office of the Fire Commissioner, in communication with the City, will decide at what point during the wildfire event an evacuation is justified. RCMP and the local fire department are then responsible for implementing the evacuation.

The City should be aware of those populations that may require special assistance to evacuate. These include primary schools and day care, assisted living and care homes and hospitals. All departments within the City should be aware of their responsibilities during an evacuation. This includes, but is not limited to: the police department, fire department, public works, utilities and parks and recreation.

During a wildfire event, the movement of residents and suppression resources is critical. Road systems that have dead ends are a concern for evacuation. There are some less developed areas of the City that only have one access road. Alternative access routes to these areas should be considered during future land use planning.

Public Education

A majority of hazardous fuel areas within the urban interface are privately owned. Therefore, building public awareness and promoting stewardship of the City's natural areas and its many values is a key component of an effective wildfire program. Following are general recommendations to be considered for development of a public education program. Chapter 6 of the FireSmart Planner provides detailed recommendations for developing a public communications plan. There are two main goals of a comprehensive public education and awareness strategy:

1. Raising knowledge and awareness of wildfire risk and prevention; and
2. Developing and encouraging stewardship opportunities for individuals and community-based volunteer organizations.

Changes in behaviour often come about because people believe that there is an advantage for doing so and also, that they can achieve it. Therefore, gaining support or acceptance for a specific course of action often relies upon both education as well as persuasion. Furthermore, research has demonstrated that these types of initiatives are more likely to effect changes in behaviour when they are targeted at the community level using direct engagement. Upon the completion of this CWPP, a public presentation should be planned. This should include a summary of the findings and the major recommendations.

When large planned events take place in or near natural areas, a representative from the City Parks Department and the Fire Department could be present to hand out educational material and help raise wildfire awareness.

Youth engagement is sometimes overlooked as a public education strategy, but it is very important to meeting long-term management goals. By actively engaging the youth, the City can encourage the next generation of citizens to be educated and active in wildfire planning and management. In addition, educated youth will often effectively pass on this information to older generations in their family that are more difficult to directly engage.

The City should explore educational opportunities in the City of Surrey School system. The fire department should be invited to make classroom presentations. Also, stewardship initiatives such as young wardens programs are recommended to instil a sense of responsibility in youth.

Field trips with school groups can be organized to raise awareness of wildfire risk and strategies for its mitigation. Educational and interactive self-walking tours can be established in fuel treatment areas.

When a fuel treatment program is planned, an open house should be organized and used as a forum to inform and educate local residents. This will provide an opportunity to be proactive and raise awareness of issues and options that local residents have to mitigate risk on their properties.

A summary of this CWPP, the wildfire risk maps and the Homeowners FireSmart Manual should be distributed to residents within 100m of moderate to high risk natural areas. Materials should be also made available at public locations including City Hall, the parks department, post offices, fire departments, community centres and libraries. The wildfire risk maps should also be printed and posted at some of these locations.

Technology is an important avenue to communicate ideas and information. This is particularly true of on-line and electronic media. The City's website currently includes a section on interface wildfire protection. This should be updated to include this report and associated maps. This site should be updated regularly to include future interface fuel treatments and education events. The webpage functions as a virtual open house giving residents information, and the flexibility to participate on their timeline. This is also an effective means of communicating with individuals who do not have time or cannot physically participate in open house and local events.

On line sources of education that should be considered include videos that can be linked to the webpage. YouTube is a free and effective means to distribute educational material. A variety of videos can be posted to update the public of upcoming events and to showcase successes in the City.

Wildfire awareness signs should be placed in and around the City to raise awareness of the risks of wildfire. These should indicate the current Fire Danger level, restrictions during the fire season and the emergency number to call when a fire is detected (1-800-663-5555 or *5555 from a cellular phone). Signs should be bold and placed in clear view, particularly at all major through routes into the City and all recreation sites in natural areas.

Number	Action Item	Priority
Rec # 25	Wildfire awareness signs should be posted along major transportation corridors, at camp sites, recreation areas and high use trail heads that specify how to report a wildfire	A
Rec # 26	The City should develop a public education and awareness program for wildfire management	B
Rec # 27	Distribute educational material to all private land owners within 100 m of moderate to high risk areas	A
Rec # 28	Summaries of this report and associated maps should be posted at strategic public locations.	A

Number	Action Item	Priority
Rec # 29	A series of public presentations should be planned once this CWPP is adopted	A
Rec # 30	A representative from the Cities Parks Department and the Fire Department should be present at public events that take place in or near natural areas	A
Rec # 31	Establish a school education program to engage youth in wildfire management	B
Rec # 32	Digital media including video and the City's website should be updated to include this plan	A

Post Fire Evaluation and Rehabilitation

When a wildfire in or adjacent to the interface area in the City has been suppressed, a post-fire ecosystem impact assessment and rehabilitation plan should be completed. A qualified professional should visit the fire site and make observations regarding the impact of the fire on the ecosystem. Factors to consider are listed in Table 15.

Table 15. Post fire evaluation considerations

• Estimated burn area; • Species and size of surviving trees; • Potential overstory mortality; • Estimated number of hazard trees;	• Expected vegetation response; • Potential soil erosion issues; • Presence of invasive species or potential for introduction.

A summary of suppression activities should be documented. This should include the management decisions made and actions taken, in addition to any incidents of concern. A log of all interface fires should be compiled for future reference. Wildland fire may create hazard trees and these should be assessed immediately post fire. Any hazard trees that pose a striking danger to adjacent roads and trails should be removed immediately. If the wildfire causes extensive degradation of the organic soil horizons on a steep slope or within a riparian area, the site should be assessed for slope stability and requirements for erosion control.

Wildfire is a natural disturbance agent in the Lower Mainland ecosystems. If invasive plant species or erosion is not a concern, the site could be left to rehabilitate naturally. The only types of damage that should be addressed are those caused by suppression activities such as construction of fire breaks and use of heavy machinery in the stand.

Number	Action Item	Priority
Rec # 33	In the event of a wildfire, a post-fire ecosystem impact assessment and rehabilitation plan should be completed	B

Fiscal Responsibility

Pilot projects should be pursued to treat City owned interface polygons recommended in Appendix C. Landscape level fuels mitigation should be addressed in co-operation with the Ministry of Forests, Lands and Natural Resource Operations, First Nations and BC Transmission Corporation. The City should work with these groups (either through monetary contribution or general support) to undertake fuel hazard reduction within the interface areas. The UBCM provides 50-90% in-kind funding for local governments to undertake fuel management pilot projects.

Number	Action Item	Priority
Rec # 34	Pursue funding sources to undertake pilot projects to treat the City owned interface polygons recommended in Appendix C.	A

Final Remarks

Landscape level analysis and field assessments show that there is relatively low risk of wildfire in and adjacent to the City of Surrey. The fire behaviour potential of most forest fuel types is low due to a high percentage of deciduous trees and wet lowland ecology. Most forested areas are fragmented and suppression resources are readily available. Areas that do pose a wildfire risk can be managed through appropriate fuels mitigation, suppression planning and preparedness. Success of this plan will require cooperation between agencies, public support and designation of sufficient resources. The City should commit to becoming a “FireSmart” community and embrace this opportunity to exemplify an inspired concept for wildfire management. By implementing the recommendations in this document, the City will reduce the risk of wildfire and potential impacts to people, buildings and infrastructure.

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Appendix B - Wildfire Risk Analysis Methodology

The following document is an overview of the methodology followed to produce the landscape level Wildfire Risk Analysis (WRA) for the City of Surrey and adjacent area. It provides some baseline knowledge of the ranking system structure and how the results are presented.

The WRA is a GIS-based model that spatially quantifies and analyzes the relationships that exist between the critical factors affecting wildfire risk. The objective of this model is to provide planners with a decision making tool to spatially identify the severity of wildfire threat on a landscape level. This information allows planners to analyze and explore the implications of different management activities in relation to wildfire risk.

The overall hazard ranking spatially determines wildfire threat by incorporating four key components as follows:

1. Fire behaviour characteristics (40% of the weighting);
2. Risk of ignition (10% of the weighting);
3. Threat to structures, natural features and cultural features of significance (25% of the weighting); and
4. Suppression constraints (25% of the weighting).

These four components are in turn calculated from contributing factors, each of which is represented by a layer in GIS. The wildfire hazard of each component is calculated by overlaying the relevant contributing factors. Layers representing these four components are subsequently overlain to produce the final wildfire risk rating.

Component #1 - Fire Behaviour

The fire behaviour component of the WRA measures how wildfire will behave under extreme weather conditions. The Canadian Fire Behaviour Prediction System (FPB) provides quantitative outputs of selected fire behaviour characteristics for the major Canadian fuel types (Hirsch 1996).

Fuel Types

Sixteen national benchmark fuel types, which are divided into five categories, are used by the Canadian Fire Behaviour Prediction System to forecast how wildfire will react. These fuel types were defined using the forest inventory and guidelines developed by the Ministry of Forests. Six fuel types were identified in the study area. It is important to note that these fuel types represent a type of behaviour pattern and their generic names do not accurately describe the type of stand that is found. These descriptions are referenced from the MNRO Wildfire Management Branch website.

Weather Inputs

Weather conditions used to calculate fire behaviour were derived from historic records dating back to 1981 for two Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) weather stations. These stations were selected as they best approximate typical climate and weather conditions found in Surrey.

Table 16. MFLNRO weather stations

Station #	Station Name	BEC zone	LATITUDE	LONGITUDE	ELEV_M_	Start Year	End Year
72	UBC research station	CWH dm	49.265	-122.573	98	1981	2011
45	Saltspring Island	CDF mm	48.774	-123.474	34	2001	2011

Historical weather data was statistically analyzed for the months of May to September. The 80th percentile indices were used to represent the worst-case scenario for fire weather conditions. This information, in addition to ground fuel plot data, was used to model fire behaviour characteristics.

Table 17. Fire weather indices between the months of May to September

	Fine Fuel Moisture Code	Duff Moisture Code	Drought Code	Initial Spread Index	Build Up Index	Fire Weather Index	Relative Humidity	Precip. (mm)	Temp.
#72 - UBC Research Station									
80th Percentile	86.4	34.3	275.6	3.1	49	8.0	87	3.3	23.1
Average	62.3	21.1	166.7	41.7	29.6	4.1	69.0	3.0	18.7
Maximum	97.1	148.3	615.6	42.8	173.7	34.8	100	100.8	37.4
#45 - Saltspring Island									
80th Percentile	87.0	92.2	554.2	5.8	99.2	20.1	71	0.5	21.8
Average	76.6	40.6	370.0	3.8	60.7	11.4	65.5	1.1	18.5
Maximum	94.9	153.0	802.1	16.2	203.4	42.0	100	34.2	35

Topographical attributes required to predict fire behaviour include slope and aspect. The study area was delineated into polygons based on slope breaks of 10% intervals and aspects of 45 degrees. Cardinal wind direction was calculated from the aspect so that it was blowing upslope and the elapsed time was set at 24 hours. Wind speed was set at 25 knots.

All of the data pertaining to fuel types, topographical attributes, and fire weather was compiled for the entire study area. This information was then run through the modelling software (Remsoft FPB97) to create the three output fire behaviour layers: fire intensity, rate of spread and crown fraction burned.

Fire Intensity

This layer is a measure of the rate of heat energy released per unit time per unit length of fire front and is based on the rate of spread and the predicted fuel consumption. Units for this layer are kilowatts per meter.

Rate of Spread

This layer is a measure of the speed at which a fire extends its horizontal dimensions. It is based on the hourly Initial Spread Index (ISI) value and is adjusted for the steepness of slope, the interactions between slope and wind direction and increasing fuel availability as accounted for through the Build Up Index (BUI). The units for this layer are meters per minute.

Crown Fraction Burned

This layer is a measure of the proportion of tree crowns involved in the fire. It is based on the rate of spread, the crown base height and the foliar moisture content and is expressed as a percentage value.

Weightings of the fire behaviour layers were designated to a total maximum value of 40 and categorized into risk categories as follows: 6-19 = Low; 20-29 = Medium; 30-40 = High.

Table 18. Fire behavior units and weighting

Layer	Units	Unit Value	Weight
Fire Intensity	Kilowatts per meter (kW/m)	>0-500 501-1000 1001-2000 2001-4000 4001-10000 10001-30000 >30000	4 – Very Low 8 – Low 10 – Low 12 – Medium 16 – Medium 18 – High 20 – Very High
Rate of Spread	Meters per minute (m/min)	>0-5 6-10 11-20 21-40 >40	2 – Very Low 4 – Low 6 – Medium 8 – High 10 – Very high
Crown Fraction Burned	Percent of canopy crown burned (%)	0 1-9 10-49 50-89 90-100	0 – None 3 – Low 6 – Medium 8 – High 10 – Very high

Component #2 – Risk of Ignition

Fires are ignited by either human causes or lightning. The most common source of human caused ignition includes the use of motorized machinery, discarded cigarettes and matches from smoking, fires started in houses, campfires lit within natural areas, sparks from railways and trees falling and striking hydro distribution and transmission lines. This is accounted for by buffering all areas where these causes are most likely to occur. A 30-meter buffer has been established around all roads, structures, hydro lines and railways. Higher risk rankings have been assigned where these areas run through fuel types that are more likely for fires to ignite.

It is difficult to predict the risk of lighting striking across a landscape. Therefore, all fuel types that are likely to sustain a fire ignition due to a lighting strike have been identified and assigned a moderate risk ranking. All deciduous fuel types have been assigned a low ranking and non-fuels have been assigned a weighting of 0.

Weightings of risk of ignition were designated to a total maximum value of 10 and categorized into risk categories as follows: 1 = Low; 5 = Medium; 10 = High.

Table 19. Risk of ignition units and weighting

Layer	Units	Weight
Risk of Human Caused Ignition	Areas within 30 meters of ▪ Structures ▪ Roads ▪ Trails ▪ Hydro Transmission lines ▪ Railways	10
Risk of Lightning Caused Ignition	All fuel types except deciduous or non-fuels (C2, C3, C5, C7, M2)	5
	All Deciduous fuels (D1/D2)	1
	All non-fuels (W, I, U, N)	0

Component #3 - Values at Risk

The 'values at risk' component of the model identifies human structures which are at risk of being damaged or destroyed by wildfire. All structures within the wildland interface were identified using orthophotos and buffers of 30 m, 100 m and 2 km were then created around these structures. Weightings were assigned to these buffers as per the table below.

Structures at Risk

The weightings of the structures and natural features at risk were designated as follows with a total maximum value of 25 and categorized into risk categories as follows: 5 = Low; 10-25 = High.

Natural and Cultural Features at Risk

This layer identifies unique natural features that could be detrimentally impacted by wildfire. It includes the locations of key wildlife habitat, rare plants and plant associations. Information pertaining to the rarity, conservation status and locations of animals, plants and plant associations was obtained from the BC MoE, Resources Inventory Branch; Forests Conservation Data Center (CDC). This data includes information pertaining to populations and communities, environmental features associated with the species as well as geographical and ecological data. Element occurrence reports were obtained from the CDC which include verified locations of rare animal species, plant species or plant associations within the study area. A search of British Columbia's Ministry of Environment Conservation Data Centre database found six occurrences of Red-listed plants and animals and 17 Blue-listed species.

Table 20 Red and Blue-listed species recorded within the City of Surrey

Common Name	Scientific Name	Category	BC_LIST
American Avocet	*Recurvirostra americana*	Vertebrate Animal	Red
Needle-leaved Navarretia	*Navarretia intertexta*	Vascular Plant	Red
Oregon Forestsnail	*Allogona townsendiana*	Invertebrate Animal	Red
Pacific Water Shrew	*Sorex bendirii*	Vertebrate Animal	Red
Streambank Lupine	*Lupinus rivularis*	Vascular Plant	Red
White Sturgeon (Lower Fraser River population)	*Acipenser transmontanus* pop. 4	Vertebrate Animal	Red
American Bittern	*Botaurus lentiginosus*	Vertebrate Animal	Blue
Beaverpond Baskettail	*Epitheca canis*	Invertebrate Animal	Blue
California-tea	*Rupertia physodes*	Vascular Plant	Blue
False-pimpernel	*Lindernia dubia* var. *anagallidea*	Vascular Plant	Blue
Field Dodder	*Cuscuta campestris*	Vascular Plant	Blue
Green Heron	*Butorides virescens*	Vertebrate Animal	Blue
Henderson's Checker-mallow	*Sidalcea hendersonii*	Vascular Plant	Blue
Northern Red-legged Frog	*Rana aurora*	Vertebrate Animal	Blue
Pointed Broom Sedge	*Carex scoparia*	Vascular Plant	Blue
Pointed Rush	*Juncus oxymeris*	Vascular Plant	Blue
Slender-spiked Mannagrass	*Glyceria leptostachya*	Vascular Plant	Blue
Small Spike-rush	*Eleocharis parvula*	Vascular Plant	Blue
Three-flowered waterwort	*Elatine rubella*	Vascular Plant	Blue
Trowbridge's Shrew	*Sorex trowbridgii*	Vertebrate Animal	Blue
Two-edged Water-starwort	*Callitriche heterophylla* var. *heterophylla*	Vascular Plant	Blue
Ussurian Water-milfoil	*Myriophyllum ussuriense*	Vascular Plant	Blue
Vancouver Island Beggarticks	*Bidens amplissima*	Vascular Plant	Blue

Archaeological sites include those documented with the provincial government. It should be noted that First Nation values are often not available through the provincial government data bases due to the sensitive nature of the information. Therefore, it is note accounted for in this analysis. In the event there is a wildfire, the local First Nations should be contacted to ensure the local knowledge of cultural features is accounted for.

The weightings of the structures, natural and cultural features at risk were designated as follows with a total maximum value of 25.

Table 21. Values at risk weighting

Layer	Units	Weight
Structures and facilities at risk	Areas within 30 meters of any structures	25
	Areas within 100 meters of any structures	20
	Areas within 2km of any structures	5
Natural and cultural features at risk	▪ Red Listed CDC element occurrences (CDC) ▪ Red listed pant communities ▪ CDC Masked Sensitive occurrences (CDC) ▪ Archaeological sites	10
	▪ Blue Listed CDC element occurrences (CDC) ▪ Old Growth Forests (>250 years old)	7
	▪ Riparian Habitat – 30m from all Fish Bearing/Perennial Streams ▪ Mature Forest (80-250 years old) ▪ 100m buffer around eagles nest	5
	▪ Riparian Habitat - 30m from all Non-fish Bearing/Ephemeral Streams	3

Component #4 – Suppression Constraints

The ability to suppress a wildfire depends on a number of factors including terrain characteristics, accessibility and the availability of suppression resources. Four factors were used to determine the overall rating for suppression capability: proximity to roads, proximity to water sources, initial attack time and steepness of terrain.

Proximity to Roads – Access

This layer accounts for the accessibility of suppression resources to fight a wildfire by creating 100 m, 500 m and 1000 m buffers along all roads in and adjacent to the study area. These buffers were assigned threat weightings that decreased with their proximity to roads.

Proximity to Water Sources

This layer is a measure of the availability of water sources for fire suppression. It was derived by creating 100 m buffers around all fire hydrants and perennial rivers, creeks and lakes. Fire hydrants were designated the lowest weighting of 2, perennial water sources (ponds, reservoirs, lakes, rivers) were designated a weighting of 6 and all other areas were designated a weighting of 10.

Steepness of Terrain

Steepness of terrain influences the timely ability of ground crews to access the fire and construct fire lines. Areas were weighted based on their average slope class derived from the municipality ecosystem mapping database. Designated weights increase relative to the steepness of the slope.

Weightings of the suppression constraints were designated using a total maximum value of 25 and categorized into risk categories: 0-9 = Low; 10-19 = Medium; 20-25 = High.

Table 22. Suppression constraints units and weighting

Layer	Units	Unit Value	Weight
Proximity to roads	Distance from roads in meters	0-100 from roads	1
		101-500 from roads	3
		501-1000 from roads	6
		>1000 from roads	10
Proximity to water sources	Distance from water sources in meters	Fire hydrants	2
		< 100m from perennial water sources (ponds, reservoirs, lakes, rivers)	5
		>100 meters from perennial water sources (ponds, reservoirs, lakes, rivers)	10
Steepness of terrain	% Slope	0-20	1
		21-40	2
		41-60	3
		60-100	4
		>100	5

*The entire area was weighted based on distance from roads. Risk was reduced by three if the area was accessible by a trail.

Final Wildfire Risk Rating

The final wildfire hazard rating has been calculated by adding together the ratings of the four primary components to produce a final weighting out of 100. Final weightings have been categorized as follows:

Table 23. Final Wildfire Risk weighting and hazard class

Final Weight	Wildfire Hazard
0-39	Low
40-59	Moderate
60-79	High
>80	Very high

Appendix C - Interface Fuels Assessments of City Owned Lands

All City owned forested lands with a moderate to high wildfire behaviour risk and within 100m of any structures were identified as candidate polygons requiring an interface fuel hazard assessment. These areas were evaluated using the provincial assessment system outlined in the "Rating Wildfire Interface Threats in British Columbia" (MOFR 2008). Rankings from this assessment resulted in a prioritized list of areas for treatment. These treatment areas were then compiled along with their attributes into a GIS database and labelled according to their priority ranking.

Summary of Polygons

The following table is a summary of areas visited in the field. The polygon number and ranking are provided with results of the interface rating.

Table 24 Interface polygon assessment

Plot	Duff and Litter Depth (cm)	Flammable Surface Vegetation Continuity	Vegetation Fuel Composition	Fine Woody Debris Continuity (<7cm)	Large Woody Debris Continuity (>7cm)	Coniferous Crown Closure (%)	Deciduous Crown Closure (%)	Confier Crown Base Height (m)	Suppressed & Understory Conifers	Continuous Forest Land (ha)	Coniferous Forest Health (% cover of	Biogeoclimatic Zone	Historical Wildfire Occurrence (by MoFR	Aspect	Slope (%)	Terrain	Position of Structure/ Community to Rating	Type of Development	Total Points	Wildfire Threat Class	Priority for treatment	COMMENTS
1	2	1	2	2	2	10	10	2	2	4	4	1	10	10	1	1	0	0	64	2		Healthy stand with a high ladder fuel height. Low conifer under story. Poor opportunities for treatment. Surrounded by roads with wide (2 m) paths throughout. All structures separated by road.
2	2	1	2	2	3	10	7	5	2	1	4	1	10	10	1	1	0	0	62	2		Healthy stand surrounded by road and deciduous stand. Poor opportunities for treatment. Mostly deciduous understory and a small portion on land. Surrounded by roads with wide (2 m) paths throughout. All structures separated by road.
3	2	1	2	2	2	10	10	5	2	4	4	1	10	10	1	1	0	0	67	2		Healthy stand with a high ladder fuel height. Low conifer under story. Poor opportunities for treatment. Surrounded by roads with wide (2 m) paths throughout. All structures separated by road.
4	2	1	2	2	2	10	10	5	2	1	4	1	10	10	1	1	0	0	64	2		Healthy stand with a high ladder fuel height. Low conifer under story. Not much can be done for treatment. Surrounded by roads with wide (2 m) paths throughout. All structures separated by road.
5	3	1	2	5	3	5	5	5	2	1	4	1	10	10	1	1	0	0	59	2		Healthy stand with a high ladder fuel height. Low conifer under story. Poor opportunities for treatment. Consists of M2 (40% deciduous and 60% conifers). Surrounded by roads with wide (2 m) paths throughout. All structures separated by road.

Plot	Duff and Litter Depth (cm)	Flammable Surface Vegetation Continuity	Vegetation Fuel Composition	Fine Woody Debris Continuity (<7cm)	Large Woody Debris Continuity (>7cm)	Coniferous Crown Closure (%)	Deciduous Crown Closure (%)	Confier Crown Base Height (m)	Suppressed & Understory Conifers	Continuous Forest Land (ha)	Coniferous Forest Health (% cover of	Biogeoclimatic Zone	Historical Wildfire Occurrence (by MoFR	Aspect	Slope (%)	Terrain	Position of Structure/ Community to Rating	Type of Development	Total Points	Wildfire Threat Class	Priority for treatment	COMMENTS
6	3	1	2	2	2	5	5	2	1	1	4	1	10	10	1	1	5	5	61	2		Healthy stand with a high ladder fuel height. Low conifer under story. Poor opportunities for treatment. Could remove a few understory conifers. Surrounded by roads with wide (2 m) paths throughout. A few structures built up to forest edge. **Construct a fuel buffer for interface houses.**
7	2	1	2	2	2	10	10	5	2	1	4	1	10	10	1	1	0	0	64	2		Healthy stand with a moderately dense understory of conifers. Lower ladder fuel height. **Could be a candidate for thinning and ladder fuel treatment. Not a priority.** Surrounded by roads with paths (2m) throughout.
8	2	1	2	2	2	10	10		5	1	4	1	10	10	1	1	0	0	62	2		Healthy stand with a moderately dense understory of conifers. Lower ladder fuel height. **Could be a candidate for thinning and ladder fuel treatment. Not a priority. Build trails to facilitate access.** Surrounded by roads with paths (2m) throughout.
9	3	1	2	5	2	5	5	5	2	1	4	1	10	10	1	1	0	0	58	2		Healthy M2 (50% deciduous, 50% conifer) stand with a moderately dense understory of conifers. Lower ladder fuel height. **Could be a candidate for thinning and ladder fuel treatment. Not a priority. Build access trails for easier access.** Surrounded by roads with paths (2m) throughout.

Plot	Duff and Litter Depth (cm)	Flammable Surface Vegetation Continuity	Vegetation Fuel Composition	Fine Woody Debris Continuity (<7cm)	Large Woody Debris Continuity (>7cm)	Coniferous Crown Closure (%)	Deciduous Crown Closure (%)	Confier Crown Base Height (m)	Suppressed & Understory Conifers	Continuous Forest Land (ha)	Coniferous Forest Health (% cover of	Biogeoclimatic Zone	Historical Wildfire Occurrence (by MoFR	Aspect	Slope (%)	Terrain	Position of Structure/ Community to Rating	Type of Development	Total Points	Wildfire Threat Class	Priority for treatment	COMMENTS
10	2	1	2	2	3	10	10	5	2	1	4	1	10	10	1	1	5	5	75	2		Healthy stand with a moderately dense understory of conifers. Lower ladder fuel height. **Could be a candidate for thinning and ladder fuel treatment. Build access trails for easier access.** Surrounded by roads with paths (2m) throughout. **Construct a fuel buffer for interface houses.**
11	2	1	2	2	3	10	7	5	2	1	4	1	10	10	5	5	15	8	93	2		Healthy M2 (50 deciduous, 50% conifer) stand with a high number of suppressed conifers. Creek running down through steep gully. **Could be a candidate for thinning and ladder fuel treatment. Construct a fuel buffer for interface houses.**
12	2	1	2	5	3	10	7	5	2	1	4	1	10	10	1	1	0	0	65	2		Moderately healthy stand. **Could be a candidate for thinning and ladder fuel treatment. High percentage of large woody debris that could be either removed or layed flat on the ground.** Homes on the other side of road.
13	2	1	2	2	3	10	7	5	2	1	4	1	10	10	1	1	0	0	62	2		Healthy stand overall, but a few heavy use trails throughout. Damage to some trees. **Remove dead standing trees. Remove or limb fresh fallen trees.**
14	2	0	2	2	3	10	7	5	2	1	4	1	10	10	1	1	5	5	71	2		Healthy stand with a high percent cover of non-flammable shrubs. High percentage of cedar regen that could be thinned. Not a priority.
15	2	2	2	2	3	10	7	5	2	1	4	1	10	10	1	1	5	5	73	2		Healthy stand overall, but a few heavy use trails throughout. Damage to some trees. **Remove dead standing trees. Remove or limb fresh fallen trees.**

Plot	Duff and Litter Depth (cm)	Flammable Surface Vegetation Continuity	Vegetation Fuel Composition	Fine Woody Debris Continuity (<7cm)	Large Woody Debris Continuity (>7cm)	Coniferous Crown Closure (%)	Deciduous Crown Closure (%)	Confier Crown Base Height (m)	Suppressed & Understory Conifers	Continuous Forest Land (ha)	Coniferous Forest Health (% cover of	Biogeoclimatic Zone	Historical Wildfire Occurrence (by MoFR	Aspect	Slope (%)	Terrain	Position of Structure/ Community to Rating	Type of Development	Total Points	Wildfire Threat Class	Priority for treatment	COMMENTS
15	2	0	1	5	5	10	7	5	3	1	4	1	10	10	1	1	0	0	66	2		Healthy dense forest with a heavy moss layer and high deciduous cover.
16	2	1	1	2	5	15	10	5	3	1	4	1	10	10	1	1	0	0	72	2		Healthy dense forest with vine maple and low percentage of conifer regen.
17	2	1	2	3	5	10	7	5	2	1	4	1	10	10	1	1	0	0	65	2		Healthy dense forest with vine maple and low percentage of conifer regen. **Could remove dead standing deciduous trees.**
18	2	0	2	5	5	10	7	5	2	1	4	1	10	10	1	1	0	0	66	2		Healthy dense forest with vine maple and a high percentage of large woody debris. **Remove some large woody debris.**
19	2	1	2	5	5	10	10	5	2	1	0	1	10	10	1	1	8	5	79	2	yes	Good treatment site. High percentage of dead standing trees and large woody debris. **Remove or lay fallen trees on ground. Remove large woody debris.**
20	3	1	2	2	2	5	7	8	3	1	4	1	10	10	5	7	15	5	91	2		Open canopy stand with deciduous trees in gully and conifers on top. Trail thoughout.
21	3	1	2	5	2	10	10	2	2	1	4	1	10	10	1	1	8	8	81	2	yes	Healthy self thinned conifer stand. Houses right up to forest in some areas. **Could remove dead standing and thin conifers. Create fuel buffer adjcaent to houses.**
22	3	1	2	5	2	2	2	0	1	1	4	1	10	15	5	7	8	0	69	2		Deciduous stand with highway above. No treatment recomended.
23	3	1	2	5	3	10	10	5	2	1	4	1	10	15	5	5	8	12	102	2	yes	Houses intermix through stand. Ivy covering ground and stems. **Could prune up lower limbs and thin canopy. Create fuel buffer adjcaent to houses.**

Plot	Duff and Litter Depth (cm)	Flammable Surface Vegetation Continuity	Vegetation Fuel Composition	Fine Woody Debris Continuity (<7cm)	Large Woody Debris Continuity (>7cm)	Coniferous Crown Closure (%)	Deciduous Crown Closure (%)	Confier Crown Base Height (m)	Suppressed & Understory Conifers	Continuous Forest Land (ha)	Coniferous Forest Health (% cover of	Biogeoclimatic Zone	Historical Wildfire Occurrence (by MoFR	Aspect	Slope (%)	Terrain	Position of Structure/ Community to Rating	Type of Development	Total Points	Wildfire Threat Class	Priority for treatment	COMMENTS
24	2	1	2	5	4	15	10	8	3	1	4	1	10	12	1	1	5	5	90	2		Healthy forest with numerous trails throughout. High percentage of large woody debris. Structures on the other side of the road. **Candidate for crown thinning and removal of large woody debris.**
25	2	1	2	5	4	15	10	8	3	1	4	1	10	10	1	1	8	5	91	2		Healthy forest with numerous trails throughout. High percentage of large woody debris. **Candidate for crown thinning and removal of large woody debris.**
26	3	1	2	5	2	5	5	8	2	1	0	1	10	10	1	3	8	5	72	2		Healthy forest with numerous trails throughout. Small patches of understory conifers thoughout. **Could thin those small patches of suppressed conifers.**
27	3	1	2	5	2	5	5	8	2	1	0	1	10	2	5	5	15	5	77	2		Healthy forest with numerous trails throughout. Paved road and path cutting the block in half. Small patches of understory conifers thoughout. **Could thin those small patches of suppressed conifers.**
28	3	1	2	5	2	5	5	8	2	1	0	1	10	2	5	5	15	5	77	2	yes	Healthy forest with trails throughout. Small patches of understory conifers thoughout. **Could thin those small patches of suppressed conifers. Could create buffer on northwest corner between houses and stand.**
29	3	1	2	5	2	5	5	8	2	1	0	1	10	2	5	10	15	5	82	2		Healthy forest with trails throughout. Small patches of understory conifers thoughout. **Could thin those small patches of suppressed conifers. Create fuel buffer between houses and stand.**

Plot	Duff and Litter Depth (cm)	Flammable Surface Vegetation Continuity	Vegetation Fuel Composition	Fine Woody Debris Continuity (<7cm)	Large Woody Debris Continuity (>7cm)	Coniferous Crown Closure (%)	Deciduous Crown Closure (%)	Confier Crown Base Height (m)	Suppressed & Understory Conifers	Continuous Forest Land (ha)	Coniferous Forest Health (% cover of	Biogeoclimatic Zone	Historical Wildfire Occurrence (by MoFR	Aspect	Slope (%)	Terrain	Position of Structure/ Community to Rating	Type of Development	Total Points	Wildfire Threat Class	Priority for treatment	COMMENTS
30	2	1	2	5	2	10	7	8	3	1	0	1	10	12	10	7	15	5	101	2		Healthy stand in a steep gully with no buffer between stand and houses. Small area is park land. **Remove lower branches and thin. Create fuel buffer between houses and stand.**
31	2	1	2	2	2	10	5	8	2	2	0	1	10	12	10	7	15	5	96	2		Healthy stand in a steep gully with no buffer between stand and houses. Conifers were mostly dominate stems with high crowns. **Remove lower branches and thin. Create fuel buffer between stands and houses.**
32	2	1	2	2	2	5	7	8	2	2	0	1	10	10	10	10	15	5	94	2		Healthy stand in a steep gully with no buffer between stand and houses. Small area is park land. Small partches of young cedar. **Remove lower branches and thin. Create fuel buffer between stands and houses.**
33	2	1	2	5	2	5	7	8	2	1	0	1	10	12	5	7	12	5	87	2		Healthy stand in a steep gully with no buffer between stand and houses. Mostly open canopy with a dense deciduous understory. Trails thoughout. Small partches of young cedar. **Remove lower branches and thin. Create fuel buffer between stands and houses.**
34	2	1	2	5	2	5	5	8	2	1	0	1	10	10	10	10	15	8	97	2		Healthy stand in a steep gully with no buffer between stand and houses. Mostly intermediate conifers. **Remove lower branches and thin. Create fuel buffer between stands and houses.**
35	3	1	2	2	2	5	7	0	3	1	0	5	10	10	1	1	5	5	63	2	yes	Moderate treatment site. No buffer between houses and stand. **Remove lower branches and thin. Create fuel buffer between stands and houses.**

Plot	Duff and Litter Depth (cm)	Flammable Surface Vegetation Continuity	Vegetation Fuel Composition	Fine Woody Debris Continuity (<7cm)	Large Woody Debris Continuity (>7cm)	Coniferous Crown Closure (%)	Deciduous Crown Closure (%)	Confier Crown Base Height (m)	Suppressed & Understory Conifers	Continuous Forest Land (ha)	Coniferous Forest Health (% cover of	Biogeoclimatic Zone	Historical Wildfire Occurrence (by MoFR	Aspect	Slope (%)	Terrain	Position of Structure/ Community to Rating	Type of Development	Total Points	Wildfire Threat Class	Priority for treatment	COMMENTS
36	3	2	2	5	3	10	10	0	2	1	0	5	10	10	1	1	5	5	75	2		Moderate treatment site. **Clean up coarse woody debris.**
37	3	2	2	2	2	2	10	0	3	1	0	5	10	10	1	1	5	5	64	2		Poor treatment site. **Limb intermediate trees.**
38	3	2	2	2	2	10	10	0	1	1	0	5	10	10	1	1	5	5	70	2		Poor treatment site. **Limb intermediate trees and remove coarse woody debris**
39	3	2	2	2	3	10	10	0	3	1	0	5	10	10	1	1	5	5	73	2	yes	Moderate treatment site. **Remove coarse woody debris. Provide fire info for users to reduce residence woody debris waste. Thin suppressed trees**
40	4	1	2	5	2	10	10	0	1	1	0	5	10	10	1	1	5	5	73	2		Poor treatment site. **Limb intermediate trees.**
41	3	1	2	5	3	10	10	2	2	1	0	5	10	10	1	1	5	5	76	2	yes	Moderate treatment site. Road surrounding forest. **Remove large woody debris and fine woody debris. Thin and remove branches of intermediate Western Redcedar.**
42	3	4	2	5	2	10	10	2	2	1	0	5	10	10	1	1	5	5	78	2	yes	Moderate treatment site. **Remove dead standing trees and coarse woody debris.**
43	3	4	2	5	2	10	10	2	2	1	0	5	10	10	1	1	5	5	78	2	yes	Moderate treatment site. **Remove dead standing trees and coarse woody debris.**
44	3	2	2	2	2	5	7	2	3	1	0	5	10	10	1	1	5	5	66	2		Low priority treatment site. **Remove dead standing trees and coarse woody debris.**
45	4	2	2	2	3	2	7	5	2	1	0	5	10	10	1	1	5	15	77	1		Low priority treatment site. **Remove dead standing trees and coarse woody debris. Limb Western Redcedar.**

Plot	Duff and Litter Depth (cm)	Flammable Surface Vegetation Continuity	Vegetation Fuel Composition	Fine Woody Debris Continuity (<7cm)	Large Woody Debris Continuity (>7cm)	Coniferous Crown Closure (%)	Deciduous Crown Closure (%)	Confier Crown Base Height (m)	Suppressed & Understory Conifers	Continuous Forest Land (ha)	Coniferous Forest Health (% cover of	Biogeoclimatic Zone	Historical Wildfire Occurrence (by MoFR	Aspect	Slope (%)	Terrain	Position of Structure/ Community to Rating	Type of Development	Total Points	Wildfire Threat Class	Priority for treatment	COMMENTS
46	4	4	2	5	3	5	7	5	2	1	0	5	10	10	1	1	5	5	75	1		Poor treatment site. Surrounded by roads. Mixed deciduous and conifer stand. **Remove dead standing and coarse woody debris, limb intermediate trees. Flammable ground cover**
47	3	2	2	5	3	10	10	2	3	1	0	5	10	10	1	1	5	5	78	1	yes	Moderate treatment site. Trees right up to the house. **Create fuel free buffer.**
48	4	2	2	2	2	10	10	2	1	2	0	5	10	12	5	3	12	5	89	1		Poor treatment site. Good buffer exists.
49	4	2	2	2	2	10	10	2	1	2	0	5	10	12	1	3	5	5	78	1		Poor treatment site. Good buffer exists.
50	4	2	2	2	2	10	10	2	3	1	0	5	10	12	1	1	5	5	77	1	yes	Moderate treatment site. Located at a busy park. Trees right up to house side. **Create fuel free buffer.**

Appendix D – Summary of FireSmart Recommendations

The FireSmart manual was developed to provide guidelines to individuals, communities and planners on how to reduce the risk of loss from interface fires. Following is a summary of guidelines related to development planning in the wildland interface.

Vegetation Management

FireSmart recommends treatments around structures in three 'priority zones'. Treatments in these zones involve fuel removal, fuel reduction, and fuel conversion. The objective in these zones is to create 'defensible' space around a home from which to suppress a wildfire. Survivability of a home is often dependent on the distance from the structure to the adjacent forest. Detailed goals and treatments can be found in the FireSmart manual in Chapter 3. Priority zones are based on distance from the structure, and the slope below the structure:

- Priority Zone 1 (within 10 m from structures): Remove fuel and convert vegetation to fire resistance species to produce an environment that does not support combustion.

- Priority Zone 2 (10 to 30 m from structures): Increase fuel modified area by reducing flammable vegetation through thinning and pruning and produce an environment that will only support low-intensity surface fires

- Priority Zone 3 (30 to 100 m+ from structures): Eliminate the potential for a high-intensity crown fire through thinning and pruning, thereby slowing the approach of a fire approach towards structures.

The area within 30 meters of the structures (priority zones 1 and 2) should be treated heavily enough to create a defensible space between the structures and the adjacent stand. Treatments in priority zone 3 need not be as intensive as those adjacent to the structures but should still reduce the potential for a crown fire under 90th percentile weather conditions.

The slope of the terrain has a strong influence on fire behavior. The rate of spread (ROS) of a fire doubles for every 30% increase in slope, up to 60%. The recommended treatment zone distances around structures should be adjusted accordingly. Steeper slopes should be treated to a further distance, thinning should be to a lower density and pruning height should be higher. Typically, slopes of 30% below buildings should have the priority zone 2 extended to 60 m below the structure and to 45 m side slope. On a 55% percent slope, priority zone 2 should be extended to 120 m down slope of the structure and 60 m horizontal. The necessary distance and extent of treatment should be determined by a fire behavior specialist and clearly described in the fuels reduction prescription.

Priority Zone 1-Fuel Free Zone (10 m from buildings)
A fuel free zone should be created around all homes and outbuildings. The fuel free zone should extend 10 m from the structure, or further if the terrain is sloped. Guidelines include:

- There should be enough defensible space to protect buildings from approaching wildfire and to reduce the potential for a building fire spreading to the wildland.
- Annual grasses within 10 m of buildings should be mowed to a height of 10 cm or less and watered regularly during the summer months.
- Surface litter and downed trees should be removed regularly.
- Dead, and dying trees should be removed.
- Structures at the top of a slope will need a minimum of 30 m of defensible space.
- Vegetation within this zone should be of a fire-resistant species
- Trees within this zone should be pruned to a height of 2 to 3 m and not overhang the house or porch.
- Remove all piled debris (firewood, building materials, and other combustible material) outside of the fuel free zone.
- Defensible space should be provided by the developer and maintained by the property owner.
- Community Strata rules should enforce the maintenance of this zone.

Priority Zone 2-Fuel Reduction Zone (10 to 30 m from buildings)
Fuel modification in this zone should include thinning and pruning to create an environment that will not support a high intensity crown fire. A surface fire may occur in this zone but it will be of low intensity and easily suppressed. Guidelines for this zone are as follows:

- Actions in this zone should be oriented towards fuel reduction rather than removal.
- Deciduous composition in the overstory should be promoted (i.e. deciduous species should not be thinned out).
- This zone should be extended as slope increases. The 20 m concentric distance from the boundary with priority zone 1 should be corrected for slope.
- Thin trees for two tree lengths from buildings.
- Treatments within this zone will include thinning of the canopy, thinning the understory and pruning lower branches
- Leave trees should be the largest on site and canopy heights should be pruned to a height of 2 to 3 m.
- Remove all dead and dying trees.
- Dispose of all slash created by treatments through pile and burning or removal from the site.
- This zone should be constructed by the developer and maintained by the property owner.
- Community strata rules should enforce the maintenance of this zone.

Priority Zone 3-Fuel Reduction and Conversion (30 to 100 m from buildings)
Strategies for this zone are similar to those of priority zone 2 with the distance being slope dependent. This environment should be one that does not support a high-intensity crown fire. A surface fire may occur, but it will be of low intensity and easily extinguished. Vegetation management should concentrate on vegetation conversion and reduction rather than removal. Guidelines for this zone include:

- Fuel management in this zone should only be undertaken if there are high hazard levels from heavy continuous fuels and steep topography.
- Deciduous species should be promoted.
- On sloped terrain, the width of this zone will need to be corrected for slope distance.
- Thinning and pruning
- This zone should be constructed by the developer and maintained by the property owner.
- Community Strata rules should enforce the maintenance of this zone.

Buildings and Construction

During an interface fire, homes usually burn down as a result of burning embers landing on and igniting the roof. Alternatively, embers land on or in a nearby bush, tree or woodpile and, if the resulting fire is near the home, the walls of the home will ignite through radiant heat. Small fires in the yard can also spread towards the home and beneath porches or under homes. Therefore, the building material and construction techniques are a paramount concern for homes in the WUI.

The FireSmart Manual provides guidelines for safer construction methods. These include materials, building techniques and maintenance. The following is a summary of these construction and landscaping specifications that should be incorporated into the design guidelines for building on site.

Roofs

- Use only fire retardant material (Class A materials) on roofs; and
- Keep roofs clean of all combustible material.

Wood Chimneys

- All chimneys should have approved spark arrestors (securely attached and made of 12-gauge welded or woven wire mess screen with mesh opening of less than 12 mm);
- Chimney outlets should have at least 3 meters clearance from all vegetation and obstructions; and
- Chimney outlets should be 0.6 m higher than any part of the roof within 3 meters.

Siding

- Siding should be predominantly fire resistant material; and
- Siding should extend from the ground level to the roofline.

Windows and Door Glazing; Eaves, Vents and Openings

- Remove vegetation from within 10 meters of glazed openings unless there are solid shutters to cover the glazing;
- All eaves, attics, and underfloor openings need solid, non-flammable protective covers; and
- Laminated glass and 20 minute rated door assembles should be used on building surfaces facing the forest interface.

Balcony, Decks and Porches

- Deck surface material should be made of predominantly non-combustible or fire-resistant materials such as wood composite products;
- Slotted deck surface allow needle litter to accumulate beneath the deck. Provide access to this space to allow for removal of this debris.

Guidelines during Construction

- During construction of houses, all waste construction materials including brush and land clearing debris needs to be cleaned up on a regular basis to minimize the potential risk. No combustible materials should be left at the completion of construction;
- Prior to construction of any wood frame buildings, there must be fire hydrants within operating range.

Landscaping

The majority of high risk fuels are planned to be cleared for the construction of buildings and associated infrastructure. It is important to plan landscaping to ensure that adequate defensible spaces are maintained adjacent to all structures in the long term. All areas to be landscaped within 20 meters of buildings should adhere to the following guidelines.

- All flammable trees and shrubs growing within 20 meters of any structures should be removed and replaced with fire resistant species. The most flammable species include those that accumulate dead foliage and braches and have a high content of oils and resin.

- Characteristics of fire resistant species to be replanted include the following:
    - Deciduous species;
    - Low growing plants;
    - Plants with thick woody stems;
    - Plants that accumulate low amounts of dead vegetation;
    - Plants with low resin content (deciduous species);
    - Plants that retain high moisture content.

Utilities-Electric and Gas

Overhead transmission and distribution lines are a major ignition risk. Falling trees or branches can knock a powerline to the ground, where it will remain charged and potentially start a fire. Primary distribution lines are the most problematic as they are remote and difficult to inspect and maintain. Secondary lines contain less voltage but are more susceptible to being overgrown by vegetation, which can lead to arcing and ignition. Underground power lines are the most FireSafe.

When planning new developments, underground power line systems should be considered. Where such a system is not feasible, overhead utility lines should have a clearance of at least 3 metres from vegetation.

Propane tanks surrounded by vegetation are potential hazards. Combustion adjacent to these tanks could increase the internal pressure causing the tank to vent through a relief valve. The resulting fire can be one of a high-intensity with the potential to destroy adjacent buildings. Hence, when positioning tanks, the relief valves should point away from buildings. Faulty relief valves will not allow pressure to discharge resulting in a boiling liquid explosion dangerous to those within 300m.

Propane tanks should have surrounding vegetation cleared for at least 3 m in all directions. Tanks should be located at least 10 m from any building. Future development around the tank should respect this distance and be monitored by the development strata.

Home Sprinkler Systems

When designing new developments, particularly those in remote locations some distance from emergency services, consideration should be given to the installation of sprinkler systems. These systems used for irrigation and as an interface suppression tool. Sprinklers can be located on rooftops of homes and outbuildings. In the event of a wildfire, sprinklers would engage and increase the relative humidity and fuel moisture content around the house. This would result in lower flammability and fire behaviour potential. Rooftop sprinklers are recommended for homes in the interface that do not have fire resistant roofing or siding.