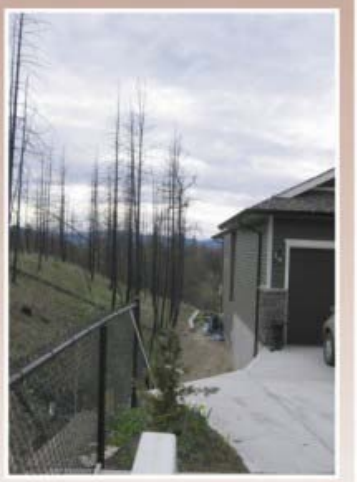
Review of Policies, Procedures and Bylaws Relating to Wildland Fire





Submitted by: B.A. Blackwell & Associates Ltd.
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CITY OF KELOWNA

REVIEW OF POLICIES PROCEDURES AND BYLAWS RELATING TO WILDLAND FIRE

Options for Wildland Urban Interface Management Policy Change in the City of Kelowna, British Columbia

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Finally, the authors would like to thank those residents of the City of Kelowna who took the time to complete the door-to-door and online surveys conducted as part of this review.

Executive Summary

The 2003 wildfire season in British Columbia (BC) resulted in the most damaging forest fires the Province had experienced on record. The fires destroyed more than 334 homes and businesses, and caused the evacuation of 45,000 people (Filmon, 2004). The overall cost of the fires was estimated at $700 million (Filmon, 2004). The most extensive fire damage occurred within the City of Kelowna, where 238 homes were destroyed and more than 33,000 people were evacuated.

While strategic fuel reduction activities on public land in Canada will substantially decrease the risk of extreme wildfire behaviour, it will not eliminate it. In order to effectively reduce risk in the Wildland Urban Interface (WUI), these actions must be complemented by mitigation activities on private forested land, around individual homes and on structures. To achieve tangible success, policy at all levels of government needs to support these activities. The purpose of this report was to provide policy recommendations that would enable the City of Kelowna to effectively reduce the community's risk from wildfire. For the purposes of this report, policy is defined as a statement based in beliefs or intentions that are used to rationalize a course of action or inaction. The following policy recommendations summarize the outcomes of the policy review.

Recommendations

The following recommendations apply to the Wildland Fire Hazard Development Permit areas determined by the City.

Landscape Level Risk Assessment

Recommendation 1: The City should consider working with the Building Policy Branch to create a structure that would enable the municipality to better address wildland urban interface protection considerations.

Recommendation 2: The City should lobby the province to identify and document hazardous fuel types on crown land that are not within the boundary of the City but that are adjacent to residential neighbourhoods that could be impacted by a wildland urban interface fire. Effort must be directed at encouraging the province to initiate a fuel treatment program for these lands and this may include coordinating lobbying initiatives with other local governments from within the Okanagan valley.

Recommendation 3: The City should investigate the establishment of agreements with the Province that would allow developers to treat crown land directly adjacent to new developments as a required part of the development process. The Province would then pay the mitigation cost to the developer upon satisfactory completion of the work.

Subdivision Considerations

Recommendation 4: In new subdivisions within the Wildfire Development Permit areas the City should require roofing materials that are fire retardant with a Class A and Class B rating. While it is recognized that wholesale changes to existing roofing materials within the City are not practical, a long-term replacement standard that is phased in over the roof rotation period would significantly reduce the vulnerability of the community. The City should obtain legal advice regarding the implementation of building requirements that are more restrictive than the BC Building Code.

Recommendation 5: The City must work towards improving access in existing areas of the community that are considered isolated and that have inadequate developed access for evacuation and fire control.

Recommendation 6: New subdivisions should be developed with access points that are suitable for evacuation and the movement of emergency response equipment. The number of access points and their capacity should be determined during subdivision design and be based on threshold densities of houses and vehicles within the subdivision.

Recommendation 7: Where forested lands abut new subdivisions, consideration should be given to requiring roadways to be placed adjacent to those lands. If forested lands surround the subdivision, ring roads should be part of the subdivision design. These roads both improve access to the interface for emergency vehicles and provide a fuel break between the wildland and the subdivision.

Recommendation 8: Proximity of hydrant locations to access points for forested parks should be a consideration during the design process for new subdivisions.

Recommendation 9: The City should investigate the potential of partnering with residents to promote treatment of public lands adjacent to private property. Private land owners could be encouraged to not only clean their own yards of debris and brush but also to be responsible for the removal of debris and brush from public lands immediately adjacent to them to a depth of 20 metres. Removal of material would be coordinated with the spring yard waste pickup program.

Recommendation 10: The City should work with the local development community to construct a City owned FireSmart show home that can be used as a tool to educate and communicate the principles of FireSmart to the public. The demonstration home would be built to FireSmart standards using recommended materials for interface communities. Vegetation adjacent to the home would be managed to guidelines outlined in the FireSmart program and would be both fire resistant and drought tolerant in nature.

Recommendation 11: The City should adopt a consistent standard for Registered Professional Forester reports that are required as part of the Development Permit waiver process. This would ensure that hazard mitigation activities are consistent and appropriate within all subdivisions in Wildland Fire Development Permit Areas (a proposed standard is contained within this report).

Recommendation 12: City should proactively enforce wildfire covenants requiring owners to maintain their properties hazard free on all properties in Wildland Fire Hazard Development Permit areas. Enforcement will serve to minimize fuel risks on problematic private properties and provide improved protection to adjacent lands.

Recommendation 13: City staff should investigate the creation of a process whereby new development on a given parcel that directly abuts an untreated private parcel triggers a requirement that the developer contact the adjacent land owner seeking permission to treat (thinning and brushing) the bordering area to a distance of no less than 100 m creating an immediate defence zone for the new development. This would reduce wildfire behaviour potential in the short term; however, a solution would still be needed to address maintenance of these treated areas if they are not developed within the next 10 years.

Individual Lot Considerations

Recommendation 14: The City should develop a landscaping standard for vegetation within Wildland Fire Hazard Development Permit areas (a proposed standard is contained within this report). The vegetation contained in the proposed standard should attempt to meet both the goals of fire resistance and drought tolerance to ensure water conservation. This standard should be applied to all new properties within the proposed Wildfire DP areas and be implemented on existing properties when building permits are requested for renovations/retrofits.

Recommendation 15: Many homes are built immediately adjacent to the forest edge. It is recommended that the City alter the Zoning Bylaw to require that developers leave building set backs on private land so that there is a minimum distance of 10 m between buildings and the forest interface. This standard should be applied to housing bordering both City owned and forested private land.

Management of City Parks and Green Spaces

Recommendation 16: The City should conduct an inventory of sensitive ecosystems identifying areas containing delicate vegetation, habitat, slope stability and erosion potential to ensure that fuel treatments and other park development do not negatively impact these important areas.

Recommendation 17: Prescribed fire and the use of a curtain burner should be allowed in order to improve the cost effectiveness of fuel treatment and expand the area of treatment. Any use of fire should strictly follow smoke management guidelines to limit the health impacts of smoke.

Recommendation 18: Consistent with the standards developed for wildfire covenants, the City should adopt a standard for fuel management in parks and green spaces (a proposed standard is contained within this report).

Recommendation 19: Heavily used trail networks within City parks, where ecologically appropriate, should be thinned and understory fuels removed up to 5-metres on each side of the trail network. Thinning will limit the ability of fire to spread and improve fire suppression capability throughout these heavily used corridors.

Recommendation 20: Where fire control access could be improved in City parks, and the resulting ecological impacts are considered acceptable, consideration should be given to widening specific trails to 3.2 metres (the width required for small emergency vehicle access). This should involve the removal of all obstacles such as trees and stumps but the trails should remain unpaved. Access points should be provided where they are feasible and effective.

Recommendation 21: Consultation should occur with the Parks Department during the subdivision development phase. This consultation should deal with: 1) Reviewing the wildfire hazard mitigation plans that are prepared by the developer's Registered Professional Forester (RPF) for areas being delivered to the City as park. 2) Site inspection of mitigation work prior to the City accepting new lands as park or open space. 3) Site mitigation plan review and site inspection of private portions of subdivisions. (Currently, Parks Staff do not review or inspect wildland fire mitigation plans on the private portions of subdivisions. These areas are evaluated by the Subdivision Approving Officer. Developer employed RPFs are supposed to sign off on their work plan but this is inconsistent. To ensure professional and un-biased evaluation of private lands within a subdivision the Subdivision Approving Officer should have access to a professional evaluation of both the work plan and the work completed by the developer.)

Recommendation 22: The City should always require the developer to mitigate the fire hazard on forested lands before they become the property of the City.

Other Considerations

Recommendation 23: The City should create an interactive website that outlines community fire risks and proactive steps individual homeowners can use to make their homes safer within the community. Other information, such as fire danger, FireSmart principles and reporting on recent treatment initiatives in the community could be maintained on the local site so that fire management issues specific to Kelowna could be easily communicated to the local population.

Recommendation 24: The City should assess funding options, such as a cogeneration plant, composting program or a minimal increase in property taxes, which could be used to encourage and aid property owners with fuel mitigation and to facilitate treatments on public lands.

Recommendation 25: Public education programs should be enhanced by 1) Integrating a unit of "FireSmart" and wildfire safety into the local primary school curriculum promoting the principles of community wildfire protection at a young age in order to improve awareness over time. This unit could be part of a general emergency preparedness teaching program. 2) Create a "FireSmart" sticker program where Fire Department staff attend residences and certify them as meeting "FireSmart" guidelines.

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1.0 Introduction

The 2003 wildfire season in British Columbia (BC) resulted in the most damaging forest fires the Province had experienced on record. The fires destroyed more than 334 homes and businesses, and caused the evacuation of 45,000 people (Filmon, 2004). The overall cost of the fires was estimated at $700 million (Filmon, 2004). The most extensive fire damage occurred within the City of Kelowna, where 238 homes were destroyed and more than 33,000 people were evacuated.

The extent of the damage caused by the 2003 fires is not unusual when compared with losses incurred by other fire prone countries such as the United States (US) and Australia. However, it was a first for BC and served as a powerful wake-up call for the province. The hazards associated with human developments existing within and adjacent to wildland forest, commonly referred to as the Wildland Urban Interface (WUI), were brought sharply into focus. The Firestorm 2003 Provincial Review (Filmon, 2004) identified these hazards and made recommendations for their mitigation. Efforts are being made, at various levels of government, to implement these recommendations. However, the WUI presents complex challenges and implementation is not an easy task. The purpose of this report is to identify those challenges within the City of Kelowna and to make recommendations for changes to policies, procedures and bylaws that will effectively reduce the City's wildfire risk. For the purposes of this report, wildfire risk is defined as the probability and consequence of a wildfire event.

Much of the Southern Interior of British Columbia contains fire-prone ecosystems that are adapted to relatively frequent (0 to 35 years) but low severity (low tree mortality) fires (Blackwell and Gray 2003). Fire suppression has been a long-standing and, in general, extremely effective policy in BC. While suppression is necessary in areas where fire is likely to endanger human life and property, there is a conflict between this policy and the natural environment. This conflict is particularly critical in fire-prone ecosystems because fuel builds up in the forest over time. Without frequent, low-severity fire, the fuel load continues to increase rather than being reduced naturally by fire. If an ignition occurs after a long period of fuel build up and when weather conditions have allowed the forest fuels to dry sufficiently, then a high severity (high tree mortality) fire occurs. High severity fires tend to have much more extreme fire behaviour and are more difficult to control. Due to their severity, these fires have negative consequences for both humans and the environment. While strategic fuel reduction activities on public land in Canada will substantially decrease the risk of extreme wildfire behaviour, it will not eliminate it. In order to effectively reduce risk in the WUI, these actions must be complemented by mitigation activities on private forested land, around individual homes and on structures. To achieve tangible success, policy at all levels of government needs to support these activities. For the purposes of this report, policy is defined as a statement based in beliefs or intentions that are used to rationalize a course of action or inaction.

2.0 Wildland Urban Interface Background

The classical definition of WUI is the place where the "*forest meets the community*". Other configurations of the WUI can be described as intermixed. Intermixed areas include smaller, more isolated developments that are embedded within the forest. An example of an intermixed interface is shown in Figure 1. In each of these cases, fire has the ability to spread from the forest into the community or from the community out into the forest. Although these two scenarios are quite different, they are of equal importance when considering interface fire risk. Within the City of Kelowna, the probability of a fire moving out of the community and into the forest is equal or greater to the probability of fire moving from the forest into the community. Regardless of which scenario occurs, there will be consequences for the City and this will have an impact on the way in which the community plans and prepares for interface fires.

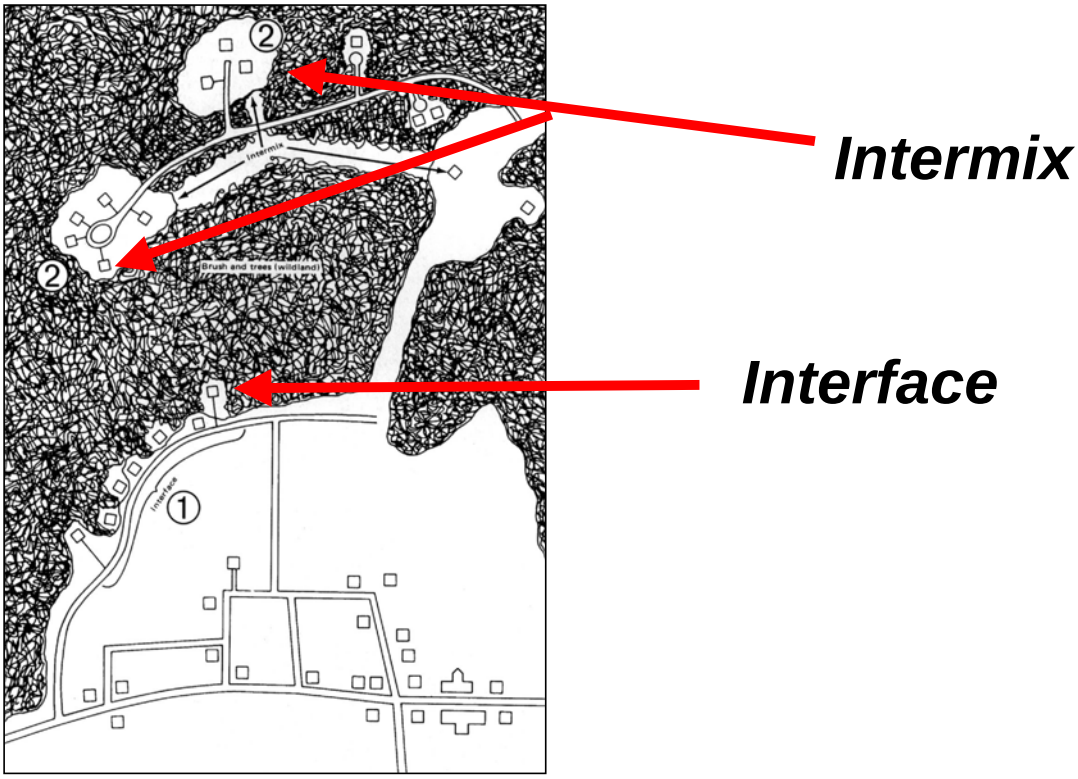

Figure 1. Graphical example showing variation in the definition of interface.

2.1 Wildland Urban Interface Continuum

The wildland urban interface continuum (Figure 2) summarizes the main options available for addressing WUI fire risk.

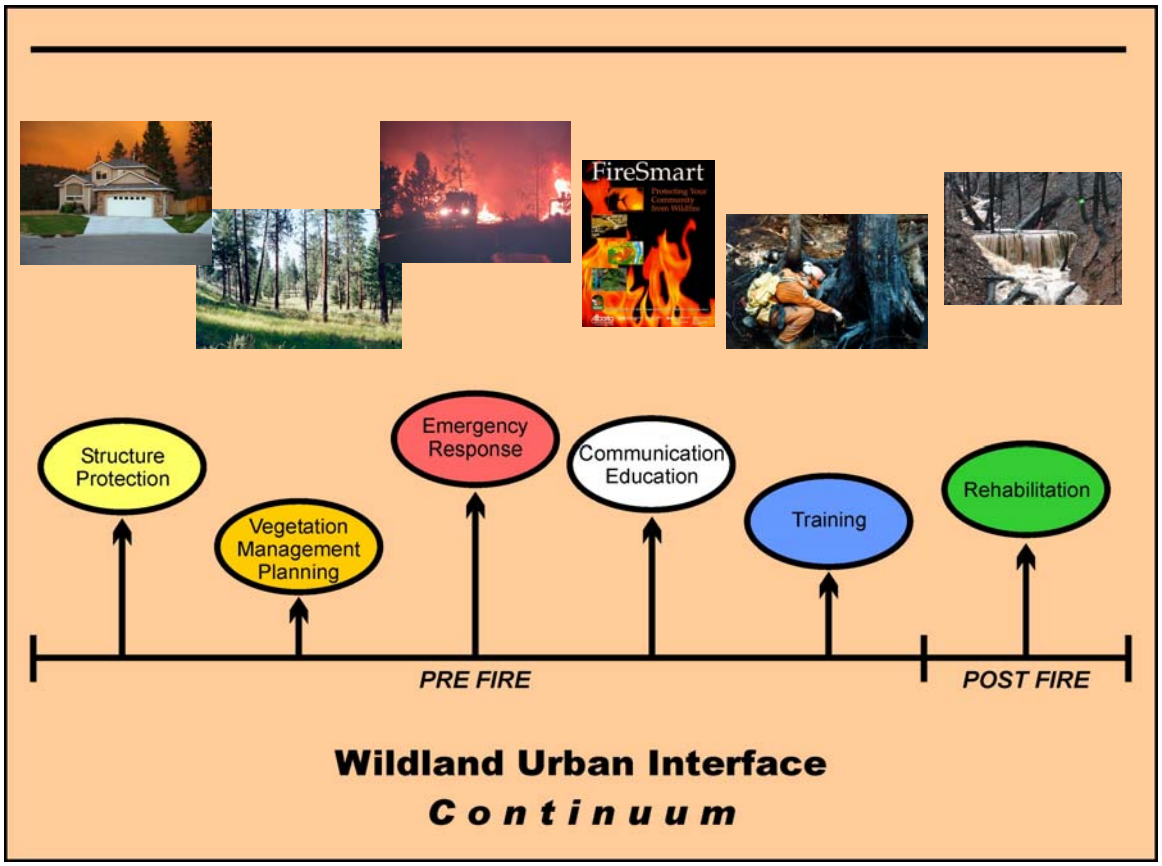

Figure 2. Wildland urban interface continuum.

The appropriate management response to a given wildfire risk profile is based on the combination and level of emphasis on several key elements: communication and education, training, emergency response, structure protection, and vegetation management. For example, in an interface area with a high-risk profile, equal weight may be given to all elements. Alternatively, in this same high-risk example, active intervention through vegetation management may be given a higher emphasis. This change in emphasis is based on the values at risk (consequence) and level of desired protection required. In a low risk situation the emphasis may be on communication and education combined with emergency response and training. In other words, a variety of management responses in different jurisdictions and/or within the same jurisdiction are appropriate and can be defined by the wildfire risk profile.

3.0 Review of Relevant Literature

A review of the available literature on policy as it relates to wildfire within the WUI suggests that many communities around the world are struggling with the WUI 'problem'. This review focuses primarily on policy in countries with similar political and socio-economic profiles to Canada. This is because the WUI problems and potential solutions identified in these countries, namely the US and Australia, were thought to be more applicable to the City of Kelowna. Canada, the US and Australia are all experiencing increased growth in the WUI, negative consequences of long-term fire suppression and increasing costs associated with wildfire. These three countries' existing mechanisms for dealing with increased wildfire risk are similar, as are their vulnerabilities.

None of the literature reviewed indicated that any jurisdiction had been successful in completely solving the WUI problem. However, it is unrealistic to expect that wildfire risk could be completely mitigated in any interface community. There is intrinsic wildfire risk associated with living in the WUI because, by definition, interface is human development within a matrix of forest fuels. However, there are also intrinsic amenity values associated with interface that compel people to live in the WUI despite the wildfire risk. The same is true for people who, for example, choose to live in flood prone and earthquake prone areas. The challenge for communities located in 'at-risk' areas is to be adequately prepared so that, when a disturbance event occurs, their risk is reduced such that their chance of survival is maximized.

3.1 Prevalent Issues

3.1.1 Policy Development, Community Values and Implementation

Historically, policy relating to wildfire in Canada, the United States and Australia has primarily consisted of fire suppression under all circumstances. This policy has been, for the most part, extremely successful; however, it has generated a legacy of problems for today's interface communities. These problems consist of the increased fire hazard associated with decades of fuel build-up and a widely held negative view of fire in the environment. The challenge for policy makers now, and in the future, will be to develop and implement policy that takes an integrated approach to mitigating wildfire risk, rather than a unilateral 'suppress all fires' approach.

Australia and some states, such as California, in the US have implemented building policies that restrict building design and define the types of external materials used in construction in order to reduce the ignitability of buildings (Australian Standard AS3959 1999; California Department of Forestry and Fire Protection 2005). In Australia, several problems were identified with these approaches when applied at the national level including inconsistent development outcomes, inconsistent site assessment using different processes and compromised policies due to commercial pressure (Zillante and Hamnett 2005; Cotrell and Lowe 2005). There is a great deal of evidence to support the use of more fire resistant building materials and the development of

policies that implement their use (Dombeck *et al*. 2003; Wildfire News 2005; Bradshaw 1988; Leonard and Bowditch 2003); however, it is important that policy supports well defined, consistent and tested standards for hazard mapping and hazard assessments so that communities are not subject to overly restrictive or inadequate building requirements.

In Australia, fire risk mapping at the federal level determines where the AS3959 standard for building in bushfire areas applies. However, experience has led to calls for system reforms that require mapping to occur at a local scale and be updated on a regular basis. Due to the costs associated with performing a mapping analysis, Zillante and Hamnett (2005) recommended that the frequency of mapping updates be based on the extent of changes over the previous period. In other words, if the mapping boundaries remained largely the same between the first and second mapping analysis, the period of time between the second and third mapping analysis could be lengthened. A coarse scale (federal or provincial) mapping exercise is not appropriate for determining where building regulations will apply within a municipality because it is likely to over- or under-state the risk in some areas.

Much of the literature has discussed the need to not only focus on changes such as building codes and bylaws, but to also consider the values of the specific interface community where the policies are to be implemented. Permanent and seasonal residents, absentee landowners, industry, visitors and public land management agencies share both wildfire risk and the consequences of a wildfire event (Winter and Fried, 2000). Therefore, policies need to address this broad stakeholder group. A number of authors note that the success of wildfire risk mitigation policy is dependent on collaborative partnerships between the stakeholders affected by wildfire in an interface community (Talberth *et al.* 2005; Dale 2004; Nelson *et al*. 2005; Bradshaw 1988; Cohen 1988). In general, public attitudes can vary widely with geographic location, past experience, residency status, residential choice factors, length of residency, environmental knowledge, trust in land management agencies and mitigation effects on adjacent homeowners (Blanchard *et al*. 2004). A number of studies have found that people tend to perceive "others" or "nature" as the primary contributors to wildfire risk and prefer policies that shift the responsibility for wildfire risk mitigation to government authorities (Winter and Fried 2000; Kumagai *et al*. 2002; Leonard and Bowditch 2003). However, other studies have found that people consider the reduction of wildfire risk to be a joint responsibility and are willing to take voluntary action to reduce their risk (Winter and Fried 2000). Local government policy should be tailored to the values of the specific community to which it applies.

Emphasis has also been placed on the need for different levels of government (municipal, provincial and federal) and individual landowners to work together in order to successfully reduce their risk (Dombeck *et al*. 2003; Dale 2004; Winter and Fried, 2000). Because fire does not recognize property or government boundaries, actions taken within one boundary, if not complemented and supported by actions 'next door', are likely to fail. Provincial governments, through legislation, affect what kinds of policies are possible at the municipal level. Private landowners and industry, through values held and perceptions of risk, determine whether a municipal policy can be successfully implemented. For example, people who value the aesthetic

and conservation aspects of their surrounding forested environment are unlikely to support a policy that requires them to clear their property of all trees. This kind of policy could also result in slope stability hazards. While some tree removal is likely warranted to reduce wildfire risk in most communities, policy must be designed to ensure that it is implemented in an appropriate way. When designing policy, it is important to be aware of all stakeholder values and activities so that policies will not fail when implemented, or have unforeseen long-term consequences.

There are two types of wildfire safety regulations most commonly used by local governments: Type 1) regulations that restrict the use of fire; and, Type 2) regulations that restrict building materials, require setbacks or restrict zoning. Generally, homeowners find the first type of regulation more acceptable because the onus is on the individual to refrain from high fire risk behaviours for the common good (Winter and Fried 2000). The second type of regulation imposes restrictions on the choices people can make about the placement and aesthetic qualities of their homes. It is potentially challenging to convince people that Type 2 regulations are beneficial, particularly when full insurance is available. However, other jurisdictions (Australia and California) have adopted Type 2 regulations because their risk reduction benefits outweigh their unpopularity (Australian Standard AS3959 1999; California Department of Forestry and Fire Protection 2005).

Several Type 2 policy options are generally available to local governments. These primarily include:

- Voluntary fire risk reduction for landowners (building materials and landscaping)
- Bylaws for building materials and subdivision design
- Covenants requiring set-backs and vegetation spacing
- Site assessments that determine the imposition of fire protection taxes
- Education
- Zoning in fire prone areas
- Treatments on private and public land (commercial thinning, non-commercial mechanical thinning, clear-cut commercial harvesting or prescribed burning)

According to a study by Winter and Fried 2000, homeowners most prefer voluntary, preventative mechanical vegetation treatments at the landscape scale and educational policies. Least favoured were coercive strategies that required homeowners to change aspects of their properties and prescribed burning.

Policies must strive to ensure that the cost of wildfire risk reduction is shared fairly between residents so that there are no cases of some people enjoying a reduction in risk at no cost, while others are constrained but do not receive any benefit (Winter and Fried 2000). Winter and Fried (2000) state that: “Wildland fire management is a non-excludable public good in that it is a service that must be provided to everyone living in the WUI if it is provided to anyone”.

3.1.2 Structure Ignitability

Whether or not a house will ignite during a wildfire is not an exact science as there are numerous variables involved. Under some conditions, even the most 'fireproof' structure is potentially vulnerable to ignition. However, there are a number of factors that reduce the probability of a structure igniting.

Wildfire can ignite structures by: 1) radiant heat from the flaming fire front (Figure 3); 2) conduction from burning embers (Figure 4); and, 3) convection from hot gasses (Bradshaw 1988). Burning embers or convective gasses containing burning embers are the major source of structure ignition during wildfires (Zillante and Hamnett 2005; Wildfire News 2005; Rhodes 2002; Cottrell and Lowe 2005; Leonard and Bowditch 2003). Radiant heat from the fire front is rarely responsible for structure loss. However, burning ember showers can occur for extended time periods during a wildfire and can pile up against and ignite combustible material on or around a structure, or find gaps in the house and ignite the house interior (Leonard and Bowditch 2003). Studies have found that, if minor ignitions are extinguished following the pass of the fire front, there is a much greater chance that a structure will be saved (Ramsay and McArthur 1995; Ramsay et al. 1987; Rhodes 2002). Minor ignitions that are unattended can result in structure loss in the hours following the pass of the fire front. Once structures ignite, radiant heat and flame contact can ignite adjacent structures. Structures in close proximity (within approximately 10 m) to one another are more likely to spread fire than those that are further apart (Bradshaw 1988). The radiant heat from a fire in a nearby structure lasts for a much longer period of time than the passing of a fire front (Leonard and Bowditch 2003). Timber fences and hedges between properties have also been found to spread fire between properties.

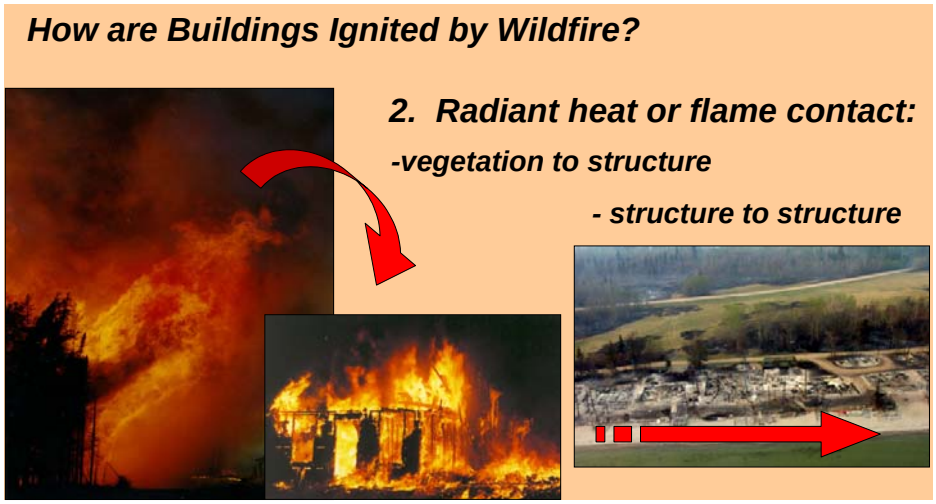

Figure 3. Radiant heat and flame contact allows fire to spread from vegetation to structure or from structure to structure.

Figure 4. Firebrand caused ignitions: burning embers are carried ahead of the fire front and alight on vulnerable building surfaces.

Research conducted after the unprecedented urban encroachment of the 2003 Canberra (Australia's capital city) Bushfires found that, of 516 homes destroyed, none were directly impacted by flames from the fire front itself (Leonard and Bowditch 2003). This fire penetrated well into urban Canberra despite the adequate set back provided by the perimeter roads that buffered the suburbs from the forest fuels. The houses in the affected areas were particularly vulnerable to ember attack because there were no restrictive design or building requirements for the 30-year-old suburb and AS3959 is not applied retroactively (Leonard and Bowditch 2003). The placement of large houses on moderate sized blocks allowed fire to spread quickly between structures (Leonard and Bowditch 2003). Vegetation and timber fencing around people's homes was also a major contributing factor to structural fire spread. Both the burning structures and vegetation created ember showers that started fires downwind, further towards central Canberra. Leonard and Bowditch (2003) state that "the contribution/synergistic effect of a number of factors resulted in an extreme level of impact on the urban interface – an impact far greater than had previously been considered probable". It is important to note that this impact was not considered probable even though these fires occurred in a landscape that regularly experiences extreme fire behaviour. The fire behaviour that occurred during this fire was more extreme than was previously thought possible by Australian fire behaviour specialists (McLeod 2003).

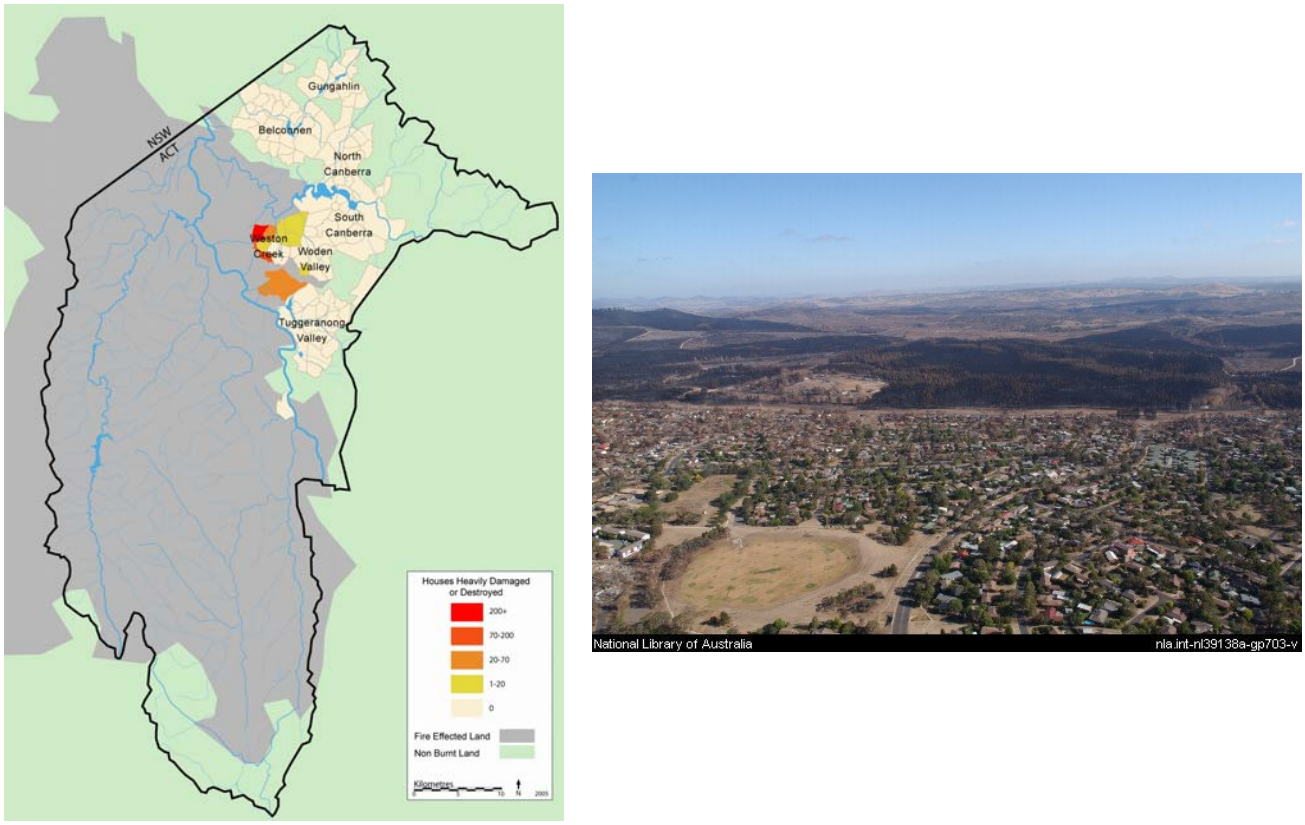

Figure 5. The image on the left shows the fire boundary and the Canberra neighbourhoods where homes were destroyed. The image on the right shows the road around the edge of the neighbourhoods. The burnt forest on the other side of the road was a radiata pine plantation. The fire spread from native forest, through grassland and into the pine plantation before reaching the urban edge.

Because embers are thought to play the major role in structure loss, it is generally accepted that a balance between building materials and vegetation management will substantially reduce structure damage during a fire (Zillante and Hamnett 2005; Cohen 2000; Bradshaw 1988; Leonard and Bowditch 2003; Dennis 2001). These measures include placing small mesh screens on confined spaces, clearing flammable vegetation within 10 m of structures, providing adequate separation between structures, and using non-combustible roofing material (Bradshaw 1988). It is particularly important to fireproof a structure when it is required to act as a safe haven during a fire. However, if policy places greater emphasis on full evacuation for life protection rather than the defence of unattended structures, it may be appropriate to require less stringent building requirements (Zillante and Hamnett 2005). The determination of how far to take building requirements depends on the costs versus the benefits. Zillante and Hamnett (2005) describe the determination of this balance as a public safety policy decision, where the cost of additional wildfire structure protection has to be balanced against the potential for reduced structure losses. Where full insurance is available, there may be less incentive to incur an extra cost for 'fireproofing' a structure. However, everyone benefits when a parcel or lot is

more fireproof because it reduces the likelihood of fire spreading from or to that property and frees up fire suppression resources (Winter and Fried 2000).

The implementation of Type 2 policies can present challenges in existing subdivisions (Blanchard and Ryan 2004; Bradshaw 1988). This is likely due to the increased cost associated with replacing materials on existing homes. However, as long as developers agree to use alternative materials in new construction, these policies are likely to succeed in new subdivisions (Blanchard and Ryan 2004). In addition, policy can require existing homeowners to use more fire resistant building materials during retrofits or renovations of their homes. In this way, there are few, if any, additional costs associated with the homeowner complying with the policy.

3.1.3 Fuel Mitigation on Public and Private Land

Fuel mitigation on forested public and private lands is a complex and expensive undertaking. Funding is a major issue because of the cost of fuel treatments. Governments tend to under-fund fuel mitigation and there is little incentive for private landowners to pay the cost on their own land. Talberth *et al.* (2005) attributes under-investment to the 'free-rider' problem and conflicts between fuel treatment and amenity values in the WUI. In other words, because fuel hazard mitigation is a public good with benefits that no one is excluded from, people are unlikely to pay for it voluntarily (Winter and Fried 2000; Wildfire News 2005). Policy options that have been used to provide incentive and financial aid for fuel hazard mitigation in the past include: cost sharing between organisations; government grants; pilot projects; education; commercial thinning; provision of technical assistance to landowners; and the dissemination of risk information (Dombeck et al. 2003; Fire Plan Leaflets 2005).

In terms of conflicts with amenity values, tree removal must be aesthetically and environmentally sensitive. The environmental consequences of mechanical fuel treatments (thinning) are not yet well known. However, removal of all trees on a steep slope or all trees on a forested landscape raises visual, slope stability and environmental concerns. To be successful, fuel hazard mitigation treatments involving tree removal need to achieve a balance between removing too much and removing too little (Busenberg 2004). Prescribed fire is an environmentally appropriate treatment in fire prone ecosystems but it is often difficult to implement due public concerns regarding smoke and fire escape. However, an out of control wildfire is far more dangerous in terms of smoke and fire rate of spread than a well-planned and smoke vented prescribed burn. Studies have shown that people are more likely to pay for fuel hazard mitigation activities if there are clear links between the activity and the preservation of uninsurable values such their forested surroundings (Talberth *et al*. 2005). In a community where the surrounding forested landscape is highly valued it may be beneficial to develop policy that emphasizes values such as ecosystem resilience to fire, water quality, wildlife habitat, forest health, aesthetic values and ecosystem restoration rather than fire control (Dombeck *et al*. 2003; Talberth *et al*. 2005). Policy that emphasizes these uninsurable values may encourage some people not just to pay for the work, but also to undertake the work.

On a smaller scale, encouraging people to create set-backs around their homes can also be challenging. On existing properties, creating set-backs can require a substantial change to existing landscaping. On new properties, the set-back can be built into the landscaping and may then be easier to implement. The success of such a policy is likely to be dependent on how well it works with existing homeowner values (Nelson 2005). It is important that information and education is provided on fire resistant landscaping options so that, as new owners move to a home or as existing owners change their vegetation over time, they are more likely to create a fire resistant landscape that fits within their value set (Nelson 2005). Covenants and ordinances have been widely used to require set-backs around homes. In most cases, these policies have failed because they are not enforced (Winter and Fried 2000). Coordination between government policy and insurance agencies can provide incentives for people to create setbacks and to remove fuels around their homes. Providing homeowners with help from government agencies to determine trees that should be removed and to help with cutting and or debris disposal has been successful in engaging homeowners in risk reduction (Wildfire News 2005).

3.1.4 Subdivision design

The major aspects of subdivision design that influence wildfire risk are access, water pressure and hydrant locations. The number of access points and the width of streets and cul-de-sacs determine the safety and efficiency of evacuation and emergency response. The width of water mains can impact the water pressure available to fire fighters. The spacing of fire hydrants influences how effectively fire fighters can protect structures. Water mains and hydrant spacing can be improved in new subdivisions with a marginal increase in cost. However, the cost of changing these factors in existing subdivisions is extremely high and may not be generally practical.

Changing access in existing subdivisions is also costly if the road is not being built for other purposes. However, in terms of life safety during evacuation, the costs of road building are likely to be justified where access is particularly bad. In interface communities, roads are often narrow and densely vegetated in order to protect the privacy of homes and the character of the neighbourhood. On-street parking can also contribute to the hazard on these roads, which are already unlikely to have a high capacity under heavy smoke conditions (Cova 2005). When the time for evacuation is limited, poor access has contributed to deaths associated with entrapments and vehicle collisions during wildfires (DeRonde, 2002). Methodologies for access design at the subdivision level can provide tools that help to manage the volume of cars that need to egress an area within a given period of time (Cova 2005).

4.0 Stakeholder Survey Results

4.1 Survey of Kelowna Residents

Survey questions (Appendix A) were asked during two days of door to door surveys in two Kelowna neighbourhoods and during a four day web survey on www.castanet.net. The full results are presented in Appendix A.

Overall, perceptions of risk varied between neighbourhoods, most probably due to their different experience with wildfire. Most people felt that the protection of their home from wildfire was either shared or primarily their own responsibility. However, there was substantial uncertainty regarding whether or not the City and the Province had done enough to protect their homes from wildfire. People were generally supportive of the City taking measures to reduce wildfire risk regardless of whether this meant new bylaws, enforcement or increased property taxes. However, people cautioned that these changes would have to be 'within reason'. The survey did not gain an indication of how much more people were willing to pay. Most people felt that, as individuals, they had done enough to protect their homes from wildfire. However, the data collected by the surveyors on roofing and vegetation indicates that most homes would not be rated as FireSmart (Partners in Protection 2003). Table 1 provides a more detailed summary of the main survey results.

Table 1. Summary of main points from the resident survey process.

Question	Summary of Responses
3	**My home is at risk from wildland fire (yes/no)**
Perceptions of wildfire risk differed between neighbourhoods and between surveys. In Glenmore, 74% of people surveyed considered that their homes were at risk from wildfire. In the South Mission 63% of people considered that they were not at risk. The reason for this response in the South Mission is attributed to the 2003 wildfires that burnt through that neighbourhood and residents concluding that their homes are 'no longer' at risk. The web survey indicated that, within Wildfire DP Areas, there was uncertainty about whether or not their homes were at risk. Outside Wildfire DP Areas, the majority of people considered that their homes were not at risk.	
5	**I feel the responsibility for protecting my home from wildfire lies mostly with: a. myself, b. the Kelowna Fire Department, c. the City of Kelowna, d. the Provincial Government.**
The door to door surveys indicated that the majority of people felt that the responsibility for protecting their homes from wildfire was shared between themselves, the Kelowna Fire Department, the City of Kelowna and the Provincial Government. The 'combination' option was not available for the web survey and respondents were very varied in terms of whom they selected as being responsible for protecting their homes from wildfire.	
6	**I have done enough to protect my home from the threat of wildfire (yes/no)**
Respondents generally felt that they had done enough to protect their homes from wildfire. However, during the door to door survey, people frequently commented that they did not feel that their neighbours had done enough.	
7	**The City of Kelowna has done enough to protect my home from the threat of wildfire (Yes/No/Don't Know)**
8	**The province has done enough to protect my home from the threat of wildfire (Yes/No/Don't Know)**
In general, people felt that the City had done enough to protect their homes from wildfire. People's responses were very different when asked whether the Province had done enough to protect their homes from wildfire. In Glenmore, 83% of people responded as 'don't know' or 'yes'. A number of people commented that they didn't think the Province was even relevant to the protection of their home. However, in the South Mission 74% of people answered 'no' or 'don't know'. Many people in the South Mission commented that the Province did not do enough to prevent the Okanagan Mountain Park Fire but that they did do enough during and after the fire.	
9	**Would you support a change to City Bylaws such that renovations or retrofits of existing buildings**

Question	Summary of Responses
	would trigger requirements for wildland fire risk reduction? (Yes/ No)
In all cases respondents supported changes to bylaws such that renovations or retrofits of existing buildings would trigger requirements for wildland fire risk reduction.	
10	**Would you support the creation of cleared fire breaks adjacent to your neighbourhood to enhance protection from wildfire if it meant an increase to your property taxes? (Yes/ No)**
People were generally supportive of fire breaks even if it meant an increase to their property taxes. However, during the door to door survey, some people commented that they were not supportive of fire breaks because they didn't feel they worked, not because of the potential property tax increase. There were also several comments regarding the extent of the tax increase – it would be supported as long as it was 'within reason'. The two issues combined within this question mean that it is difficult to interpret the reason for people's 'no' responses.	
11	**As a resident, which of the following would you rank most highly: A. The character created by the presence of easily combustible vegetation on or near your property. B.The enhanced protection of your home created by removing all easily combustible vegetation. (A/ B)**
Question 11 presented some challenges during the door to door survey as people were unsure of the implications of responses A and B. The surveyors were instructed to respond, if people asked, that this referred to modifying their existing vegetation in favour of less combustible species and creating a 10 m fuel free zone around their home. People were far more reluctant to change their existing landscape. The additional information given to door to door respondents is likely to be the primary reason for the difference between the web and door to door survey responses. However, survey results indicated that the majority of people were in favour of enhanced protection created by the removal of easily combustible vegetation around their homes (Door to Door 52%, 52%, Web 77% and 90%).	
12	**Would you support initiatives that would compel individual private land owners to reduce the hazard risk on their properties thereby reducing the risk to the overall community? (Yes/ No)**
In all case respondents supported initiatives to compel individual private land owners to reduce the hazard risk on their properties, thereby reducing the risk to the overall community.	
13	**Do you support: A. The wholesale clearing of land for the purpose of new development in interface zones for the purpose of wildland fire protection. B. The sensitive integration of housing into the landscape at the expense of some security from wildland fire? (A/B)**
Except for those people living outside wildfire DP areas, the majority of respondents were against the wholesale clearing of land for development.	
14	**My roof is made from: a. wood b. metal c. clay tiles d. asphalt shingles e. other non-combustible material (A/ B/ C/ D/ E)**
15	**My home is setback from wild grass and forest vegetation by a distance of: a. < 10 m b. 10-30 m c.> 30 m (A/ B/ C)**
16	**There is a zone of 10 m around my house that is cleared of fuel including dead wood, trees, shrubs, wild grass and woodpiles. (Yes/ No)**
17	**The trees within 30 m of my house have their crowns spaced 3-6 metres apart and shrubs are sparse or absent. (Yes/ No)**
18	**There are dead or unhealthy trees around my home. (Yes/ No)**
19	**My home is on a slope. (Yes/ No)**
20	**My home has mostly: a. wood siding, b. vinyl siding, c. stucco d. other (A/ B/ C/ D)**
The final part of the survey was answered by the surveyors and was intended to determine what percentage of the two neighbourhoods had non-fire smart characteristics. In terms of roofing materials, 85% of the homes surveyed in Magic Estates had unrated wooden roofs. Only 7% of homes in the South Mission had unrated wooden roofs. In both neighbourhoods only a small (<4%) percentage of homes were surrounded by a 10 m zone that was free of fuels. The spacing between tree crowns was also inadequate around the majority of homes in both neighbourhoods.	

4.2 Survey of Civic Stakeholders

In addition to the resident survey, stakeholders from within the City of Kelowna were surveyed. Survey questions were sent out by email and responses were either by email, phone or at the stakeholder meeting. The information received from these stakeholders was used to develop and refine the recommendations contained in this report. The following people were surveyed:

- Policy, Research and Strategic Planning Manager
- Development Services Manager
- Subdivision Approving Officer
- Inspection Services Manager
- Permits and Plan Checking Manager
- Development Engineering Manager
- Environment/ Solid Waste Manager
- Environment Technician II
- Risk Manager
- Fire Chief
- Fire Prevention Officer
- Parks Manager
- Parks and Landscape Planner
- Urban Forestry Supervisor
- Planner Specialist

4.3 Survey of External Stakeholders

Stakeholders external to the City were also surveyed by email and phone. The following organizations were contacted:

- Ministry of Agriculture and Lands
- Protection Branch (Ministry of Forests and Range)
- Building Policy Branch (Ministry of Forests and Range)
- Ecosystem Section (Ministry of Environment)
- Urban Development Institute: Kelowna Chapter
- Interface Fire Committee
- Office of the Fire Commissioner
- Home Builder's Association: Kelowna
- Provincial Emergency Program
- Insurance Bureau of Canada

Responses were received from all but Provincial Emergency Program, Interface Fire Committee and Protection Branch. Stakeholder input was used to develop and refine the recommendations contained in this report.

5.0 Wildfire Vulnerability within the City of Kelowna

The results of the Provincial Strategic Threat Analysis indicate that the probability of fires within and adjacent to the City of Kelowna, hereinafter referred to as 'the City', is high. Therefore, based on the current and future values at risk, a high standard of fire planning and protection is warranted in order to minimize future fire losses to the City.

The City has taken a number of steps to reduce the community's vulnerability to fire. Most notably, emergency response and coordination with the Ministry of Forests and Range has been improved to more effectively deal with wildland urban interface fires.

The City has utilized the results of a wildfire hazard-mapping project from 2004 to rationalize the most recent Wildland Fire Hazard Development Permit (Wildfire DP) areas that require special considerations for wildfire hazards during development planning.

While the City has made progress towards addressing wildland urban interface issues, significant change is still required to embrace and adopt the key concepts of becoming a FireSmart community.

The City's options for management of wildfire risk include developing and modifying policy and bylaws to improve clarification of responsibility, mandated standards, enforcement tools, and long-term effectiveness monitoring. There are currently a number of policy and bylaw processes that are managed by different departments with varying resources and mandates, which limits the coordination and effectiveness of the process.

5.1 Landscape Level Risk Assessment

An assessment of spotting risk identified forested areas, existing both within and outside the City, capable of producing burning embers that can spot into the interface. This analysis demonstrated that a substantial portion of the City is vulnerable to spotting from forests within and bordering City limits.

Both the Provincial Strategic Threat Analysis and subsequent work on this project have identified a major risk associated with fuel types on Crown land. Clearly, these fuels are the responsibility of the Provincial Government. Similar to the Okanagan Mountain Park fire, these areas have the potential to allow fire to travel into City limits and/or to create spot fires that could impact specific neighbourhoods within the City of Kelowna.

Spotting risk from fuel types within City limits is associated with both City owned land and parcels of private land. While there is a process to address fuel hazards on City owned property, there is a problem in dealing with large undeveloped forested lots that pose a significant wildfire risk.

5.2 Subdivision Considerations

Within the Wildfire DP areas, there are large numbers of homes that currently have roofing that is vulnerable to fire. This roofing problem is associated with both older and current subdivision construction. This is considered one of the key issues that must be addressed if the City is to effectively reduce its vulnerability to wildfires.

Within the Wildfire DP areas, numerous subdivisions border on to City owned green spaces or privately owned undeveloped lots. Typically, vegetation is growing an unacceptable distance from homes, which increases the probability of radiant heat and flame contact from vegetation to structure.

The City's current covenant process is intended to reduce fire risk in new subdivision developments and is an appropriate policy tool. However, several issues reduce the effectiveness of covenants. These include:

- Inconsistency in the standards for RPF fire hazard reports that are required as part of the Development Permit waiver process;
- Lack of fuel management standards;
- Inadequate consideration of landscape level risk;
- Ineffective enforcement following the initial sale of land; and,
- Inadequate consideration of long-term vegetation management.

Access for emergency vehicles and evacuation routes are inadequate within much of the City's urban interface. Many subdivisions are considered isolated because of one-way access in and out. The subdivisions accessed via Clifton Road are considered a classic example of this issue. Road widths in some cul-de-sacs are also of concern because large vehicles cannot easily turn around. Road widths of access routes may become a concern during evacuations, particularly if there is heavy smoke and a large volume of cars and emergency vehicles using the road. Hydrant location and water pressure were also identified as issues. In particular, hydrants are not necessarily present at park access points but, if they were, the efficiency of fire suppression within and adjacent to parks could be greatly improved.

5.3 Individual Lot Considerations

The fire department has been active at the local neighbourhood level to communicate with and educate residents about FireSmart. However, even with an increase in the overall awareness of fire risk within the City, many property owners retain landscaping that elevates the risk of fire to individual properties.

Building materials used in the construction of new homes in several of the subdivisions visited as part of this project have not met the FireSmart standard. Many new homes within the wildland urban interface have major components of wood construction and/or design features that are vulnerable to wildfire, such as: vulnerable exterior siding, open balconies, decks and porches, and eaves and open venting.

Landscaping choices are also of concern on many properties. Highly combustible vegetation has been widely used in landscaping. In addition, many properties do not have an adequate setback to forest and grass vegetation. In the South Mission, it was noted that a number of trees that the City had marked as hazard trees for removal following the 2003 wildfires have not been removed. These trees are on private property and there are no mechanisms for the City to

enforce the removal of hazard trees unless they impact public property. The current system means that concerned residents have to negotiate the removal of these trees with their neighbours. Dead or unhealthy trees on private property are a fuel, property and personal safety hazard.

5.4 Management of City Parks and Green Spaces

Since the Okanagan Mountain Park Fire the City has been implementing fuel treatments according to a plan that identified the highest priority areas for treatment. Currently, there is no standardized approach to fuel treatments; instead site-specific prescriptions have been developed with the help of a consultant. Long-term maintenance is being considered, however at the present time Parks is still dealing with the backlog of areas that have never been treated.

The City of Kelowna does not have an inventory of sensitive ecosystems and habitats that may be negatively impacted by fuel treatments. Within some parks and green spaces, important ecological values in specific locations may be negatively impacted if these values are not inventoried.

There is a considerable build-up of fuel within some City parks and green spaces. The application of prescribed fire and/or the use of a curtain burner would increase the City's ability to treat specific identified hazard areas at an acceptable cost. While it is recognized that the resultant smoke may be a potential health hazard, careful planning and consideration of smoke venting indices can mitigate the negative impacts of smoke. The positive benefits of treatment could out weigh the negative health hazard, particularly if consideration is given to the amounts of smoke that would be generated by a large and destructive fire such as the Okanagan Mountain Park Fire.

The responsibility for the identification and management of fuel hazards within City parks appears to be well defined. However, occasionally the city purchases or receives land at the time of subdivision, where fire mitigation has not been considered or completed. In most cases the developer is asked to complete fuel mitigation on these lands prior to turning them over to the city. A city policy is needed to ensure that all lands are treated in this manner and to avoid taxpayers having to subsidize treatment once the land transfer has already taken place.

Access within City parks and green spaces could also be improved. In existing City parks the access is not wide enough for emergency vehicles, which could hinder suppression efforts in the event of a wildfire. The City sometimes creates access points in green spaces within subdivisions, which enable access for fuel mitigation. However, there is no consistency in planning where these access points are located.

Forest health within City parks and green spaces is declining due the effects of long-term fire suppression and related insect and pathogen damage. This decline in forest health is expected to result in continued increases in fuel loads and associated fire risk over the next decade. Improving forest health will help to mitigate the wildfire hazard on forested lands. A discussion

of the forest health factors affecting the City of Kelowna and some recommendations for addressing them are contained in a summary report completed by Janice Hodge of JCH Pest Management (Appendix C) as part of this project.

6.0 Corrective Policy Remedies Recommended for Application in Kelowna

#	Policy Action	Rationale	Responsibility	Cost/Resource Requirements	Priority
1	Consider working with the BC Building Policy Branch to create a structure that would enable municipality to better address wildland urban interface protection considerations.	The City cannot currently implement policy that has more restrictive requirements than the BC Building Code. The City must either work with the BC Building Policy Branch to change the code at the provincial level or get an allowance to have a more restrictive requirement through the Concurrent Authority Provisions of the Community Charter.	Inspection Services	Low: $3000 for staff travel and lawyer review of bylaw language. Medium: $4000. additional funds for consultation with selected stakeholders High: $5000. Additional funds for detailed consultation with stakeholders and public.	High
2	Lobby the province to identify and document hazardous fuel types on crown land that are not within the boundaries of the City, but that are adjacent to residential neighbourhoods that could be impacted by a wildland urban interface fire. The City should lobby the Province to initiate a fuel treatment program that addresses these areas.	Both the Provincial Strategic Threat Analysis and subsequent work on this project have identified a major risk associated with fuel types on Crown land. Currently, the municipality is expected to pay 50% of the costs for treatment of adjacent Crown Land, and to pay for stumpage on any wood removed regardless of its commercial value. Clearly, these fuels are the responsibility of the Provincial Government. Similar to the Okanagan Mountain Park fire, these areas have the potential to allow fire to travel into City limits and or create spot fires that could impact specific neighbourhoods within the City of Kelowna.	Fire Department	Staff Time to lobby the province to appropriately manage their lands or allow us to manage treatments for them and direct firms to submit the billing to them. Can be accommodated within existing staff budget.	High
3	Investigate the establishment of agreements with the Province that would allow developers to treat crown land directly adjacent to new developments as a required part of the development process. The Province would then pay the mitigation cost to the developer upon satisfactory completion of the work.	As above.	Fire Department	Staff Time to lobby the province to change existing policies surrounding treatment of crown land. Can be accommodated within existing staff budget.	High

#	Policy Action	Rationale	Responsibility	Cost/Resource Requirements	Priority
4	Require roofing materials that are fire retardant with a Class A and Class B rating in all new and existing subdivisions within the Wildfire Development Permit areas.	While it is recognized that wholesale changes to existing roofing materials within the City are not practical, a long-term replacement standard that is phased in over the roof rotation period would significantly reduce the vulnerability of the community. The City should obtain legal advice regarding the implementation of building requirements that are more restrictive than the BC Building Code.	Planning and Development Services	New Subdivisions: Amendment to Wildland Fire Development Permit area requirements within the OCP. Can be accommodated within existing staff budget. Existing Subdivisions: Cost reflected in item #1.	High
5	Work towards improving access in existing areas of the community that are considered isolated and have inadequate developed access for evacuation and fire control.	Access within some existing subdivisions is currently inadequate for both evacuation and response in the event of wildfire. As new development occurs on lands adjacent to these areas effort must be made to ensure improved and alternate access is provided.	Planning and Development Services	Can be incorporated as an additional item for staff to assess as part of the ASP evaluation process for new neighbourhoods as well as during the subdivision process. Can be accommodated within existing staff budget	Medium
6	Ensure new subdivisions are developed with access points that are suitable for evacuation and the movement of emergency response equipment. The number of access points and their capacity should be determined during subdivision design and be based on threshold densities of houses and vehicles within the subdivision.	As above.	Works and Utilities	Can be incorporated as part of the regular review process for the 'Subdivision, Development and Servicing Bylaw No, 7900'. Can be accommodated within existing staff budget.	High
7	Consider requiring roadways to be placed directly adjacent to forested lands where those lands abut new subdivisions. If forested land surrounds the subdivision, ring roads should be considered as part of the design.	Access for emergency vehicles and evacuations is inadequate within much of the City's urban interface. These roads both improve interface access for emergency response vehicles and provide a fuel break between the forested lands and the urban development.	Planning and Development Services	Can be incorporated as an additional item for staff to assess as part of the ASP evaluation process for new neighbourhoods as well as during the subdivision process. Can be accommodated within existing staff budget.	Medium
8	Assess the proximity of hydrant locations to access points for forested parks during the design process for new subdivisions	Access to water is a primary need for fire suppression.	Planning and Development Services	Can be accommodated within existing staff budget.	High

#	Policy Action	Rationale	Responsibility	Cost/Resource Requirements	Priority
9	Investigate the potential of partnering with residents to promote treatment of public lands adjacent to private property. Private land owners could be encouraged to not only clean their own yards of debris and brush but also to be responsible for the removal of debris and brush from public lands immediately adjacent to them to a depth of 20 metres. Removal of material would be coordinated with the spring yard waste pickup program.	Spotting risk from fuel types within City limits is associated with both City owned land and parcels of private land. While there is a process to address fuel hazards on City owned property, this new initiative would provide wide spread defence on an annual basis. There is a problem in dealing with large, undeveloped, private forested lots that pose a significant wildfire risk.	Parks Department	Cost would be primarily staff (or contractor) time for promotion and advertising. Pricing options would depend on the amount of time and marketing effort. Low: $5,000 per year Medium: $10,000 per year High: $20,000 per year	Medium
10	Develop a landscaping standard to be applied to all new homes within the Wildland Fire Development Permit areas and to existing properties where building permits are requested for renovations and retrofits	Many properties near the interface are landscaped inappropriately for prevention of wildfire. Vegetation used on properties at risk to wildfire should be fire resistant and drought tolerant	Planning and Development Services / Parks Department (Lead to be determined)	Low; $0 (Issue with Parks staff availability to assist in completing this project) Medium: $10,000 High: $20,000	Medium
11	Alter Zoning Bylaw 8000 to require homes to be setback a minimum of 10 meters from the forest interface	Many homes are built immediately adjacent to the forest edge. FireSmart recommends that a minimum 10 meters of space should exist between structures and the forest to prevent ignition by radiant heat.	Planning and Development Services	Can be accommodated within existing staff budget.	High

#	Policy Action	Rationale	Responsibility	Cost/Resource Requirements	Priority
12	Work with local development community to construct a City owned FireSmart show home that can be used as a tool to educate and communicate the principles of FireSmart to the public. The demonstration home would be built to FireSmart standards using recommended materials for interface communities. Vegetation adjacent to the home would be managed to guidelines outlined in the FireSmart program.	The Fire Department is actively working at the local neighbourhood level to communicate with and educate residents about FireSmart landscaping practices. However, even with an increase in the overall awareness of fire risk within the City, many property owners retain landscaping that elevates the risk of fire to individual properties. Building materials used in the construction of new homes in several of the subdivisions visited as part of this project have not embraced the FireSmart standard. Many new homes within the wildland urban interface have major components of wood construction and or design features that are vulnerable to wildfire; vulnerable exterior siding, open balconies, decks and porches, and eaves and open venting.	Fire Department	Low: $25,000. Combine project goals with a scheduled Civic Properties construction project. Funds will cover upgrade costs to FireSmart building materials and landscaping where required. Medium: $187,000. Partner with CHBA, UDI, roofing industry etc. on a 50/50 cost share to build a Firesmart house. High: $374,000. City Builds a FireSmart house. (Costs based on lot price of $150,000 and construction of a 1600sqft house @$140/sqft). (Offsetting cost may be available depending on use of structure. If the use is a single family dwelling, rental income is estimated at approximately $1,500 month)	Medium
13	Adopt a consistent standard for Registered Professional Forester reports that are required as part of the Development Permit waiver process. This would ensure that hazard mitigation activities are consistent and appropriate within all subdivisions in Wildland Fire Development Permit Areas (a proposed standard is contained within this report).	The City does currently provide a list of guidelines to Registered Professional Foresters (RPF) as part of the Development permit Waiver paperwork. Treatment recommendations received vary dramatically depending on the particular RPF creating the mitigation plan. Creating a standard that must be met will limit the variety of treatments proposed and create a more consistent treated landscape across various subdivisions	Planning and Development Services	Can be accommodated within existing staff budget	High

#	Policy Action	Rationale	Responsibility	Cost/Resource Requirements	Priority
14	Proactively enforce wildfire covenants requiring owners to maintain their properties hazard free on all properties in Wildland Fire Hazard Development Permit areas. Enforcement will serve to minimize fuel risks on problematic private properties and provide improved protection to adjacent lands.	Covenants are not effective beyond the sale of a property unless they are enforced.	Fire Department	Low, Medium, High: $70,000 (all inc.) for new Fire Prevention Officer. Existing staff are already stretched to meet inspection workload.	High
15	Investigate the creation of a process whereby new development on a given parcel that directly abuts an untreated private parcel triggers a requirement that the developer contact the adjacent land owner seeking permission to treat (thinning and brushing) the bordering area to a distance no less than 100m creating an immediate defence zone for the new development. This would reduce wildfire behaviour potential in the short term; however, a solution would still be needed to address maintenance of these treated areas if they are not developed within the next 10 years.	Within the Wildfire DP areas numerous subdivisions border on to City owned or privately owned lots and green spaces. Typically, the vegetation is within unacceptable limits of the homes, which increases the probability of radiant heat and flame contact from vegetation to structure.	Planning and Development Services	Can be accommodated within existing staff budget.	High
16	Conduct an inventory of sensitive ecosystems identifying areas containing delicate vegetation, habitat, slope stability and high erosion potential. Developing this information will facilitate a better understanding of the location of areas containing the overlapping hazards of sensitive ecosystems, sensitive slopes and wildfire. Mitigation strategies must be blended to accommodate conditions specific to these sites to protect from potential negative impacts created by addressing only wildland fire issues.	The City of Kelowna does not have an inventory of sensitive ecosystems and habitats that may be negatively impacted by fuel treatments. Within some parks and green spaces, important ecological values in specific locations may be negatively impacted if these values are not inventoried and/or wildland fire issues are addressed in isolation.	Planning and Development Services	Low, Medium, High: $40,000 for consultant work.	High

#	Policy Action	Rationale	Responsibility	Cost/Resource Requirements	Priority
17	Encourage the use of prescribed fire in order to improve the cost effectiveness of fuel treatment and expand the area of treatment. Any use of fire should strictly follow smoke management guidelines to limit the health impacts of smoke.	There is a considerable build-up of fuel within some city parks and green spaces. The application of prescribed fire would increase the City's ability to treat specific identified hazard areas at an acceptable cost. While it is recognized that the resultant smoke may be a potential health hazard, careful planning and consideration of smoke venting indices can mitigate the negative impacts of smoke. The positive benefits of treatment could offset the negative health hazard, particularly if consideration is given to the amounts of smoke that would be generated by a large and destructive fire such as the Okanagan Mountain Park Fire.	Parks Department / Fire Department	Prescribed fire could be used in co-operation with BC Ministry of Forests. Main cost would be staff time for planning, public notification, protection of property etc. The cost would be highly variable, depending on how much ground is to be burned in a year. Low: $25,000 Medium: $50,000 High: $100,000 +	High
18	Encourage the use of curtain burners in order to improve the cost effectiveness of fuel treatment and material disposal. Any use of fire should strictly follow smoke management guidelines to limit the health impacts of smoke.	As above. Curtain burners could also be used to deal with material created by beetle damage.	Fire Department / Works and Utilities	Curtain burner can be purchased or leased. Low: Lease burner a few months of year: $100,000 Medium: Lease and operate burner half a year: $400,000 High: Purchase of burner ($165,000) and operation costs all year: $500,000	High
19	Adopt a standard for fuel management in parks and green spaces (a proposed standard is contained within this report).	Since the Okanagan Mountain Park Fire the City has been implementing fuel treatments in selective areas of the Park system. Currently, there is no standardized approach to fuel treatments and the requirement for long-term maintenance of these treatments is not considered.	Parks Department	Simply adopt a standard. Can be accommodated within existing staff budget.	High

#	Policy Action	Rationale	Responsibility	Cost/Resource Requirements	Priority
20	Thinning and understory fuel removal should be implemented on heavily used trail networks within city parks. Where ecologically appropriate treatments should occur within a 5-metre area on each side of the trail network.	Thinning will limit the ability of fire to spread and improve fire suppression capability throughout these heavily used corridors.	Parks Department	Could be integrated into existing fuel modification programs. Federal and provincial funding could be sought. Additional costs would result if the City wanted to treat areas more quickly. Low: $0 (just integrate into current program) Medium: $10,000 High: $20,000	Medium
21	Consideration should be given to widening specific trails to 3.2 metres (the width required for small emergency vehicle access) to improve access for fire suppression within city parks. In city parks and green spaces there should be sufficient access points to ensure adequate fire control.	Access within city parks and green spaces could be improved. In existing City Parks the access is not wide enough for emergency vehicles, which could hinder suppression efforts in the event of a wildfire. In addition, the City sometimes creates access points in green spaces within subdivisions which enable access for fuel mitigation; however, there is no standard for planning the number or location of access points created.	Parks Department	Difficult to estimate as Parks would need to do a more detailed analysis of which trail systems should be upgraded. Rough estimate is 2-3 kilometres of trails could be upgraded. Cost per metre is approx. $14 (One time capital investment) Low: Widen 1 km, $14,000 Medium: Widen 2 km, $28,000 High: Widen 3 kilometres of trails, $42,000	Medium

#	Policy Action	Rationale	Responsibility	Cost/Resource Requirements	Priority
22	Consultation should occur with the Parks Department during the subdivision development phase. This consultation should deal with: 1) Reviewing the wildfire hazard mitigation plans that are prepared by the developer's Registered Professional Forester (RPF) for areas being delivered to the City as park. 2) Site inspection of mitigation work prior to the City accepting new land as park or open space. 3) Site mitigation plan review and site inspection of private portions of subdivisions. (Currently, Parks Staff do not review or inspect wildland fire mitigation plans on the private portions of subdivisions. These areas are evaluated by the Subdivision Approving Officer. Developer employed RPFs are supposed to sign off on their work plan but this is inconsistent. To ensure professional and un-biased evaluation of private lands within a subdivision the Subdivision Approving Officer should have access to a professional evaluation of both the work plan and the work completed by the developer.)	When subdivisions are developed, parks and green spaces within that subdivision become City property. The City owns a substantial amount of forested land within and adjacent to subdivisions that is inadequately managed from a fire risk perspective. While many of these parcels are small, they are in close proximity to homes and border sections of large subdivisions. These areas need to be inventoried and considered within the broader fire management-planning framework. The responsibility for the identification and management of fuel hazards within City parks appears to be well defined. However, occasionally the city purchases or receives land at the time of subdivision, where fire mitigation has not been considered or completed. In most cases the developer is asked to complete fuel mitigation on these lands prior to turning them over to the city. A city policy is needed to ensure that all lands are treated in this manner and to avoid taxpayers having to subsidize treatment once the land transfer has already taken place.	Parks Department	1), 2) Minimal cost, just a change in procedures. Some cost of site inspection, but for the most part that is already being done. 3) Low: $35,000. Half time staff member in Parks with appropriate qualifications available to the Subdivision Approving Officer on call. (Would need to be integrated with another half time position.) Medium: $45,000 Private Sector RPF held on retainer available of call to Subdivision Approving Officer. High: $70,000 Full time staff member (inc. vehicle etc) to do review of reports and do site inspections.	High
23	Require the developer to mitigate the fire hazard on forested lands before they become the property of the City.	The existing process turns properties over to the Parks Department without always requiring the developer to mitigate the fire risk. This results in the City having to front the cost of fuel mitigation on land with a fire hazard that was inherited from a private landowner.	Planning and Development Services	Alter OCP policies to enhance support for Subdivision Approving Officer. Can be accommodated within existing staff budget.	High

#	Policy Action	Rationale	Responsibility	Cost/Resource Requirements	Priority
24	Create an interactive website that outlines community fire risks and proactive steps individual homeowners can use to make their homes safer within the community. Other information, such as fire danger, FireSmart principles and reporting on recent treatment initiatives in the community could be maintained on the local site so that fire management issues specific to Kelowna could be easily communicated to the local population.	There is a need to maintain public awareness Fire management issues specific to Kelowna could be communicated to the local population.	Fire Department	Need for ongoing management of the web site content by staff Low: $8500. Consultant construction of a basic information based site including web hosting fees for the first year. (WH Fees = $50/ month.) Medium: $10,500 added functionality (Online surveys etc.) and Full site management for changes updates etc. (WH Fees = 250/month) High: $12,500 fully interactive site and detailed management Corporate sponsor.	High
25	Assess options available to the City to recover costs related to wildland fire mitigation programs. Examples of possible funding options might include a cogeneration plant, composting program or a minimal increase in property taxes that could be used to encourage and aid property owners with fuel mitigation and to facilitate treatments on public lands.	Funding is the primary barrier to fuel hazard mitigation treatments.	Works and Utilities	Consultant to research and evaluate available information and recommend City's best options to develop revenue generation (or equivalent savings) to offset costs associated with new wildland fire mitigation initiatives. Low: $10,000. Basic review of available research. Medium: $15,000. Basic review with general recommendations. High: $25,000. Detailed review with specific action recommendations and estimated costs included.	High

#	Policy Action	Rationale	Responsibility	Cost/Resource Requirements	Priority
26	Enhance public education programs relating to wildland fire by: 1) Integrating a unit on “FireSmart” and wildfire safety into the local primary school curriculum promoting the principles of community wildfire protection at a young age in order to improve awareness over time. This unit could be part of a general emergency preparedness-teaching program. 2) Create a”FireSmart” sticker program where Fire staff attend residences and certify them as meeting “FireSmart” guidelines.	1) Education on the principles of fire protection at a young age can improve community awareness over time and children can bring informative materials home to discuss with their parents. 2) Fire department staff could visit site and if property fails certification, offer an information package including a list of local qualified Foresters and “FireSmart” education materials. Upon homeowner completing mitigation work, Fire staff could issue a dated “FireSmart” sticker to be placed in the front window of the house. Local Real Estate Board should be enlisted to endorse program as adding value to homes located in the interface.	Fire Department	Low: Incorporate within existing education initiatives. Limited scale program as staff already stretched to meet requirements. Med: $35,000. Half time position of ‘Public Education Officer’. (Would need to be integrated with another half time position.) High: $70,000 (all inc.). Full time ‘Public Education Officer’.	Medium

6.1 Standard for Wildland Fire Hazard Assessments

Within the Wildfire DP areas the current standard for assessments is considered inadequate. It is recommended that, at an overview level, the Wildland Urban Interface Fire Hazard Assessments process[1] developed by the Province and FireSmart (Partners in Protection 2003) be used to guide the standardization of wildland fire hazard assessments in the City of Kelowna. An example of a FireSmart Assessment report is provided in Appendix D. At a minimum, assessments should contain the information listed below.

1. A detailed study area description of pre and post treatment vegetation, including an ecological site classification (listing the dominant vegetation on the site), species composition, tree density, crown base height, surface fuel conditions (both coarse and fine fuels) and a description of the forest floor. Where there is significant variability on a property the description should be stratified to address this variability.
2. A detailed description of the physiographic characteristics of the site including slope, aspect, and elevation.
3. A detailed assessment of the vulnerability of the site to fire including fire behaviour potential, and recent fire history in the general area.
4. The report should describe the hazard and risk condition of the study area based on the Interface Community Fire Hazard Form[2].
5. A standard for vegetation management is required. It is recommended that, within Wildfire DP areas, the priority zoning approach in FireSmart be adopted as the standard for vegetation management in new subdivisions.
6. Building and construction requirements should be clearly documented in the assessment; including standards for roofing, siding, and windows.
7. The proposed access configuration in and out of the proposed property should be carefully reviewed to ensure that it is acceptable to the fire department in terms of emergency response.
8. The assessment should document the proposed configuration for hydrants and water supply to ensure the appropriate volumes and pressures can be delivered to all homes within the subdivision.
9. Where the subdivision and or property backs onto other public private forested land the assessment should identify measures to reduce property vulnerability either through setbacks and or fuel reduction measures.

[1] http://www.civicnet.bc.ca/files/%7BC7F9441A-FB11-4CCE-99B5-805E9D9BC6FF%7DWildlandInterfaceAreas.pdf
[2] http://www.civicnet.bc.ca/files/%7B4CC7A0A8-D602-4D64-8EB5-219F6354CE73%7DCommunity%20Fire%20Hazard%20Form%20.pdf

10. The assessment should outline proposed the proposed hydro and gas line configuration in the subdivision and provide recommendations to limit vulnerability.

6.2 FireSmart Standard for Landscaping

Landscaping in and around homes in an area vulnerable to wildfire is considered a key element in the protection of structures from wildland urban interface fire. The two most important factors associated with landscaping are the types of vegetation and the amount (biomass) of vegetation in close proximity to the home. Total removal of all vegetation for a specified distance from a home is impractical as it reduces the aesthetic appeal of the home and may increase soil erosion potential.

It is recommended that the City of Kelowna consider the FireSmart standard for minimizing the amount of vegetation and the height of vegetation within a 10 meter perimeter around the home. FireSmart recommends a green lawn no higher than 10 cm. While this would be an ideal standard to work toward, it is not practical in Kelowna. It is therefore recommended that consideration be given to the following issues within the context of a landscaping standard:

- The 10 m perimeter should have no annual grasses greater than 10 cm in height;
- Surface litter and downed trees should be removed annually;
- Overmature, dead and dying trees with potential to ignite and carry fire should be removed;
- The recommended inter tree spacing of living healthy trees should be 7 meters and there should be no trees touching or overhanging onto homes or structures on the property;
- Vegetation used for landscaping should be native;
- Landscaping should follow xeriscaping principles;
- Prohibit the use of bark mulch and or other woody materials used in landscaping;
- Discourage the use of juniper and cedar hedges; and,
- Maintain hedges below a height of 2.0 meters.

6.3 Standard for Fuel Management in City Parks and Green Spaces

Within city parks and green spaces the goal of fuel management is to minimize fire behaviour potential and the risk of human ignition. Fire behaviour potential is of greatest concern in the

vicinity of public buildings, areas of high public use, and adjacent to private homes and businesses. The risk of human ignition is associated with areas of high visitor use and or where recreational activities (*e.g.*, use of barbeques) elevate risk. These are the types of areas where fuel management is appropriate and should be considered within city parks and green spaces.

To reduce fire behaviour potential the goal of fuel management is focused on a reduction in the vertical and horizontal continuity of surface and crown fuels. Significant accumulations of fine surface fuels (<1 cm) are considered hazards that contribute to the ease of ignition and the rate of fire spread. Accumulations of coarse surface fuels contribute to head fire intensity and flame height and enable fire to propagate into the crowns. A low crown base height (< 2 metres) allows fire to spread more easily into the crowns. High crown closure (related to high stem density) allows fire to spread more easily and rapidly between tree crowns. The species composition is also an important consideration as deciduous fuels are less vulnerable to fire in comparison to coniferous fuels. Based on these fundamental fire behaviour principals it is desirable to treat fuels in a manner that:

- Reduces surface fuel continuity (both fine and coarse fuels);
- Increases crown base height;
- Reduces the tree density and crown closure; and,
- Shift species composition from coniferous to mixed deciduous fuels.

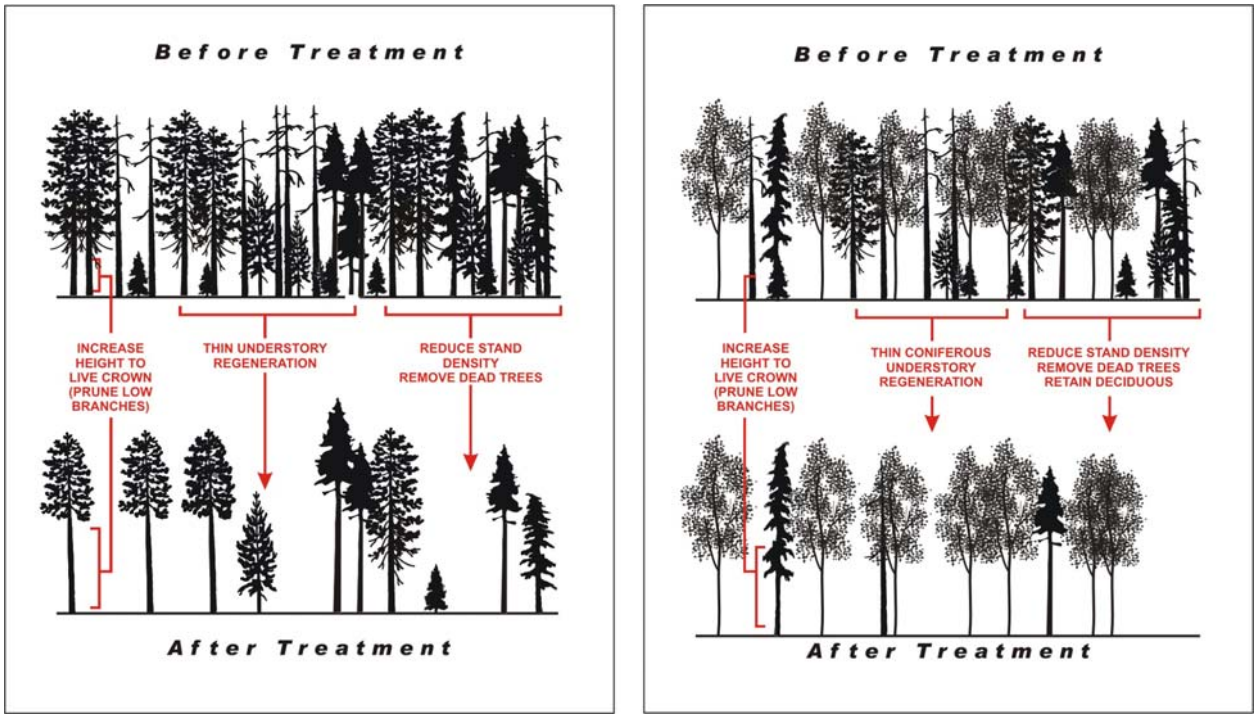

Figure 6. Conceptual examples of hazard coniferous and mixed deciduous fuel types treated to achieve a reduction fire behaviour potential.

To meet an acceptable level of fire behaviour potential and or lower the risk of ignition the following targets for specific stand attributes is recommended:

- Within mature forest types target crown closure is <35% where the distance between crowns is between 3 and 6 metres. This includes trees in all layers (1 through 4) and all tree species (coniferous and deciduous);
- Within mature forest types target crown base is an average greater than 2 metres;
- Within mature forest types target coarse woody debris retention is 5-10 pieces of CWD per hectare, 12 cm diameter or greater and greater than 5 meters in length; and,
- Within mature forest types the target deciduous component is 10 to 30%. Deciduous species composition that exceeds 30% is considered desirable.

Given that stand density varies greatly with tree age and size, no density target it provided. It is recognized that stands of a younger age may contain a greater number of stems when compared with older stands. Crown closure is probably a better measure of specific fire behaviour conditions.

From a fire perspective, the application of fuel treatments should be used to reduce hazardous understory development and provide shade to maintain higher relative humidity and a reduced temperature regime while maintaining an overstory with low crown fire potential. The focus of specific fuel treatment prescriptions should be a one time entry to remove a portion of smaller and larger diameter overstory stems, downed stems and fine fuels.

Given the forest health issues facing the City of Kelowna and the increasing mortality associated with Mountain Pine Beetle and Western Pine Beetle, fuel treatments may not be appropriate until there is a recession in the beetle populations and associated mortality. Restoration treatments that remove the dead pine may facilitate the removal of hazardous fuel accumulations. Fuel treatments prior to the beetle outbreak may limit and or reduce tree retention options in both city parks and green spaces. It is recommended that a fuel reduction strategy, that considers the impact of beetles, be developed for all park and city green spaces similar to the approach the City of Prince George is currently undertaking.

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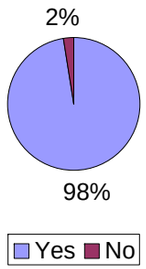
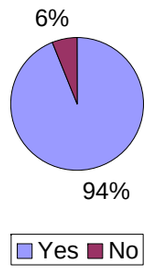
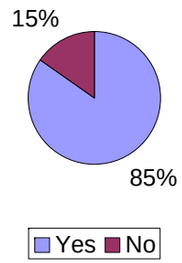
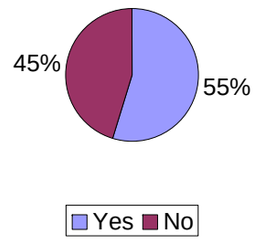
Appendix A – Survey Responses

Q 2: I own the home that I live in? Yes/No

Door to Door Glenmore Sample size: 83	Door to Door South Mission Sample size: 66	Web inside DP Areas Sample Size: 144	Web outside DP Areas Sample Size: 42
			

Q 3: My home is at risk from wildland fire. (Yes/ No)

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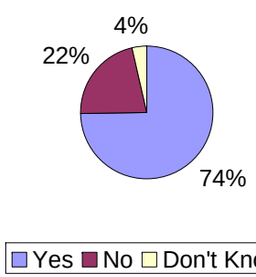	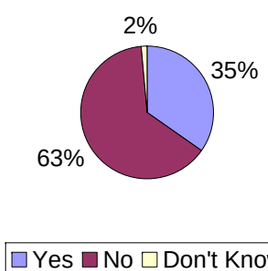	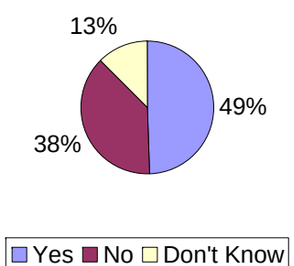	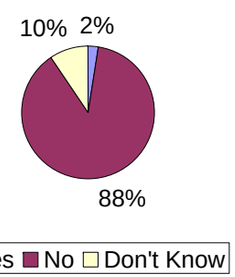

Q 4: I lived in Kelowna during the 2003 wildfires (Yes/No)

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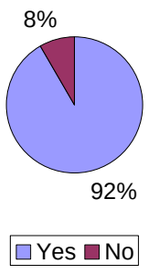	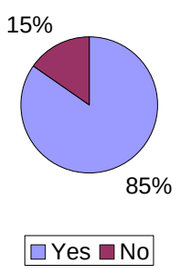	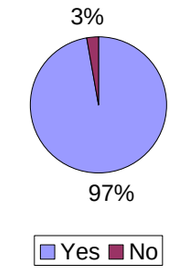	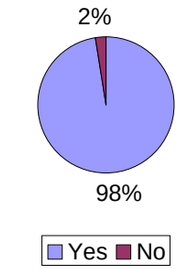

Q 5: I feel the responsibility for protecting my home from wildfire lies mostly with: A. Myself, B. The Kelowna Fire Department, C. The City of Kelowna, D. The Provincial Government (door to door were able to answer that it was a combination).

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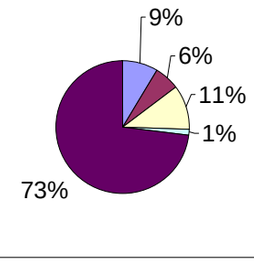
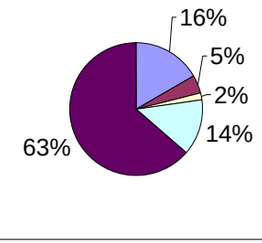
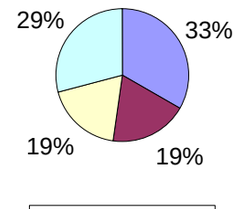
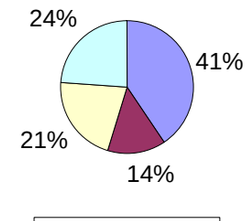
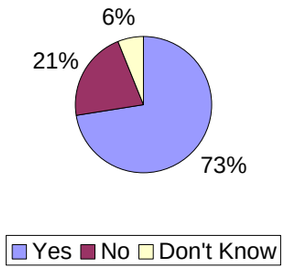
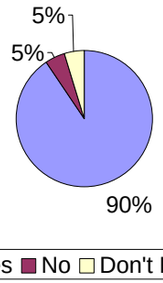
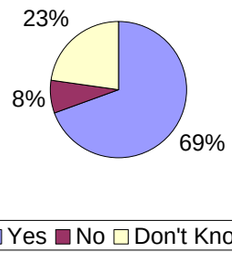
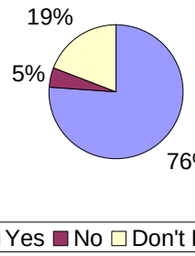
			

Q 6: I have done enough to protect my home from the threat of wildfire. (Yes/ No / Don't Know)			
Door to Door Glenmore Sample size: 83	Door to Door South Mission Sample size: 66	Web inside DP Areas Sample Size: 144	Web outside DP Areas Sample Size: 42
			

Q 7: The City of Kelowna has done enough to protect my home from the threat of wildfire. (Yes/ No / Don't Know)			
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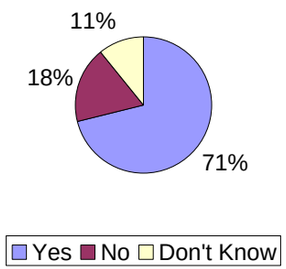	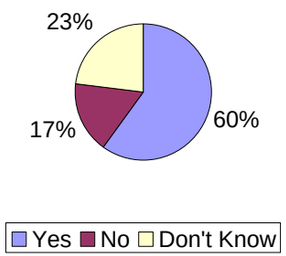	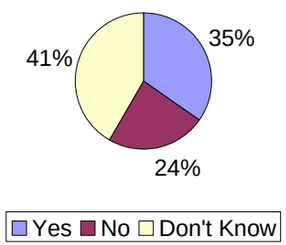	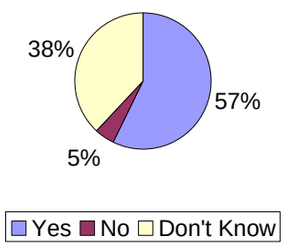

Q 8: The province has done enough to protect my home from the threat of wildfire. (Yes/ No / Don't Know)			
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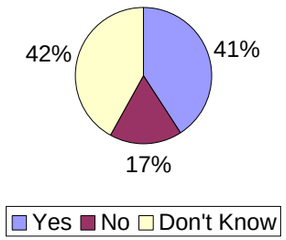
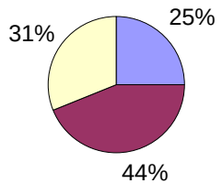
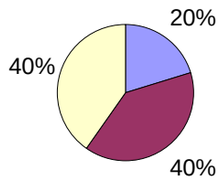
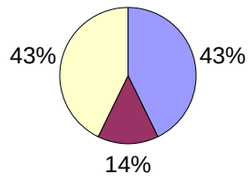
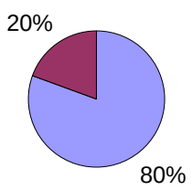
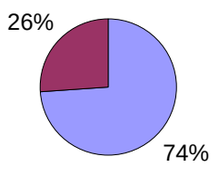
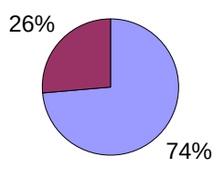
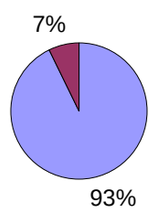
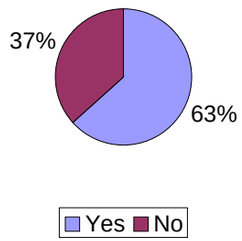
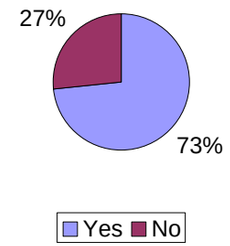
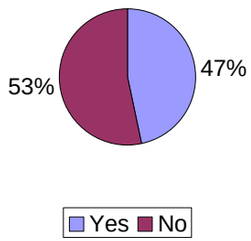
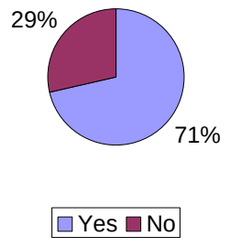
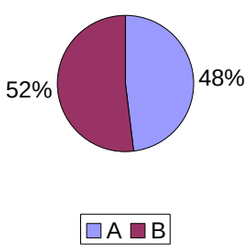
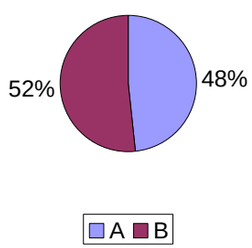
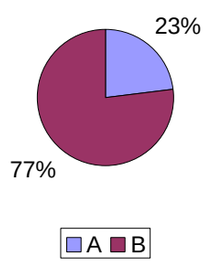
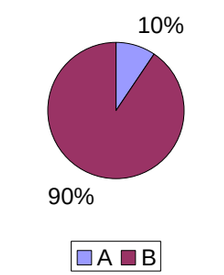
			

Q 9: Would you support a change to City Bylaws such that renovations or retrofits of existing buildings would trigger requirements for wildland fire risk reduction? (Yes/ No)			
Door to Door Glenmore Sample size: 83	Door to Door South Mission Sample size: 66	Web inside DP Areas Sample Size: 144	Web outside DP Areas Sample Size: 42
			

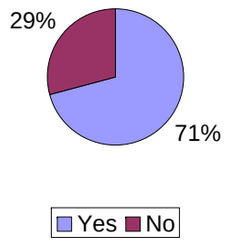
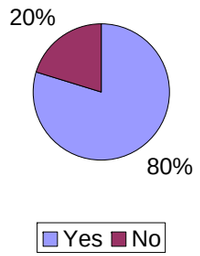
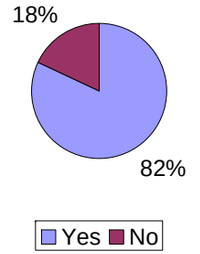
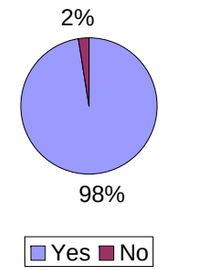
Q 10: Would you support the creation of cleared fire breaks adjacent to your neighbourhood to enhance protection from wildfire if it meant an increase to your property taxes? (Yes/ No)

Door to Door Glenmore Sample size: 83	Door to Door South Mission Sample size: 66	Web inside DP Areas Sample Size: 144	Web outside DP Areas Sample Size: 42
			

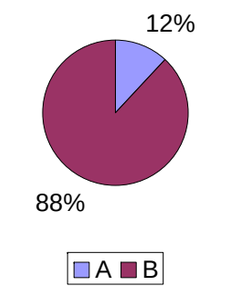
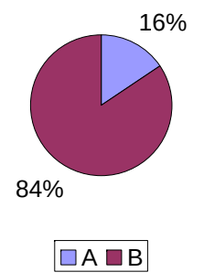
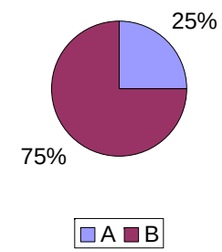
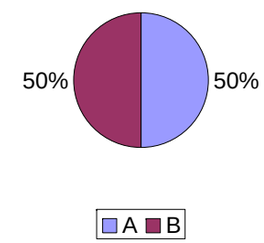
Q 11: As a resident, which of the following would you rank most highly: A.The character created by the presence of easily combustible vegetation on or near your property. B. The enhanced protection of your home created by removing all easily combustible vegetation. (A/ B)

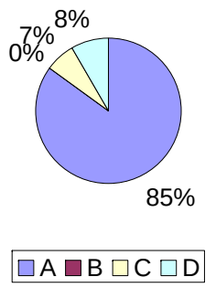
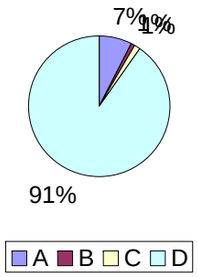
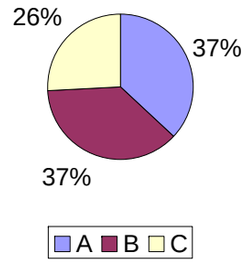
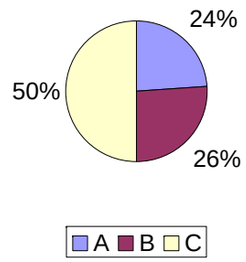
Door to Door Glenmore Sample size: 83	Door to Door South Mission Sample size: 66	Web inside DP Areas Sample Size: 144	Web outside DP Areas Sample Size: 42
			

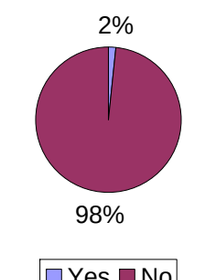
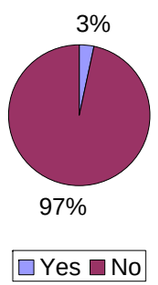
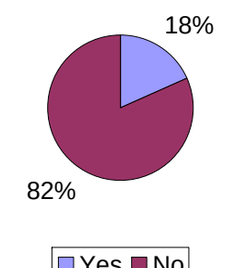
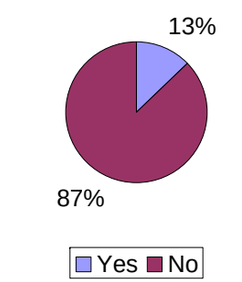
Q 12: Would you support initiatives that would compel individual private land owners to reduce the hazard risk on their properties thereby reducing the risk to the overall community? (Yes/ No)

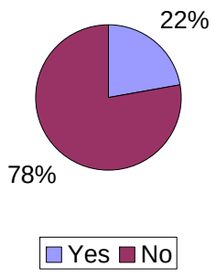
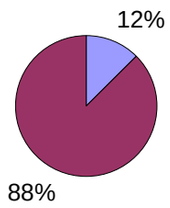
Door to Door Glenmore Sample size: 83	Door to Door South Mission Sample size: 66	Web inside DP Areas Sample Size: 144	Web outside DP Areas Sample Size: 42
			

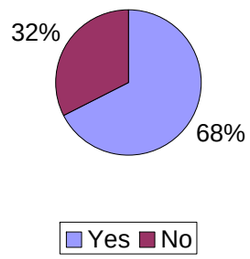
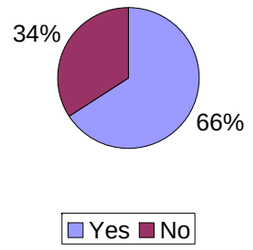
Q 13: Do you support:
A. The wholesale clearing of land for the purpose of new development in interface zones for the purpose of wildland fire protection.
B. The sensitive integration of housing into the landscape at the expense of some security from wildland fire? (A/ B)

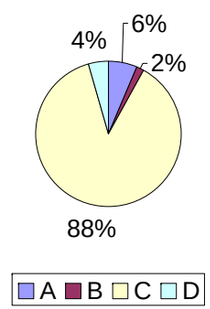
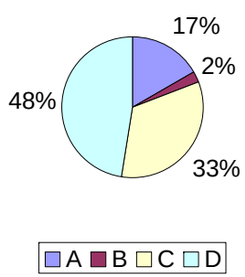
Door to Door Glenmore Sample size: 83	Door to Door South Mission Sample size: 66	Web inside DP Areas Sample Size: 144	Web outside DP Areas Sample Size: 42
			

Q 14: My roof is made from: A. wood, B. metal, C. clay tiles, D. asphalt shingles (A/ B/ C/ D)		Q 15: My home is setback from wild grass and forest vegetation by a distance of: A. < 10 m, B. 10-30 m, C. > 30 m (A/ B/ C)	
Door to Door Glenmore Sample Size: 253	Door to Door South Mission Sample Size: 217	Door to Door Glenmore Sample Size: 253	Door to Door South Mission Sample Size: 217
			

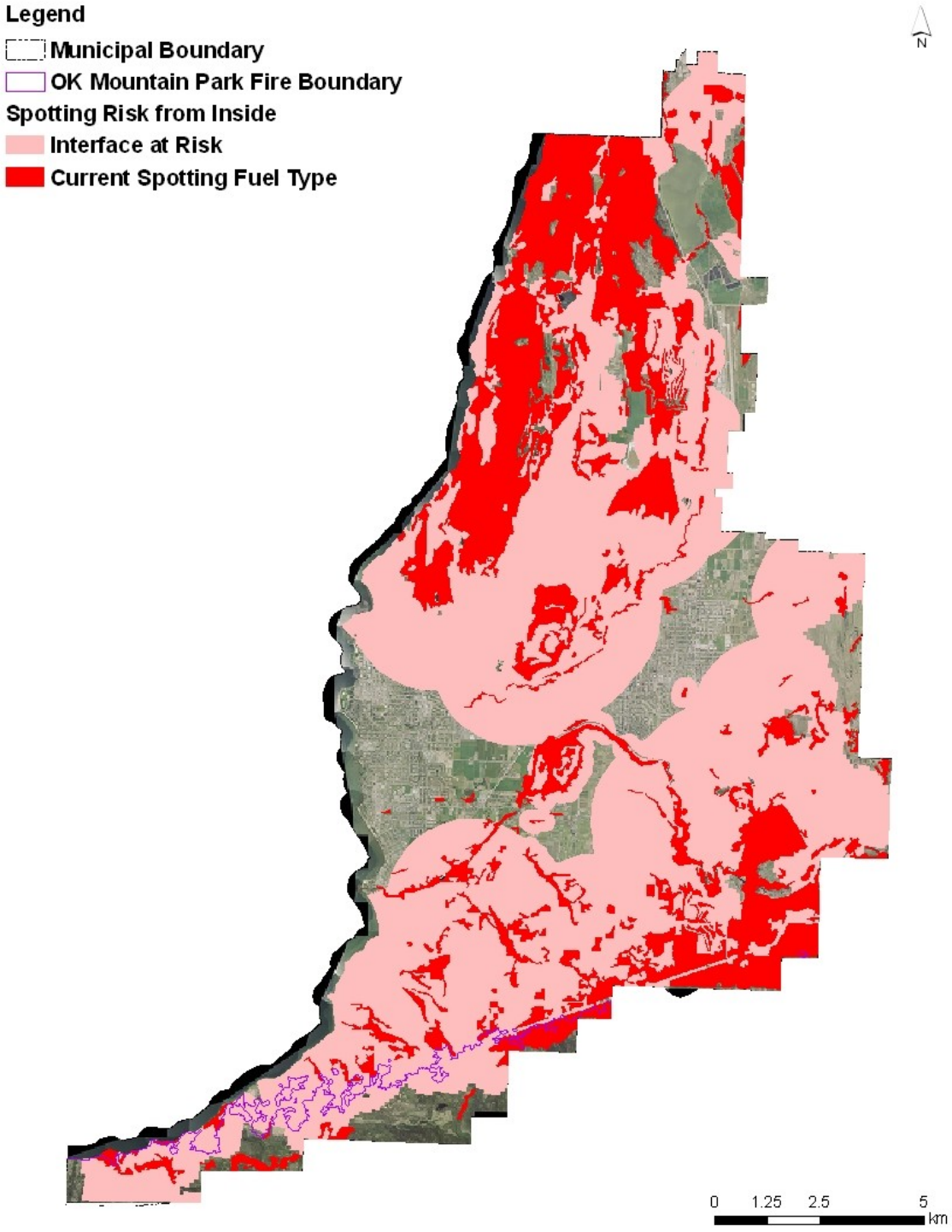
Q 16: There is a zone of 10 m around my house that is cleared of fuel including dead wood, trees, shrubs, wild grass and woodpiles. (Yes/ No)		Q 17: The trees within 30 m of my house have their crowns spaced 3-6 metres apart and shrubs are sparse or absent. (Yes/ No)	
Door to Door Glenmore Sample Size: 253	Door to Door South Mission Sample Size: 217	Door to Door Glenmore Sample Size: 253	Door to Door South Mission Sample Size: 217
			

Q 18: There are dead or unhealthy trees around my home. (Yes/ No)	
Door to Door Glenmore Sample Size: 253	Door to Door South Mission Sample Size: 217
	

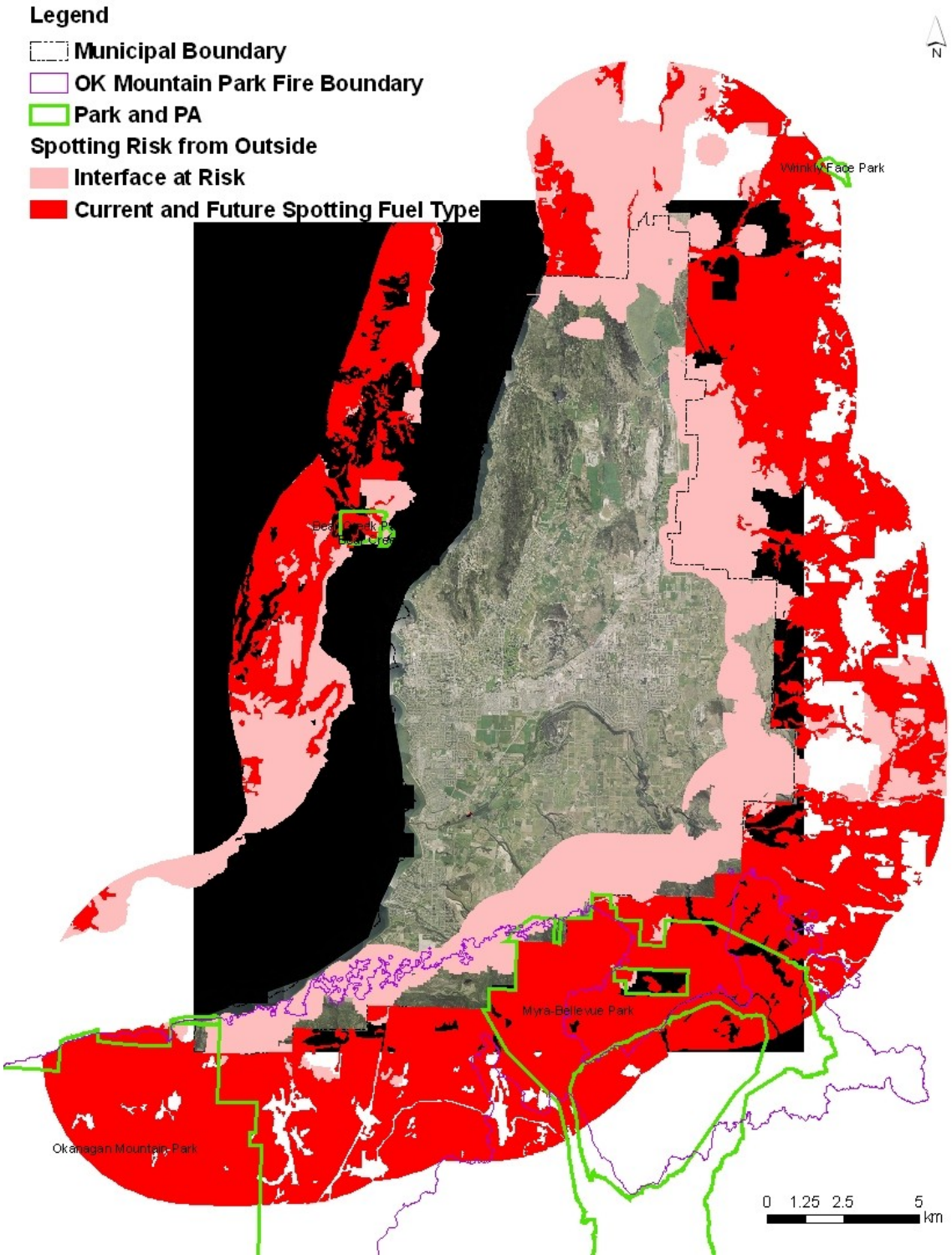
Q 19: My home is on a slope. (Yes/ No)	
Door to Door Glenmore Sample Size: 253	Door to Door South Mission Sample Size: 217
	

Q 20: My home has mostly: A. Wood siding, B. Vinyl siding, C. Stucco, D. Other (A/ B/ C/ D)	
Door to Door Glenmore Sample Size: 253	Door to Door South Mission Sample Size: 217
	

Appendix B – Spotting Analysis



Frame 1. Spotting Risk within the City from fuels both internal and external to the City.



Frame 2. Spotting risk within the City from fuel types outside the City.

Appendix C – Forest Health Background Report and Recommendations

Recommended Forest Health Policy for the City of Kelowna

Janice Hodge, RP Bio, JCH Forest Pest Management, Lumby, BC

In the last several years there has been much emphasis, both at a provincial and municipal level, on forest fuels assessment and mitigation. While this process is clearly required it is important to realize that the current level of forest fuels is merely a "symptom" of declining forest health. Fire exclusion, previous harvesting practices and changing climate had altered the successional pathways of many forest ecosystems. These changes are most obvious on extreme sites, such as the xeric and sub-xeric ecosystems in the Okanagan Basin, where forested areas may be well beyond their carrying capacity. These lower elevation ponderosa pine/Douglas-fir stands are likely at higher stocking levels than historic conditions resulting in water and nutrient deficiencies on a tree or stand level. This combined with structure and species composition changes has resulted in high hazard stands from a forest health perspective.

Given these conditions the long-term ability to reduce wildland fire hazard within and adjacent to the City of Kelowna will require a knowledge and application of sound forest health management strategies and tactics, in the form of a Forest Health Policy. This policy will provide strategic direction on the management of lower elevation ponderosa pine and Douglas-fir ecosystems. The overall degree of effectiveness i.e. reduction of landscape level hazard, will be directly related to the ability to encourage or require land and homeowners to comply.

The following are some guidelines and suggestions for a City of Kelowna Forest Health Policy.

Overall Objective

To improve the resiliency of forested areas to insect, disease and abiotic events and thereby reduce the fuels associated with their activity.

Strategy

Develop guidelines suitable for landowners, developers and foresters which promote good forest health practices and which complement the overall forest health and fuels hazard abatement objectives.

Good forest health practices refer to those which lower landscape level hazard and/or prevent the creation of such hazards or risk. The terms hazard and risk are often used interchangeably but have 2 distinctive meanings. Hazard refers to inherent forest stand characteristics which make them susceptible whereas risk is the likelihood of a disturbance event occurring. The latter is generally a function of proximity to an existing infestation or disease epicenter. Risk does not exist without hazard or without a pest.

Action Plan

1) Identify major insects and diseases and associated high hazard ecosystems (see attachment).
2) Develop guidelines for:
    a. reduction of current landscape level hazard and risk; and
    b. prevention of future hazard and risk.
3) Monitor forest health conditions annually.
4) Integrate forest health management practices into FireSmart promotion.
5) Identify foresters or forest health consultants whom are capable of accurately diagnosing and making recommendations on forest health concerns.

Reduction of landscape level hazard and risk

The key features of high hazard stands are that they are overstocked and multi-layered. Defoliators, bark beetles, root diseases and dwarf mistletoes all flourish in these types provided suitable host trees exist. These stands are also more likely to suffer from water deficits and subsequent drought mortality and/or predisposition to primary or secondary bark beetles. A landscape level strategy which encourages the return to low density single or two-layered stands will reduce the hazard to most of these forest health factors.

Exceptions are:

1) Promotion of two-layered Douglas-fir stands in areas with Douglas-fir dwarf mistletoe or a history of Douglas-fir tussock moth.
2) Promotion of Douglas-fir on sites with root disease unless landowners or developers are willing to treat stumps over 20 cm.

Tactics used for fuels management i.e. thinning from below, promote good forest health (provided there is no root disease on site). Large healthy trees are left with some co-dominants interspersed to provide for some structural diversity. Sanitation practices, i.e. removal or burning of all potential breeding material (large branches and stems), should decrease the opportunity for build-up of secondary or minor bark beetle species. The importance of this practice can not be emphasized enough as a local build-up of secondary insects is significant given the declining health of the forests. These secondary pests are generally not capable of killing healthy trees but are quite capable of accelerating the dying process on weakened or stressed trees.

Ideally strategies and tactics will deal with the landscape as a whole, rather than on a pest by pest basis. However there are tactics specific to certain pests.

Douglas-fir beetle:

1) For trees ≥30 cm keep stumps as low as possible.
2) Burn Douglas-fir before the end of March the year following removal (applies to landowners and subdivisions) or alternatively remove, destroy or peel park off all debris containing beetle progeny if it is greater than 20 cm.

3) Avoid mechanical damage to residual Douglas-fir trees.

Douglas-fir dwarf mistletoe:

1) Do not encourage 2-layered stands of Douglas-fir in areas with Douglas-fir dwarf mistletoe.
2) Prune and burn all lower brooms.

Western pine beetle:

1) Burn ponderosa pine before mid-March the year following removal (applies to landowners and subdivisions) or alternatively remove, destroy or peel park off all debris containing beetle progeny if it is greater than 20 cm.
2) Avoid mechanical damage to residual ponderosa pine trees.

Root Diseases:

1) Encourage mixed species stands where possible, with a lower percentage of Douglas-fir.

Prevention of Future Hazard and Risk

By understanding conditions which create forest health hazards or risk it may be possible to prevent or reduce the likelihood of these conditions from occurring. The creation of high hazard stands can generally be avoided by discouraging situations which favour multi-layered and/or overstocked stands. Risk elimination or prevention relies upon sanitation practices which reduce the food supply or build-up of primary and secondary insects or diseases. These include:

- minimal root disturbance and no mechanical damage to leave trees in lots or subdivision;
- selecting windfirm leave trees or patches of trees;
- burning or chipping of large diameter stems or branches to reduce the amount of material available for secondary insects;
- pruning of lower dwarf mistletoe and Elytroderma needle disease (on ponderosa pine) brooms;
- removal or treatment of root disease stumps if host trees are left behind; and
- removal or burning of bark-beetle infested trees prior to their next flight period.

Monitoring

Annually monitor and track forest health conditions. This can be thru a combination of consultations with Ministry of Forests staff and/or helicopter review of annual conditions.

Integration with FireSmart

One of the key factors to the success of a forest health policy is education. While the media has been doing a fine job reporting on the provincial mountain pine beetle epidemic, the local western pine beetle outbreak, or fire hazards, little emphasis has been placed on the link between

these disturbance agents. If land or homeowners were more aware of the conditions which create or promote suitable insect and disease habitat and their link to subsequent fuels they would likely be more than happy to comply with fuels or forest health policies. FireSmart brochures or other promotional material should integrate forest health hazards and their relationship to subsequent fuels i.e. cause and effect.

Identification of qualified individuals or companies

The ability to develop the proper prescription on any given site, be it a lot or subdivision, relies upon accurate diagnosis of a forest health problem and/or an understanding of the existing hazard and risk. A misdiagnosis or poor prescription can exacerbate an existing condition or create a forest health risk.

Forest Health and Wildland Fire: A review of forest health factors affecting forested ecosystems and their potential for affecting fire behaviour within the City of Kelowna.

INTRODUCTION

The Okanagan Valley is home to a variety of forest insects and diseases. These native pests are integral components of forested ecosystems which function at both a landscape and patch level. Although their role remains unaltered since historic times the frequency, extent and duration of outbreaks may have changed due to changes in forest structure and composition resulting from selective harvesting and/or fire exclusion. The effects of fire exclusion are most evident in the lower elevation stands which historically experienced frequent stand-maintaining fires. These forest types, referred to as natural disturbance type 4 or NDT4, dominate the forested ecosystems within and adjacent to the City of Kelowna.

From a forest health perspective the lack of stand-maintaining fires has increased the forest health hazards across the landscape. In essence forest health, or tree health, is in decline as these xeric ecosystems which traditionally supported low density shade intolerant species have been replaced with multi-layered higher density stands of mostly shade-tolerant species. These replacement forests are more vulnerable to insects and disease due to one or more of the following factors: uneven-aged stand structure composed of mostly Douglas-fir, nutrient and moisture demands in some high density stands, selective harvesting and relative susceptibility of Douglas-fir.

Pests such as western spruce budworm, dwarf mistletoes and root diseases have and will continue to flourish as a result of these past forestry practices. The bark beetles, including western pine beetle, mountain pine beetle, red turpentine beetle and Douglas-fir beetle will also become more prominent as the tree's ability to overcome attacks is lowered as a result of drought stress, overstocking and competition on many sites. Increased activity and subsequent mortality by some of these pests will result in increased fuel loads. Dwarf mistletoes, particularly Douglas-fir dwarf mistletoe (DMF), will provide ample ground and ladder fuels as mistletoe brooms will continue to intensify on individual trees and expand within an infected area.

FOREST HEALTH FACTORS

Pests of Douglas-fir

Western spruce budworm

Western spruce budworm is a cyclical defoliator which feeds primarily on Douglas-fir. High hazard stands are those which are multi-layered with a high proportion of Douglas-fir. Tree mortality is more likely to occur in the under-storey and is dependant upon the duration and severity of the outbreak. Defoliation does not generally cause mature tree mortality but may predispose trees to other forest health factors such as Douglas-fir beetle and/or root disease. Under-storey mortality however can be significant.

According to historical records 2 major and 1 minor outbreak have been recorded in the Okanagan in the last century, two of which occurred with the City of Kelowna limits. The first outbreak was the most extensive and lasted approximately 6 years from 1987-1992, and the 2nd from 1997-1998. In total over the course of both outbreaks approximately 2500 ha have been defoliated, of which 350 ha burnt in the Okanagan Mountain Park Fire in 2003. In the City of Kelowna 94% has only been defoliated for 1 consecutive year, 1% for 2 consecutive years, 4% for three consecutive years and <1% for 4 or 5 consecutive years (Figure 1).

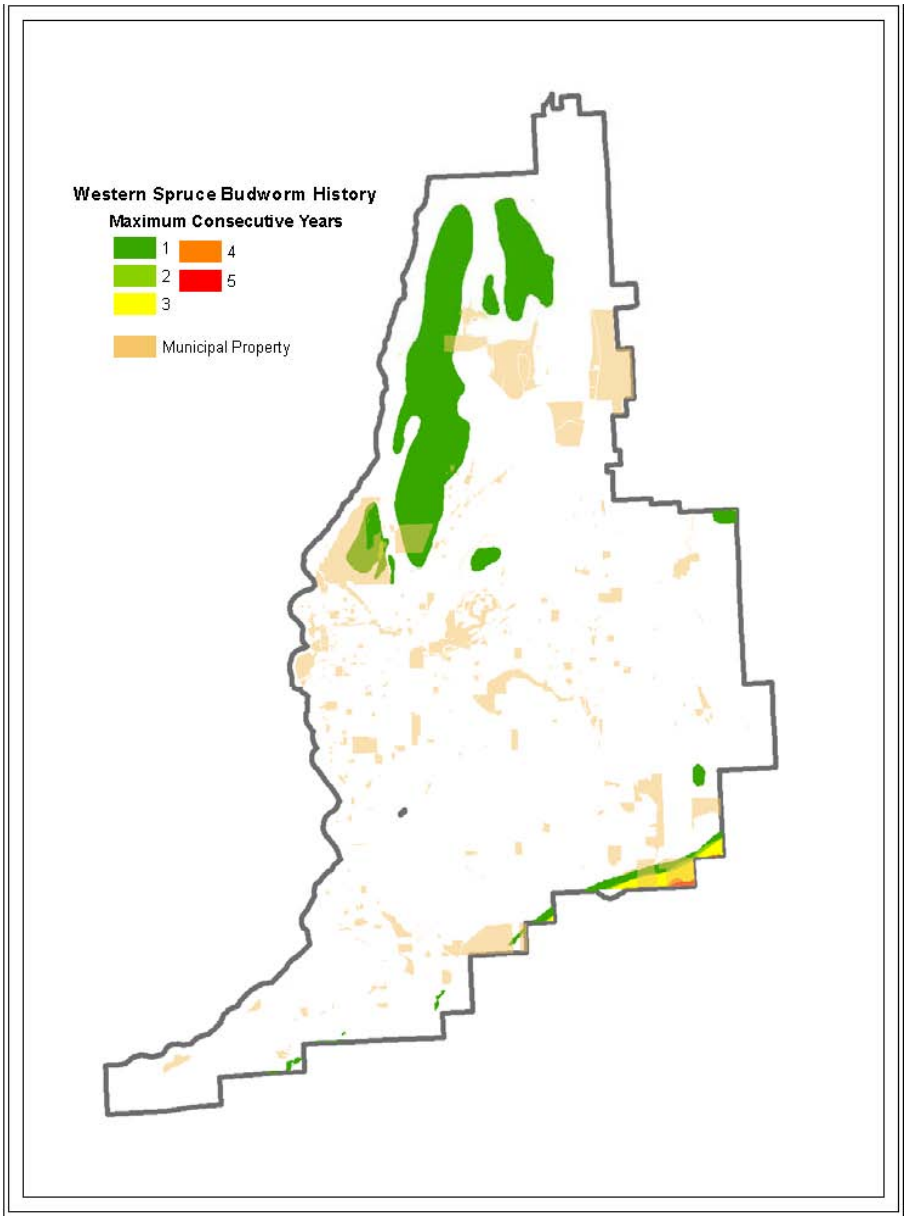


Figure 1. Extent and maximum years of consecutive defoliation by western spruce budworm in the City of Kelowna from 1987-1998.

Douglas-fir beetle

Douglas-fir beetle preferentially attack windthrown trees and those which are predisposed due to other factors such as drought, overstocking, defoliation etc. Outbreaks within the City limits have not been recorded although small patches have been recorded from Okanagan Mountain Park northwards towards Myra Canyon. In all likelihood some mortality is occurring on those sites in the Glenmore/Wood Lake area which experienced significant drought mortality in 2003.

Approximately 4400 ha of forest types contain Douglas-fir as a primary or secondary species, of which 94% are considered susceptible to Douglas-fir beetle (Figure 3).

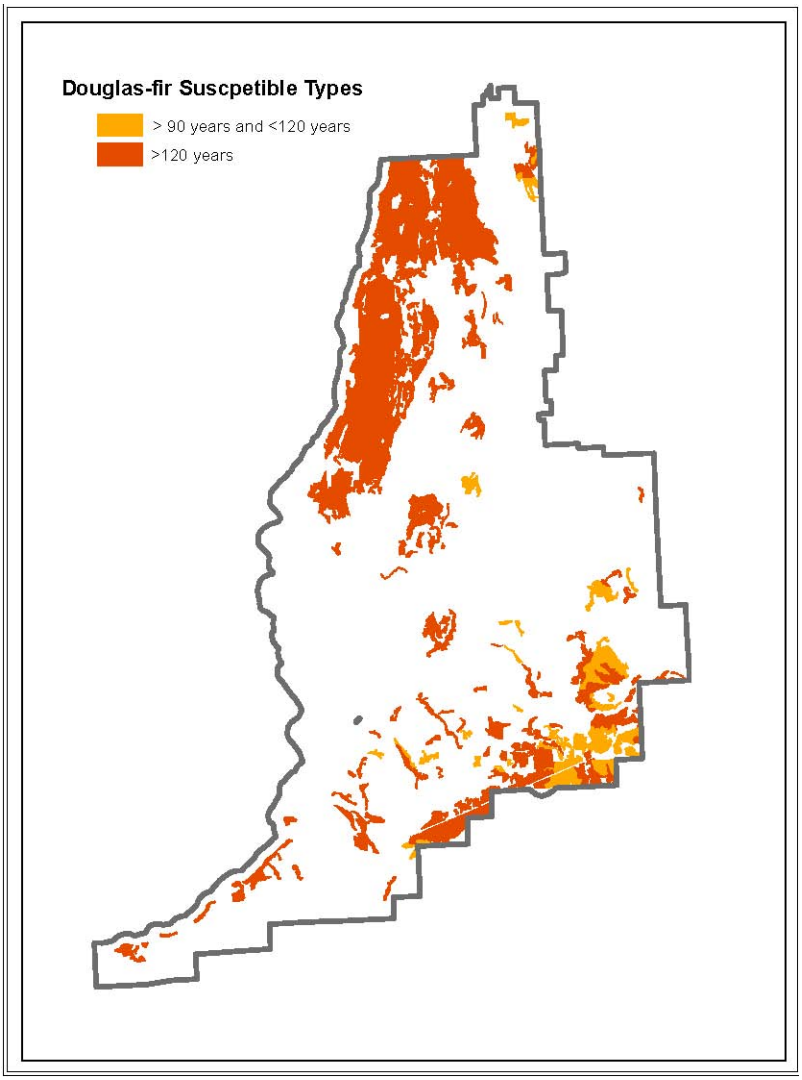


Figure 3. Distribution of Douglas-fir stands susceptible to Douglas-fir beetle.

Dwarf Mistletoes and Root Diseases

Douglas-fir dwarf mistletoe is chronic in the majority of Douglas-fir types within the City of Kelowna. Root diseases, both Armillaria and laminated root disease, are likely significant particularly on selective harvested sites, but their distribution is not as easy to quantify.

Douglas-fir tussock moth

Outbreaks of Douglas-fir tussock moth, a defoliator of Douglas-fir, tend to be smaller, more intense and of shorter duration than western spruce budworm. Mature tree mortality is possible after 1 or 2 years of feeding as larvae feed from the top of the tree downwards. Outbreaks are also cyclical and tend to occur in the same area as the female moth is not capable of flight. Several outbreaks have been recorded in the Okanagan Valley with some defoliation noted in the City of Kelowna. The most recent occurred in 2003 at Knox Mountain where a biological spray program reduced the populations significantly.

Bark Beetles of Ponderosa Pine

Western pine beetle, mountain pine beetle and red turpentine beetle are native bark beetle species which attack ponderosa pine. Although the latter is generally considered a secondary rather than a primary bark beetle it is capable of attacking and killing a tree, particularly a stressed tree.

Historical records indicate that western pine beetle is thought to have caused extensive damage to ponderosa pine in the early 1900's in portions of the Okanagan. Since then only scattered attacks of suppressed trees have been recorded. These records are based on high elevation overview flights or forest ranger descriptive diaries and do not necessarily capture all small (2-3) tree infestations, particularly on private land. The recent droughts combined with overstocking have increased the ponderosa pine susceptibility to western pine beetle. In addition the mountain pine beetle outbreak which is not anticipated to peak in the Okanagan until 2010, will likely also cause significant ponderosa pine mortality.

Red turpentine beetle has been recorded as the primary species responsible for killing ponderosa pine in the McKinley landing area. These findings are likely more widespread and are indicative of stressed, unhealthy ecosystems.

In terms of hazard approximately 4800 ha of forest contain ponderosa pine which is greater than 90 years old. The most contiguous types are in the Glenmore area (Figure 2). Eighty-four percent occur in open forests and the remainder in dense forest types. These numbers may also be an underestimate as younger trees may also be attacked, particularly in overstocked stands. As the beetle risk increases the likelihood of younger less thrifty stands being attacked also increases.

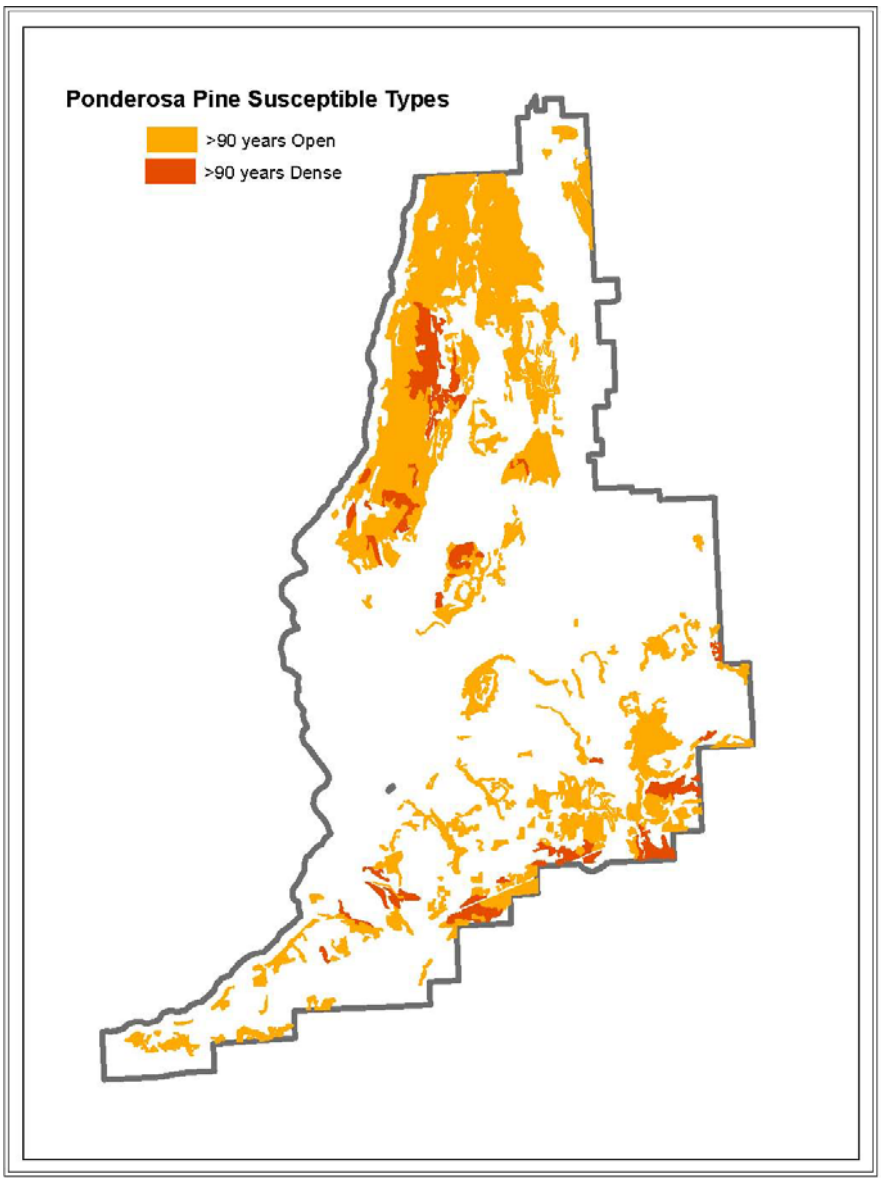


Figure 2. Distribution of ponderosa pine stands susceptible to bark beetle attacks.

Summary

From a purely insect and disease perspective the potential for fuel buildups and subsequent high intensity wildfire in forested types within the City of Kelowna is significant given the number of forest health factors capable of killing trees. Furthermore when looking at the area of overlap amongst these forest pests (Figure 4), it becomes evident that the majority of forested types within the City limits could witness mortality at many levels. Given these conditions it is paramount that the City consider imposing forest health policies i.e. insect and disease abatement, on private landowners. Although fuel modification projects on non-private lands will temper fire behaviour the fuel buildup resulting from forest pest mortality on private lands may promote intense fire behaviour. One need only look to the Okanagan Mountain Pine fire of 2003, albeit extreme weather conditions, to witness the type of fire behaviour possible given the levels

of dwarf mistletoe, western spruce budworm and mountain pine beetle in the affected area. Furthermore fuel modification projects, if not already doing so, should integrate insect and disease hazard into their selection of candidate stands.

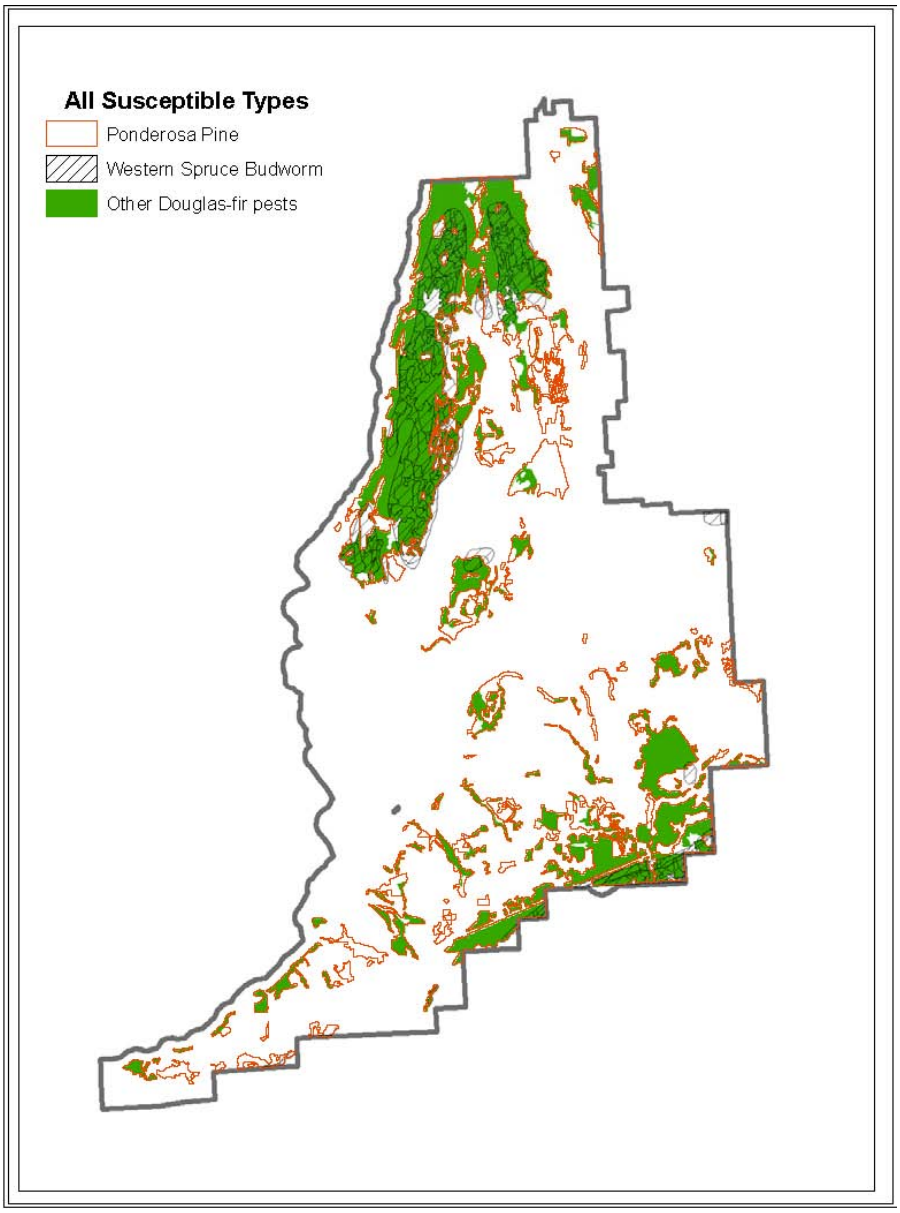


Figure 4. Distribution of all susceptible forest types within the City of Kelowna.

Appendix D – FireSmart Wildland/Urban Interface Fire Hazard Assessment – Highlands Estates

ASSESSMENT OF WILDFIRE/URBAN INTERFACE FIRE HAZARD ASSOCIATED WITH HIGHLAND ESTATES STAGE C - 19 LOT SUBDIVISION

Submitted by

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October 2, 2002

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INTRODUCTION

This report provides a detailed wildland/urban interface fire hazard assessment of *"Highland Estates, Stage C- 19 Lot Subdivision, District Highlands"*. The report was commissioned to address interface fire hazard concerns identified by the District Administrator- Bruce Woodbury. The subdivision is located approximately five minutes from the local volunteer fire department and is not serviced by District hydrants. On site, water is limited to several small natural wetlands and individual well service to each of the 19 lots. The subdivision and portions of adjacent crown land and private properties are dominated by second growth forest stands that were harvested some time ago. These past logging practices have resulted in multi-layered stands dominated by Douglas-fir that pose a significant wildfire hazard if left unchecked.

THE TERMS OF REFERENCE FOR THIS ASSESSMENT, AS SPECIFIED BY THE DISTRICT OF HIGHLANDS, ARE OUTLINED AS FOLLOWS;

A qualified Professional Forester will undertake the assessment

An Interface Fire Hazard Site Form for each proposed home site will be Prepared following the Guidelines contained in Part 2 of the Ministry of Forests Publication entitled Beware and Prepare Community Planner.

An Assessment will be undertaken to provide the following information:

1) A description of the existing site characteristics including geologic, vegetative, topographical, and environmental conditions
2) A determination as to whether the site characteristics constitute a wildland/urban interface hazard
3) An assessment of the severity of the hazard and its implications relative to future development
4) An analysis of the intensity and character of existing and proposed development and its effect on hazard
5) An analysis of the relationship between the development and the hazard, both inside and outside of the impacted area
6) Recommendations pertaining to the form, type and extent of the required mitigation measures as outlined in NFPA 299

Recommended mitigation strategies could include, but are not limited to the following:

1) Incorporating fuel breaks adjacent to or on the residential subdivision
2) Establishing zones around potential structures and homes which are clear of debris, highly combustible material or trees
3) Utilizing fireproofing techniques and fireproof materials in building design
4) Designing roads that provide evacuation routes and facilitate movement of fire fighting equipment
5) Ensuring the provision of access to local water sources as part of access requirements
6) Implementing setbacks, interface fire protections standards and building material standards pursuant to the Ministry of Forests – Beware and Prepare Community Planner.

Standards outlined in this report have been directly adopted from a combination of both the Be Aware and Prepare Community Planner (1994) and the Fire Smart: Protecting your Community from Wildfire (1999) documents.

METHODOLOGY

On October 1, 2002 Bruce Blackwell (RPF) of B.A. Blackwell & Associates Ltd. met with Bruce Woodbury and Heinz Burki of the District of Highlands to discuss the current subdivision plan. Discussion was focused around concerns identified by Mr. Woodbury. The District is concerned with the growing interface fire hazard associated with development in the interface. The District is particularly concerned with the Highland Estate subdivision as it located along the ridge above Finlayson Arm. This area is west facing, step, with forest cover dominated by Douglas-fir that is vulnerable to a stand replacement crown

fire. Any significant sized fire on this slope has the potential to impact property and public safety within the Highland Estate Subdivision.

On October 1, 2002 Bruce Blackwell, accompanied by Mr. Danny Carrier (J.E. Anderson and Associates) conducted a field assessment of the road, driveway and housing locations within the proposed subdivision. A walkthrough of the subdivision and adjacent public and private lots was conducted to assess the current wildfire hazard and risk and to develop a strategy to reduce that hazard and risk. Within the subdivision area a number of plots were established and an assessment of hazard was completed using the Ministry of Forests "Rural Interface Fire Hazard Site" form (Appendix A). This assessment was used to determine the current hazard of the area and to make recommendations on activities that should be considered as part of the subdivision development.

In addition to the field visit the "Beware and Prepare Community Planner" published by the Ministry of Forests was used to develop recommendations for subdivision development. The following sections summarize a number of issues, which should be considered as part of the subdivision development.

STUDY AREA

The proposed subdivision is located approximately 6 kilometers north of Millstream, off the Caleb Pike Road (Figure 1 and 2). The following provides a summary of the vegetation and climatic conditions that occur within the region of the subdivision. Additionally, overviews of the vegetation classification system and plant communities that are present within the area are provided.

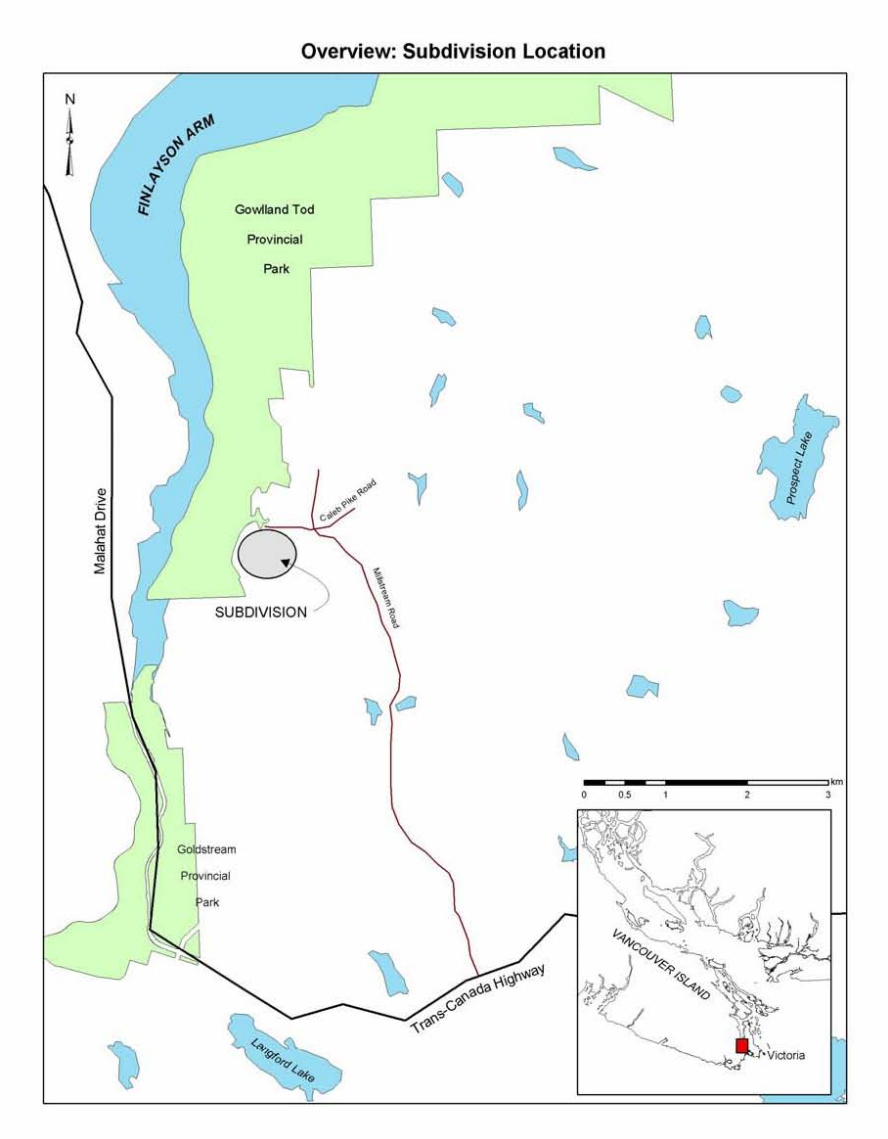

Figure 1. Location of Highlands Subdivision within the District of Highlands

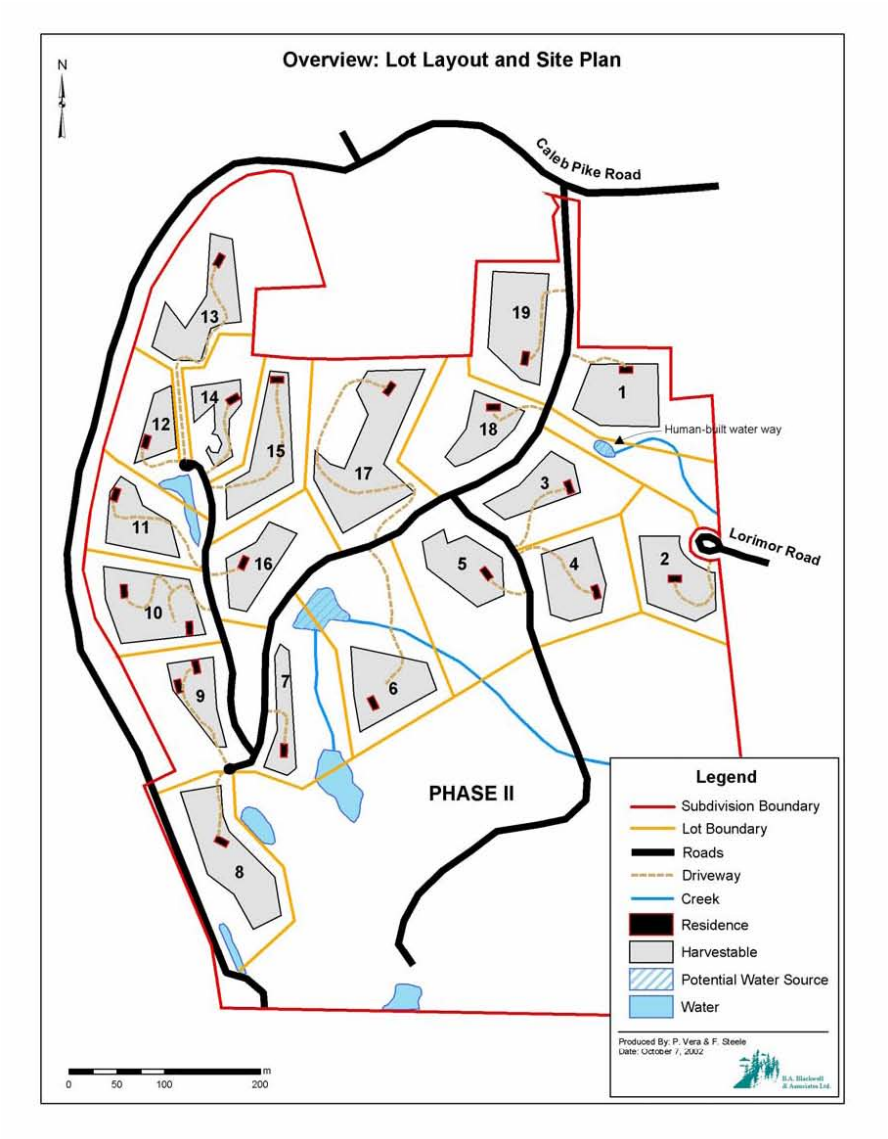

Figure 2. Detailed subdivision overview.

Vegetation

Biogeoclimatic ecosystem classification

Biogeoclimatic ecosystem classification (BEC) is the principle system used in British Columbia for ecological stratification of the landbase. It is applied to a wide range of resource management issues, including site-specific forest management, biodiversity management including identification of Sensitive Areas and developing Protected Areas Strategies, parks management, and provincial vegetation inventory. BEC also is being applied to community watershed management planning. In a recent study in the Greater Vancouver Water District, it formed the foundation for a natural resource inventory which was used to develop watershed hazard and risk models.

BEC organizes information about ecosystems at three levels: regional, local, and chronological. At the regional level, geographic areas influenced by similar climate are classified into biogeoclimatic units (e.g. zones, subzones and variants). The local level recognizes variation in sites occurring within a biogeoclimatic unit; a result of changing soils and physiography, which affect available soil moisture and nutrients. At the chronological level, the various changes an ecosystem goes through with time (ecological succession) are classified. The following provides a general description of the subdivision area in the context of the BEC system.

The proposed subdivision falls within the Coastal Douglas-fir Biogeoclimatic Zone (CDF) (Meidinger and Pojar 1991). The area has a maritime climate characterized by warm, dry summers, a fairly long growing season, and mild wet winters. The main factor controlling climate is the rainshadow created in the lee of the topographic barriers of Vancouver Island and Olympic mountains to prevailing easterly flowing air. Mean annual temperature is 9.2-10.5°C. The average minimum temperature never falls below 0°C. Mean annual precipitation ranges from 647 to 1263 mm; very little (5% or so) falls as snow from November to April. During most winter seasons the snow melts within the first week of falling.

The vegetation of the Coastal Douglas-fir includes about 50 rare species (Staley et al. 1985) restricted to the zone. Most of these species are at the northern limit of their distribution and include species of seaside, aquatic, rock outcrop, and forested habitats.

Local level

Variation in vegetation within an area of similar climate (e.g. biogeoclimatic subzone or variant) is strongly influenced by soil and physiographic properties that control soil moisture and nutrients. In the BEC system, these different sites are classified into site series, which represent areas with similar soil moisture and nutrient regimes, and thus, the potential to produce similar mature or climax plant communities. The CDF zone has a total of 11 recognized site series (Green and Klinka 1994) although not all are represented in the subdivision. The most common site series can be grouped into four major complexes (Table 1).

Table 1. Major complexes of site series.

Complex	Site series	Main features
Very Dry	FdPl - Arbutus	very shallow soils with rock outcrops.
	Fd – Oniongrass	shallow or very coarse textured soils, upper slopes
Zonal	Fd – Salal	moderately deep to deep soils, middle slopes, intermediate soil textures
Moderately Dry /Rich	FdBg – Oregon grape	moderately deep to deep soils, middle to lower slopes, base-rich rock, colluvium
Slightly Dry to Fresh/Medium	CwFd –Kindbergia	moderately deep to deep soils, flats and lower slopes, medium to fine-textured soil, fluctuating watertable

Slightly Dry to Fresh/Rich	CwBg Foamflower	moderately deep to deep soils, lower slopes and flats, medium to fine-textured soil, seepage or fluctuating watertable
Wet	Cw - Skunk cabbage	wet nutrient-rich depressions, persistent high watertable
	Pl – Sphagnum	wet nutrient-poor depressions, persistent high watertable, "peat" soil
Floodplain	Cw- Snowberry	high bench of floodplain
	Act- Red-osier dogwood	medium bench of floodplain
	Act – Willow	low bench of floodplain

Fire Weather

Fire weather data was obtained from the Environment Canada weather station at the Victoria Airport. The weather record for the station extends from 1978 to present. The daily historical record of 13:00 temperature, precipitation, relative humidity, wind speed and all Canadian Fire Weather Codes and Indices were obtained. The digital file for the station was imported into an Excel spreadsheet where variables could be summarized by month and year. The total number of days in which recorded fire weather conditions would promote ignition and spread of fires were compiled by month (June, July, August and September). Key fire weather parameters summarized as part of the analysis included;

- Drought Code
- Fire Weather Index (FWI)
- Number of days in Danger Class 5

For each of the key parameters summary graphs (Figures 3 to 5) were produced for the number of days, by month and by year. It is apparent from the summary graphs that fire weather conditions are of greatest concern in July and August where the drought code, FWI, and number of danger class 5 days are all indicative of significant periods where high to extreme fire behavior are possible. The month of greatest concern is August where historically the drought code has exceeded 500 in most years and the number of danger class 5 days has been greater than 15. Under these conditions fire behavior potential would be considered extreme where much of the current forest structure would be capable of supporting a damaging fire.

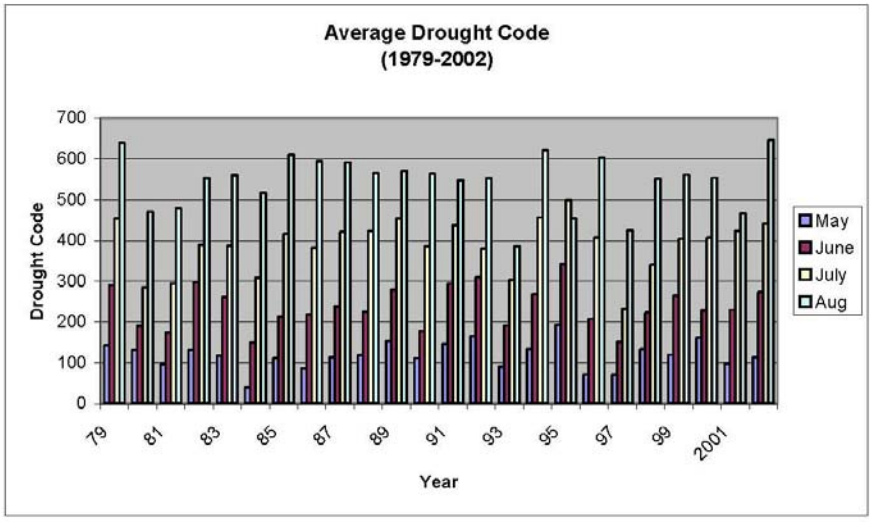

Figure 3. Average Drought Code by month.

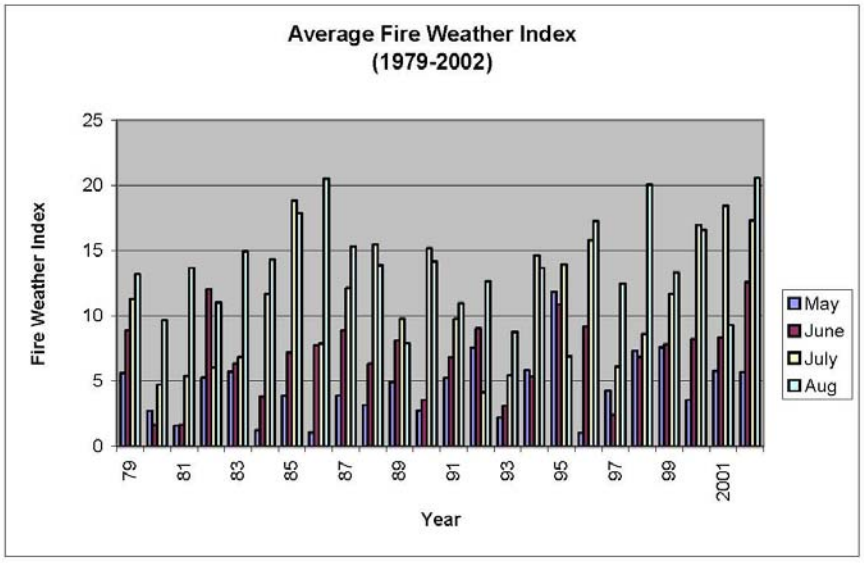

Figure 4. Average Fire Weather Index by month.

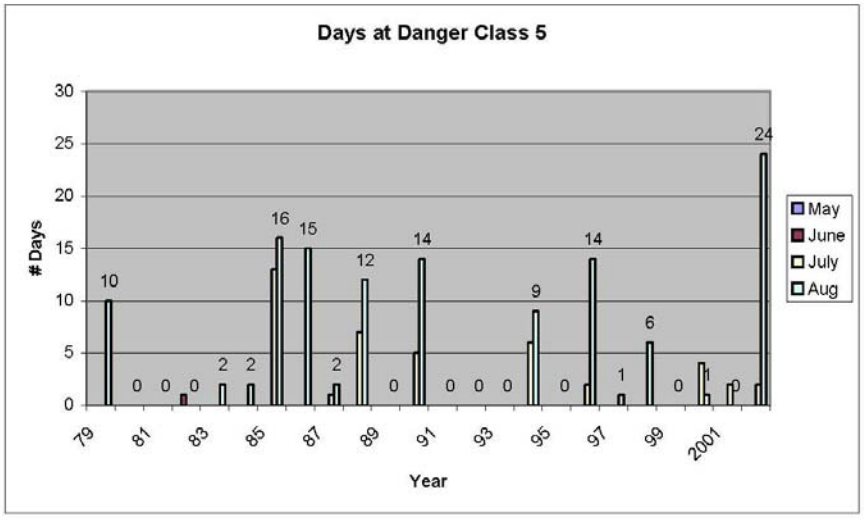

Figure 5. Number of days of Danger Class 5 by month.

Historic Fire Regime

Prior to human settlement, fires in the Coastal Douglas-fir Zone were common and were important in determining the vegetation patterns of the region. Several fire history studies have documented large landscape level fires, 300 to 400 years ago, which influenced forests stretching from Victoria to Campbell River. Douglas-fir is a fire adapted species, that as a mature tree is capable of withstanding low to moderate severity fire.

Fire appears to be the major natural disturbance in the forests of this region. The pre-settlement fire regime appears to be one of moderately frequent, moderate severity fires: a moderate-severity fire regime (Agee 1993). Low- and high-severity fires also occur in this regime, but less commonly than moderate-severity fire. Moderate-severity fire results in substantial, but far from complete, tree mortality. Common post-fire age classes in Coastal Douglas-fir-forests are 50-70 yr, 110-140 yr, and 250+ yr.

According to Agee (1993) multiple cohorts of Douglas-fir are common in unlogged stands. Each cohort appears to be a result of regeneration for a period of time after a fire. Douglas-fir regeneration between these episodic pulses is apparent, but not particularly abundant. Structural heterogeneity of the canopy in multi-cohort stands is high on both vertical and horizontal scales. Older Douglas-firs often form a discontinuous emergent layer above a more continuous canopy layer of younger madrone and Douglas-fir.

Recent Fire History

The Ministry of Forests fire reporting system was used to compile a database of fires from 1950 to present. The average number of fires per year by decade is as follows: 1950-59 – 12.1; 1960-69 – 17.7; 1970-79 – 7.5; 1980-89 – 4.3; 1990-1999 – 3.9. The most significant fire year in recent history was 1961 when a total of 31 fires were reported in the vicinity of the subdivision (Figure 6). The number of fires is significant and demonstrates the need for fire management.

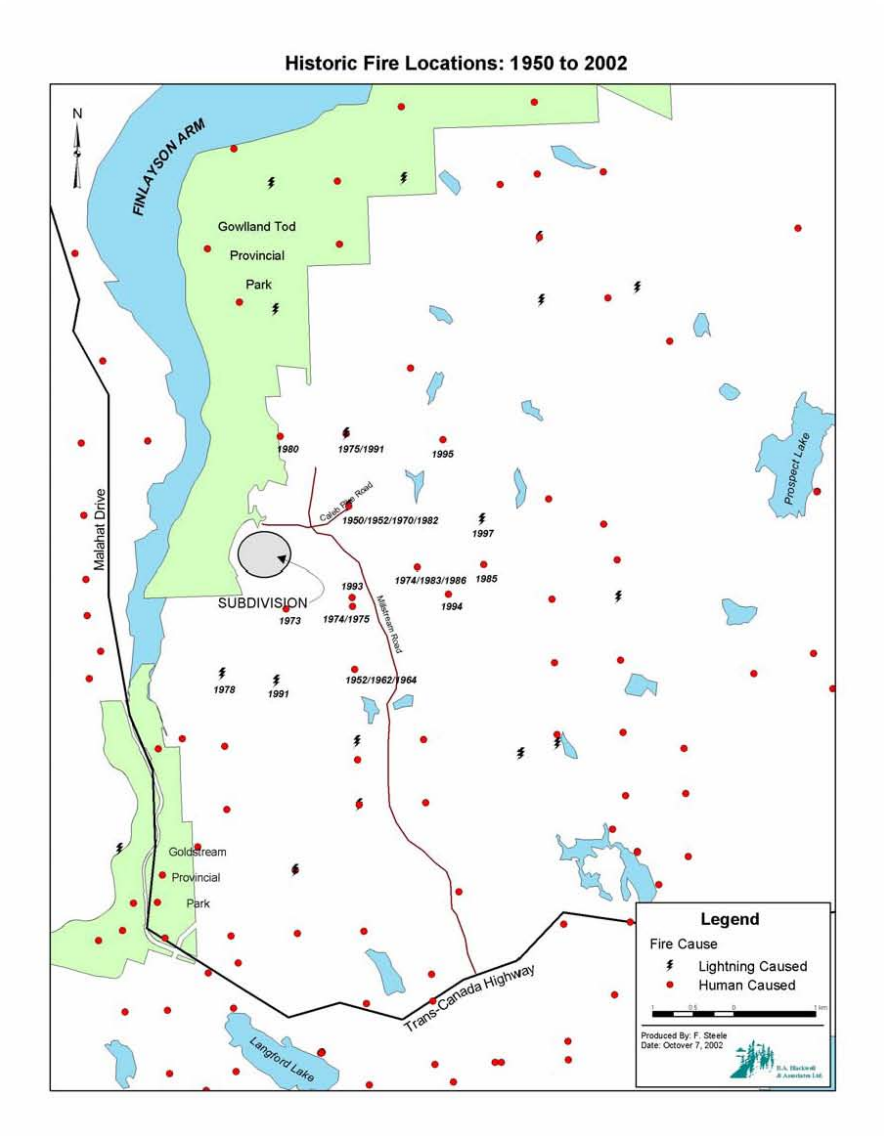

Figure 6. Fire History 1950 to 2002 within the vicinity of the subdivision.

Table 2 summarizes fires that have occurred between 1950 and 2002 within the vicinity of the subdivision by size class and cause (lightning and human caused). The total number of fires during this period was 455, of which 96% were the result of human causes. The remaining 4% of fire ignitions were lightning caused. Ninety-four percent of all fires that burned between 1950-2002 were less than 4 ha in size, while the remaining 6% were greater than 4 ha. The largest fire within the area since 1950 occurred in 1958 starting north of the subdivision on the west side of Finlayson Arm and burning an area of 728 ha.

Table 3 summarizes fire cause by decade and provides some interesting insight into the nature of fire within the vicinity of the subdivision. The highest number of fires (177) occurred between 1960 and 1969. From the beginning of the 1950s to present the number of fires per decade has been decreasing. This is likely the result of improved prevention measures. Human caused fires have represented the most significant source of ignition. The District and the Ministry of Forests must continue to be diligent in prevention and detection efforts such that these types of ignition sources are minimized.

Table 2. Fire history summary for the area surrounding subdivision from 1950 - 2002.

Size Class (ha)	Total Number of Fires	% of Total	Lightning Caused	Human Caused
<1.0	390	86	19	371
1.0-4.0	39	8	0	39
>4.0	26	6	0	26
	455	100%	19	436

Table 3. Summary of fire cause in area surrounding subdivision.

Decade	Lightning	Human	Total
1950-1959	0	121	121
1960-1969	1	176	177
1970-1980	8	67	75
1980-1989	2	41	43
1990-1999	8	31	39
2000-2002	0	0	0
Total All Years	19	436	455

FIRE MANAGEMENT TECHNIQUES

The location of the subdivision can be defined as an "organized" community that is administered by a local level of government and is serviced by a local volunteer fire department (Anon, 1994). The area falls within an established municipality (District of Highlands) containing an extensive area of forest within and surrounding their boundaries, which is typical of the wildland/urban interface.

Hazard and Risk Condition of the Study Area

As part of this assessment the Ministry of Forests "Rural Interface Hazard Site Form" was used to determine the current hazard of forest stands within the proposed subdivision boundaries. The hazard assessment ranks a series of variables individually, which are then summarized to provide a total score on which the hazard rating is based. Data was collected from throughout the proposed subdivision to assess the current hazard condition. Based on topographic position (slope and aspect) lots were grouped into three classes which included; (1) lots (8-13) located along the western boundary at the height of land above Gowlland Tod Provincial Park, (2) lots (14-19) located between the upper and main access roads into the subdivision, and (3) lots (1-7) located below the main access road (Figure 7). The hazard assessment was based on 14 variables. Each of the three groups of lots had combined scores that ranged from 37 to 45 points (Appendix A). A score for these assessments that exceeds 35 is classified as an extreme hazard. Overall the fuel complex hazard within the subdivision boundaries should be considered as extreme. In addition to the fuel complex located within the subdivision boundary, fuels identified on crown land located along the Gowlland Tod park boundary (Figure 1) and the hydro right-of-way along the southern and northwestern boundary adjacent to the subdivision (Figure 8) are classified as high to extreme hazard.

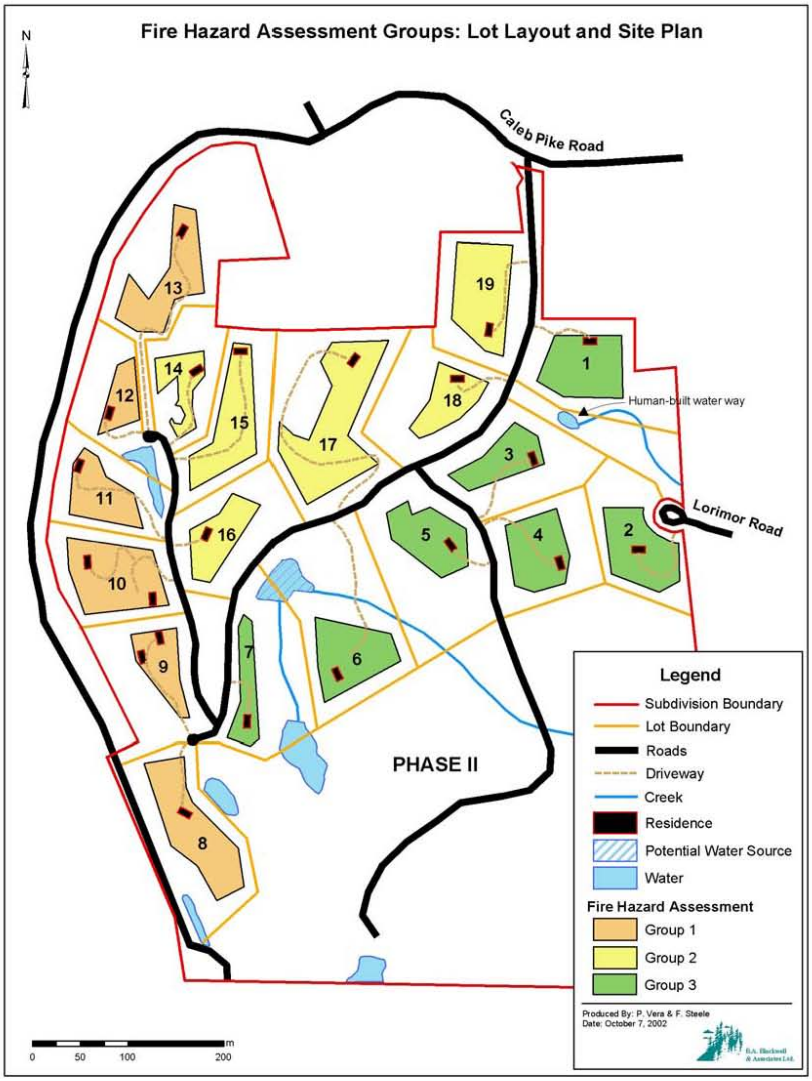

Figure 7. Fire hazard assessment lot groupings

Within the subdivision boundaries, with the exception of the road network, there are few areas that can be classified as effective fuel breaks. A large portion of the subdivision is dominated by continuous high

hazard forest cover, which is intersected by the road network, small discontinuous deciduous patches, and four small wetlands. All the house construction proposed within the subdivision boundaries is within heavily forested areas, which are not associated with any acceptable natural fuel break.

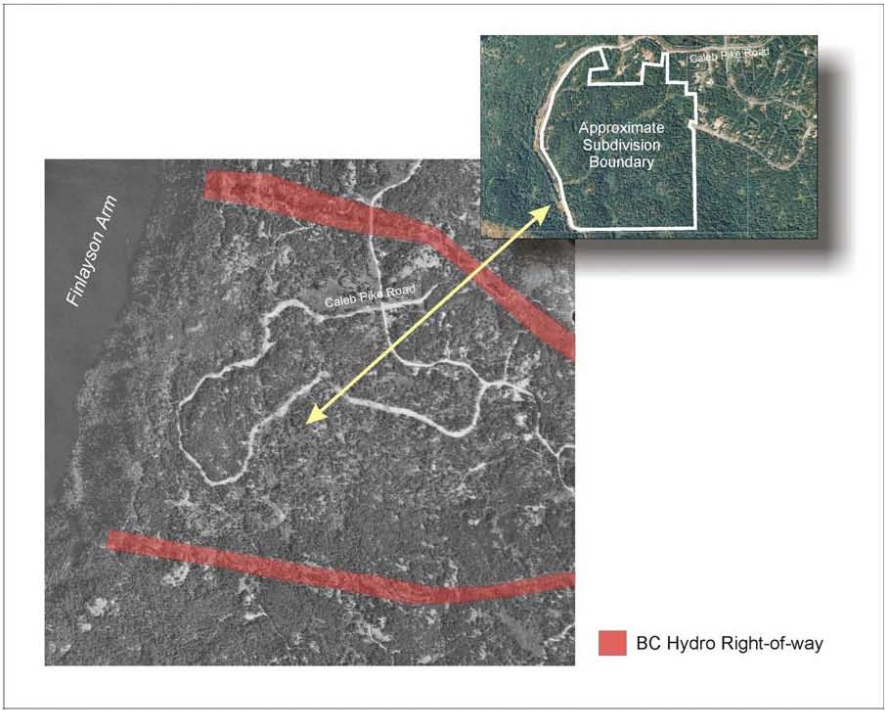

Figure 8. Aerial view of subdivision illustrating the hydro right-of-way.

Vegetation Management

The primary goal of vegetation management within a subdivision is to reduce or eliminate flammable vegetation surrounding any developed structures and homes. This creates an area defined as "defensible space" that acts as a fire break around structures and homes. The safety of homes and structures is directly correlated to the distance between the structure and forest vegetation (Figure 9).

Prior to any fuel mitigation treatments it is recommended that priority zones be established around each building. Within each of these zones there are unique management activities recommended. These are described as follows:

Priority zone 1 - the zone within 10 meters of the structure or house should be fuel free such that it will not support wildfire of any kind. The defensible space should be a fuel free zone that provides firefighters with an opportunity to attack the fire and prevents structural fires from spreading to surrounding vegetation (Anon, 1994).

Priority zone 2 – begins 10 meters from the structure or house and extends 30 meters from the building depending on topography. Within this zone fuels are managed to minimize fire behavior such that they will only support fires of lower intensity and rate of spread.

Priority zone 3 – begins 30 meters from the building and extends to 100 meters or farther from the building. Fuel management within this zone is only needed in specific cases, when high hazard levels resulting from heavy continuous fuels and steep topography are not reduced by fuel management techniques in Priority zone 2.

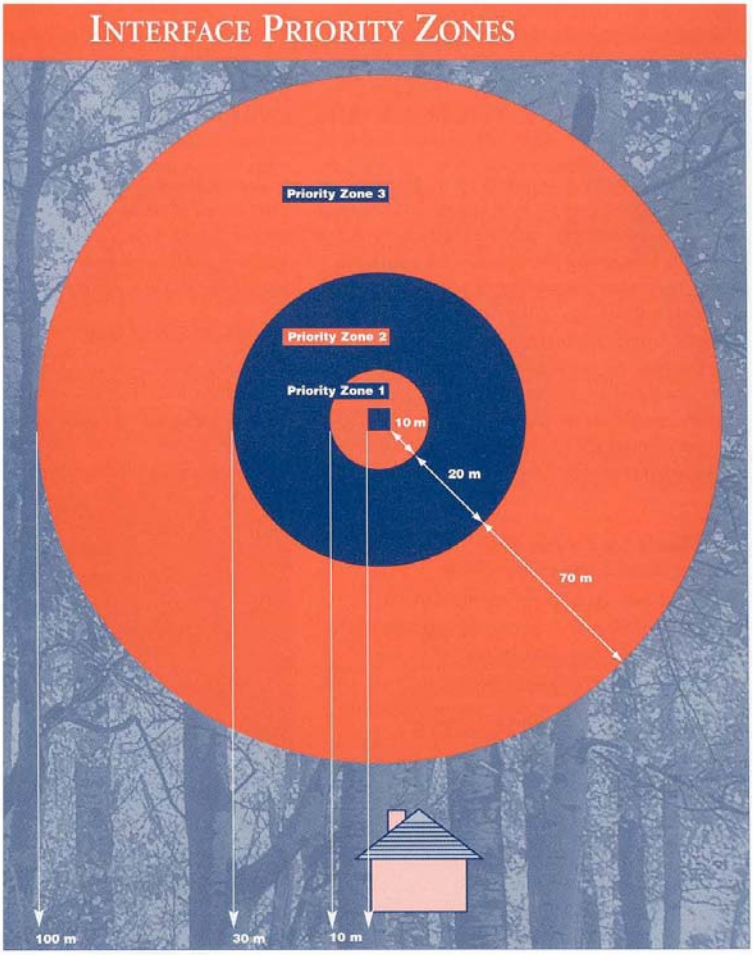

Figure 9. Interface Priority Zones as per Fire Smart: Protecting your Community from Wildfire.

Priority Zone 1 -Fuel Free Zone (10 meters)

The current hazard status of the property should be considered in the subdivision design. It is recommended that a fuel free zone be created around all houses and structures within the subdivision. This fuel free zone should be a minimum of 10 metres (30 feet) around the development perimeters (Figure 10). Guidelines for the fuel free zone are as follows:

- Defensible space should be provided by the builder and maintained by the property owner
- There should be enough defensible space to protect buildings from approaching wildfire and to reduce the potential for a building fire to spread to the adjacent forest.
- Annual grasses within 10 meters of buildings should be mowed to 10 cm or less.
- Ground litter and downed trees should be removed annually.
- Any overstory trees retained within this zone should be away from the immediate area of the building should be thinned and pruned to prevent fire from being carried towards the building. Remove the live and dead branches to a minimum of 2.5m (8 feet) from the ground.
- Tree cover within this zone should be restricted to low flammable deciduous species. Individual trees and shrubs may be kept if the vegetation does not readily transmit fire to the building.

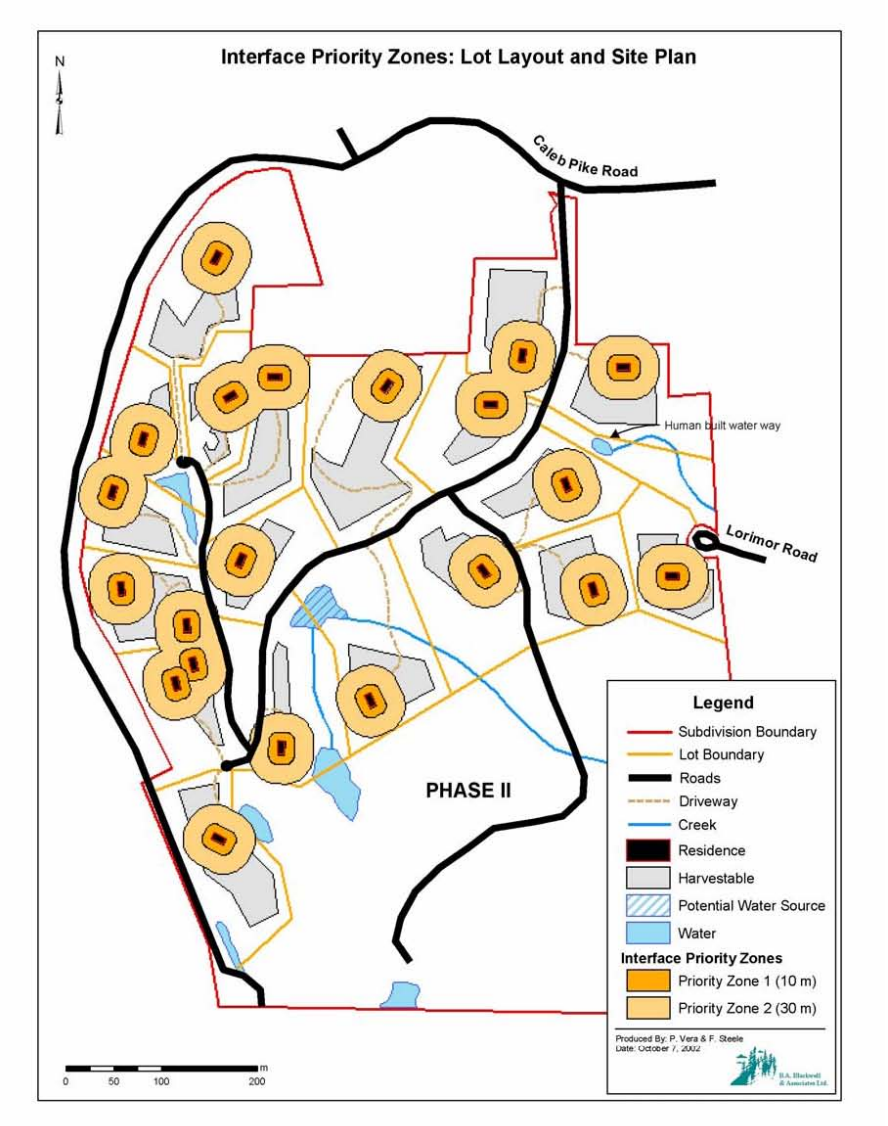

Figure 10. Fuel free buffer surrounding proposed developments.

Priority Zone 2 –Partial Fuel Removal (10-30 meters)

Areas adjacent to the fuel free zone should at minimum be treated to reduce the current heavy accumulation of crown fuels (Figure 10). It is recommended that an additional 20-meter area adjacent to the fuel free zone be created where the current fuel condition is substantially altered such that crown fuel hazard is substantially reduced. Currently within the subdivision crown closure is high and there is a significant component of ladder fuels from the understory into the crown canopy that provides fuel continuity that would promote crown fire behavior. This fuel complex should be thinned to reduce the fuel continuity. Fuel removal should be to the standards outlined in the Beware Prepare Planner (Anon, 1994);

Within this zone fuel reduction (rather than removal) is the main strategy for vegetation management in Priority Zone 2. The following guidelines apply:

Selected whole trees should be removed from the forest canopy (overstory) in this zone. Leave trees should be the largest in diameter (> 30 cm) where the crowns are well above the ground (2.5 meters). If crowns are below two meters on leave trees they should be pruned. The goal of the thinning process is to leave a forest of more fire resistant or separated trees. Separated trees are widely spaced and do not touch or overlap. Separation of the tree crowns reduces the probability of fire spreading laterally from one crown to another.

When in the vicinity of structures forest stands should be thinned for a distance of two tree heights – at least 30 meters in each direction from the building on level terrain. Remove all dead and dying trees as they have a higher potential to ignite.

In the understory all trees and larger shrubs (> 3m in height) should be removed. An understory tree is an immature tree growing under the canopy of the taller trees. The goal or purpose of the understory thinning is to reduce the probability of surface fires climbing into the forest canopy. If understory trees must be retained they should be spaced 4 meters apart and should not be left in clumps. Similar to canopy trees treatment distances from buildings should be the same.

As discussed above all remaining trees should be pruned to a height of at least 2.5 meters from the ground. Remove all live and dead branches. This will reduce the probability of surface fires spreading into the crowns. Dispose of slash created by the thinning and pruning immediately following treatment. Pile and burning is appropriate disposal method or fuels can be removed from the site.

Priority Zone 3 – Area 30 to 100 meters from a building

In the areas outside of the fuel free and partial removal zones where surface and crown fuel accumulations are high a fuel reduction treatment should also be considered. These areas would greatly benefit from both a thinning and pruning treatment. Residual slash created from the treatment of these areas should be piled and burned or removed from the site. The strategies and standards for vegetation management in Priority Zone 3 are similar to those applied in Priority Zone 2. Within the Highlands Subdivision this zone applies to all of the property area not within priority zones 1 and 2 outlined in (Figure 10).

Thinning in this portion of the subdivision should be focused on reducing the crown closure to less than 40 percent with a minimum of 4 meters between crowns (Crown closure is the percentage of area covered by tree crowns if one were looking at the tree from above). Thinning will reduce the probability of a crown fire from spreading tree to tree. Residual trees retained on the site should be healthy and free from defect. Wherever possible deciduous trees should be selected over conifers as they are more fire resistant.

Pruning should be used to remove all live and dead branches of remaining trees a minimum of 2.5 meters from the ground. This will reduce the probability of any surface fire from spreading into the tree crowns.

Buildings and Construction

There are a number of building and construction techniques that should be considered as part of the subdivision development. These are outlined in the Beware and Prepare Community Planner (Anon, 1994).

Attention to materials that are fire proof should be considered in roof design and the type of exterior siding used. It is recommended that only fire retardant roofing material rated Class A, B, or C be approved within the subdivision. Additionally, install roofing material to preclude entry of flames or embers. Enclose undersides of overhangs (soffits) built of combustible material with 12 mm sheathing. Ideally, sheathing material should be non-flammable. Exterior siding should be restricted to non- combustible materials such as stucco, metal siding, brick, cement shingles, concrete block, poured concrete and rock. Vinyl siding may melt, exposing flammable sheathing. Wooden siding offers very little fire resistance and its use in this type of subdivision should be discouraged.

Large windows that are vulnerable to fire should be used carefully. These types of windows may break or if left open allow heat and embers to enter the structure. Radiated heat from the fire can pass through the glazing igniting combustible materials inside (furniture, curtains, etc). Greater protection is provided by smaller (less than 1 metre by 1 metre) thermal pane, tempered glass windows.

Balconies, decks and eaves should be planned and constructed carefully to minimize influence as heat traps. Balconies should be constructed with non-combustible or fire resistant materials. Eaves, cantilevers, balconies and undersides of overhangs that are constructed of combustible materials should be enclosed with 12mm (1/2 inch) sheathing. Stilts can be built from or encased in non-combustible materials. Additional considerations should be given to the design of chimney/stovepipes and venting. Chimneys are considered a potential hazard if not equipped to prevent firebrands or embers from spreading. Although venting is important for the transfer of moisture they provide an entrance point for fire, allowing heat and embers to enter into the structure possibly resulting in ignition. Chimney outlets should be at least 0.6 meters higher than any part of the roof that is within 3 meters of the chimney and be located at least 0.9 meters above the point at which the chimney joins the roof surface (Figure 11).

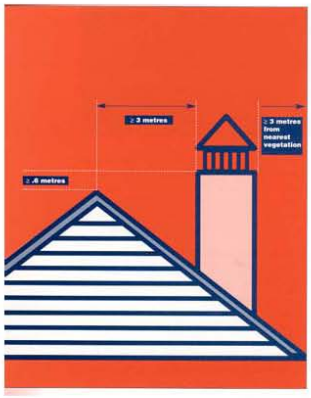

Figure 11. Standards for chimney design as per Fire Smart: Protecting your Community from Wildfire.

Access Management

In any fire situation access is considered one of the most important infrastructure components. Access problems created by narrow roads, steep grades, and underbuilt bridges are considered an obstacle in any fire suppression activity (Anon, 1994).

Roads serve three key functions in the event of a fire. These include:

- Providing access for emergency vehicles and supporting fire equipment.
- Providing an escape route for residents during fire.
- Serving as firebreaks that assist in fire prevention efforts.

As part of this review/assessment process access was one of the most important considerations in the development of this subdivision plan. For interface fire protection purposes, access route standards are divided into two categories; roadway standard, for an access route that serves three or more dwellings; and fire service access standard, for the route to a building that is located more than 45 meters off a roadway.

The following outlines roadway standard guidelines;

- Roadways should provide safe simultaneous access for emergency vehicles and public evacuation with a traveled way of not less than 7.5 meters horizontally and 4.5 meters vertically.
- Roadway curvature radius should be at least 30 meters, measured from the center line.
- Road gradient should not exceed 12 percent. Exceptions to this may be negotiated with fire officials.
- Dead-end roadways longer than 90 meters should be provided with a turnaround at the terminus having no less than 26 meters outside diameter of traveled way.
- Roadways should have a hard all-weather surface capable of supporting fire equipment likely to be on the roadway.
- Provision should be made for any factors that could reduce minimum width (drainage, parking, utilities, snow removal).

The following outlines fire service access (driveways) standard guidelines;

- Fire service access should be at least 3.7 meters wide and provide 4.5 meters vertical clearance over the full width.
- Fire service access gradient should not exceed 15 percent. Exceptions to this may be negotiated with fire officials.
- Fire service access turns should not restrict the access of the largest emergency vehicle likely to be on the fire service access. Fire officials should specify local agency requirements for emergency response.
- Fire service access roads should have an all weather surface capable of supporting any fire equipment likely to be on the fire service access.
- Dead-end roadways longer than 90 meters should be provided with a turnaround at the terminus having no less than 36 meters outside diameter of traveled way. Fire officials may authorize a hammerhead "T" turnaround to provide three-point turnaround ability. Dead end roads should be posted as no-through roads (Figure 12).

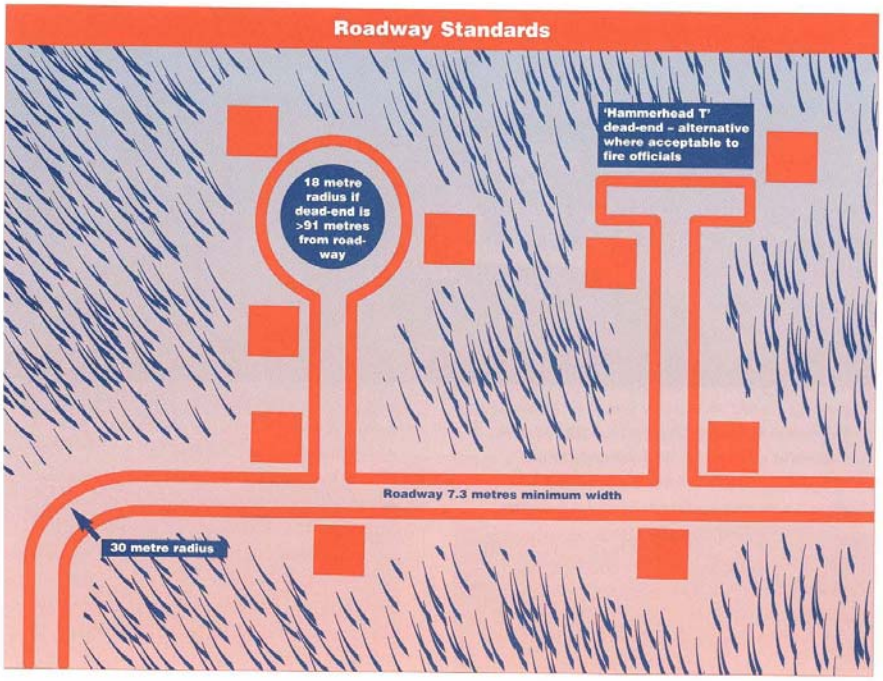

Figure 12. Roadway standards as per Fire Smart: Protecting your Community from Wildfire.

The roadway servicing Gowlland Tod Provincial Park along the western boundary of the subdivision is considered essential to the protection of the subdivision (Figure 13). This roadway serves two important functions. Firstly, it acts as a fire break to any fires that start in the Park on the slopes below the subdivision. Secondly it provides important fire access to the homes along the ridge (Lots 8 through 13). This roadway should be maintained to the same roadway standards outlined above. Additionally all scotch broom adjacent to the road should be removed as this is considered a hazardous fuel complex. During high fire hazard periods it is recommended that B.C. Parks control access through this corridor and the upper trails system in the Park to reduce human caused ignitions. B.C. Parks in conjunction with the Municipality of Highlands should be encouraged to develop a joint fire management plan to protect important elements of the park and the local community.

Figure 13. Photograph of road right-of-way separating Lots 8 to 13 and Gowlland Tod Provincial Park along the western boundary of the subdivision.

Water Supply

Water is considered the most effective fire-fighting tool available (Anon, 1994). Development of the proposed subdivision should consider the availability of water. Installation of several standpipes linked to a reliable water source and located along the roadway would provide a valuable fire suppression tool for residents in the event of a fire. Consideration should be given to developing the wetland area immediately adjacent to lot 6 and the runoff collection pond into fire suppression water storage reservoirs (Figures 2). These reservoirs would provide emergency water to firefighters. This system should be independent of the water system that serves individual residences. The system should not be dependent on community water pressure or on an electric well pump (both of which are unserviceable during a fire). Gravity fed systems located close to development structures are considered most suitable (Anon, 1994). Pressure and hose connections should be compatible with standard Ministry of Forests and local fire department equipment.

In addition to emergency reservoirs, individual homes should be serviced with exterior stand pipes located away from the main structure. This stand pipe should be linked to property well service and would provide water for initial attack prior to the arrival of the local fire department. Hose connections should be plumbed on both the exterior of the building and on standpipes located 15 meters from the building. A 37 mm line equipped with forestry quick-couple connections provides a more effective supply. Garden hose outlets and connections are acceptable as a minimum. This water source could also be used to sprinkle roofs and wet down the area adjacent to the structure to reduce damage from an on coming fire.

Community Fire Break

In addition to the priority zonation concept applied to individual structures discussed above it is necessary to consider a more expanded firebreak along the western boundary of the property. The slopes of Finlayson Arm present a significant crown fire hazard that in the absence of any breaks would be difficult to control

along the western boundary of the subdivision. The road running along the provincial park boundary helps to minimize this hazard however it is recommended that additional measures area required within the subdivision boundary are required to protect the property. The forests on the slopes below Lots 8 through 13 should be entirely treated to the same standards outlined in Priority Zone 2. This treatment area is delineated in Figure 14. This firebreak will provide additional protection in addition to the measures outlined above.

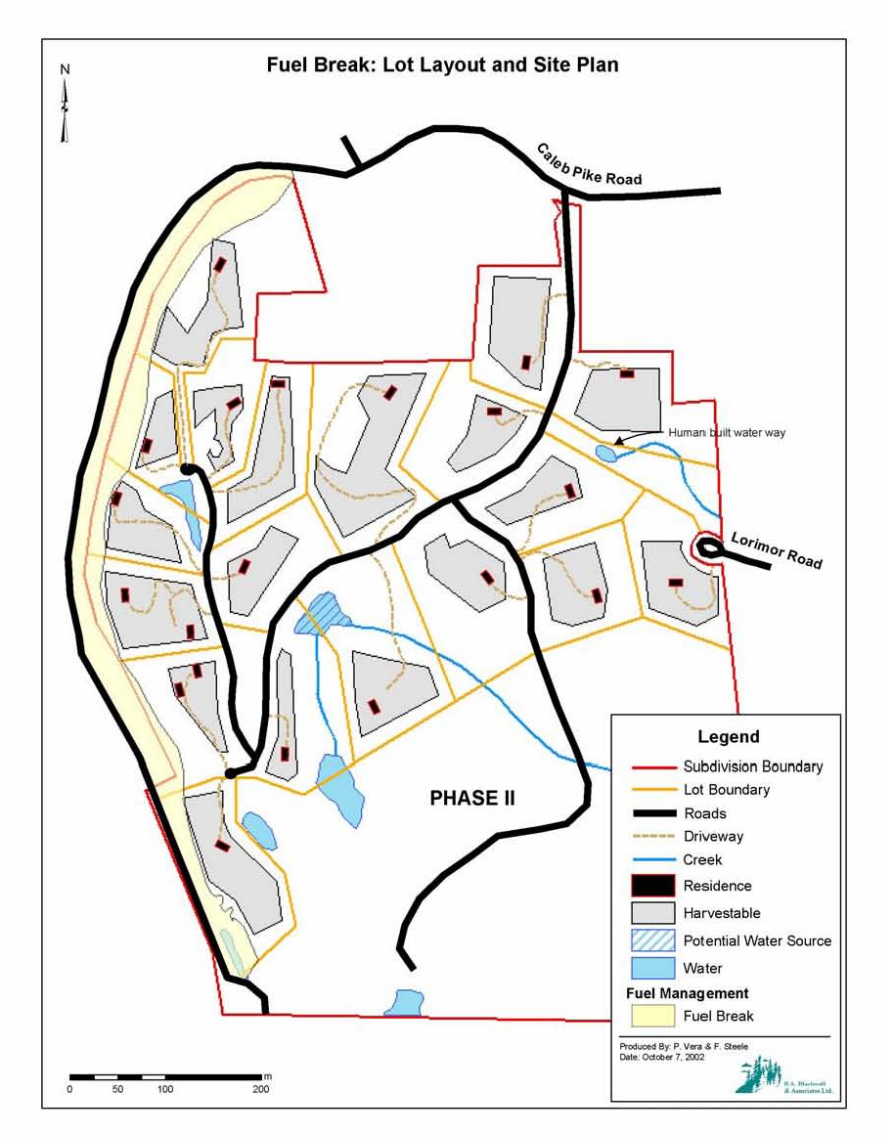

Figure 14. Proposed community fire break adjacent to Lots 8 to 13 above road right-of-way to Gowlland Tod Provincial Park.

Utilities – Electric and Gas

Overhead transmission lines are considered a source of ignition and are an overhead safety hazard during fire suppression activities. If feasible it is more desirable to supply power through an underground distribution system. The type of system is not vulnerable to falling vegetation, will not block traffic, and does not pose a wildfire safety hazard. Similarly propane and natural gas installations pose a significant fire hazard. These should be located a minimum of 10 meters (30 feet) from any structure and 3 meters (10 feet) from any vegetation (Anon, 1994).

The subdivision boundary is adjacent to an existing hydro right-of-way along the southern boundary of the property (Figure 8). This right-of-way is dominated by a high hazard fuel complex (Ocean spray and broom) with high ignition potential (Figure 15). Arching from the transmission lines has the potential to start a fire immediately adjacent to the property. The District of Highlands should work with B.C. Hydro to reduce this hazard by creating a fuel free zone within the section of the right-of-way that borders the subdivision.

Figure 15. Photograph of fuel complex along hydro right-of-way south of subdivision boundary.

RECOMMENDATIONS

1. Create both a 10 meter (30 feet) fuel free zone and a 20 meter (60 feet) partial fuel removal zone around the perimeters of all development structures.

2. In the areas outside of the fuel free and partial removal zones where surface and crown fuel accumulations are high a fuel reduction treatment should be considered.

3. A number of building and construction techniques that will make the development area more fire resistant should be considered as part of the subdivision development.

4. Ensure that access to the property follow the standards outlined in the report.

5. Install an independent emergency water system that is not dependent on community water pressure or an electric well pump by creating several storage reservoirs within the subdivision.

6. Consider supplying power through an underground distribution system.

7. Propane and natural gas installations should be located a minimum of 10 meters (30 feet) from any structure and 3 meters (10 feet) from any vegetation.

8. The forests on the slopes below Lots 8 through 13 to the road right-of-way along the boundary of Gowlland Tod Park should be entirely treated to the same standards outlined for Priority Zone 2. This area should be designated as a community fuel break that should be maintained to this standard.

9. The District of Highlands should work with B.C. Hydro to reduce the hydro right-of-way hazard along the southern boundary of the property by creating a fuel free zone within the section of the right-of-way that borders the subdivision.

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APPENDIX A

Hazard Assessment Plots

Hazard Rating for Subdivision lots (1-7) developed along the ridge crest of the western boundary.

Factor	Site Characteristics and Point Rating		
	Column A	**Column B**	**Column C**
1. Thickness of duff or litter	**Less than 5 cm** 1	5-20 cm 3	**Over 20 cm** 6
2. Fine debris < 7 cm	**None** 1	Scattered Branches and tops 3	Continuous branches and tops 6
3. Coarse debris > 7 cm	**None or scattered logs** 1	Frequent logs, grouped and crossed – less than 1 m high 3	Frequent logs, grouped and crossed – more than 1 m high 6
4. Vegetation	Infrequent wild grass, herbs, and low shrubs, immature trees 1	Frequent wild grass patches, herbs, low shrubs, immature trees 3	Continuous wild grass or other vegetation, immature trees 6
5. Forest type	***None or deciduous*** Pruned 1	Crown closure <40% Ladder absent 3 Present 4	Crown Closure >40% **Ladder absent** 5 **Present** 6
6. Slope	0-5% even 1 gullied 2	5-15% even 2 gullied 3	Over 15% even 3 gullied 6
7. Slope exposure or aspect	**North** 1	**East** 2	**South or West** 3
8. Position on slope	Flat or lower slope 0	Middle or upper slope 2	Upper slope, crest 4
9. Available water (hydrants, lakes, etc)	***Within 200 metres*** 1	200-500 metres 2	None 3
9. Response time to fire	<10 minutes 1	10-20 minutes 3	>20 minutes 6
10. Access for emergency equipment	***Tank truck*** 1	Mini pumper 2	Foot 3
12. Recreational use	***Infrequent*** 1	Frequent use (adjacent) 2	High use (trails, etc) 3
13. Risk of accidental ignition	***Low*** 1	Medium 2	High 3
14. Values at risk	Undeveloped wildland area 0	Solid development Fire potential on perimeter 2	Scattered development Fire potential throughout 4

Total = 37 points = Fire Danger Rating

Hazard Rating Classes	<21 points	= Low (safe)	**Hazard Rating Class**…..
	21-31 points	= Moderate	
	32-35 points	= High	
	>35 points	**= Extreme**	

Hazard Rating for Subdivision lots (8-13) developed along the ridge crest of the western boundary.

Factor	Site Characteristics and Point Rating		
	Column A	**Column B**	**Column C**
2. Thickness of duff or litter	**Less than 5 cm** 1	5-20 cm 3	**Over 20 cm** 6
2. Fine debris < 7 cm	**None** 1	Scattered Branches and tops 3	Continuous branches and tops 6
3. Coarse debris > 7 cm	**None or scattered logs** 1	Frequent logs, grouped and crossed – less than 1 m high 3	Frequent logs, grouped and crossed – more than 1 m high 6
6. Vegetation	Infrequent wild grass, herbs, and low shrubs, immature trees 1	Frequent wild grass patches, herbs, low shrubs, immature trees 3	Continuous wild grass or other vegetation, immature trees 6
7. Forest type	***None or deciduous*** Pruned 1	Crown closure <40% Ladder absent 3 Present 4	Crown Closure >40% **Ladder absent** 5 **Present** 6
7. Slope	0-5% even 1 gullied 2	5-15% even 2 gullied 3	Over 15% even 3 gullied 6
7. Slope exposure or aspect	**North** 1	**East** 2	**South or West** 3
11. Position on slope	Flat or lower slope 0	Middle or upper slope 2	Upper slope, crest 4
9. Available water (hydrants, lakes, etc)	***Within 200 metres*** 1	200-500 metres 2	None 3
12. Response time to fire	<10 minutes 1	10-20 minutes 3	>20 minutes 6
13. Access for emergency equipment	***Tank truck*** 1	Mini pumper 2	Foot 3
15. Recreational use	***Infrequent*** 1	Frequent use (adjacent) 2	High use (trails, etc) 3
16. Risk of accidental ignition	***Low*** 1	Medium 2	High 3
17. Values at risk	Undeveloped wildland area 0	Solid development Fire potential on perimeter 2	Scattered development Fire potential throughout 4

Total = 44 points = Fire Danger Rating

Hazard Rating Classes	<21 points	= Low (safe)	**Hazard Rating Class…..**
	21-31 points	= Moderate	
	32-35 points	= High	
	>35 points	**= Extreme**	

Hazard Rating for Subdivision lots (14-19) developed along the ridge crest of the western boundary.

Factor	Site Characteristics and Point Rating		
	Column A	**Column B**	**Column C**
3. Thickness of duff or litter	**Less than 5 cm** 1	5-20 cm 3	**Over 20 cm** 6
2. Fine debris < 7 cm	**None** 1	Scattered Branches and tops 3	Continuous branches and tops 6
3. Coarse debris > 7 cm	**None or scattered logs** 1	Frequent logs, grouped and crossed – less than 1 m high 3	Frequent logs, grouped and crossed – more than 1 m high 6
8. Vegetation	Infrequent wild grass, herbs, and low shrubs, immature trees 1	Frequent wild grass patches, herbs, low shrubs, immature trees 3	Continuous wild grass or other vegetation, immature trees 6
9. Forest type	***None or deciduous*** Pruned 1	Crown closure <40% Ladder absent 3 Present 4	Crown Closure >40% **Ladder absent** 5 **Present** 6
8. Slope	0-5% even 1 gullied 2	5-15% even 2 gullied 3	Over 15% even 3 gullied 6
7. Slope exposure or aspect	**North** 1	**East** 2	**South or West** 3
14. Position on slope	Flat or lower slope 0	Middle or upper slope 2	Upper slope, crest 4
9. Available water (hydrants, lakes, etc)	***Within 200 metres*** 1	200-500 metres 2	None 3
15. Response time to fire	<10 minutes 1	10-20 minutes 3	>20 minutes 6
16. Access for emergency equipment	***Tank truck*** 1	Mini pumper 2	Foot 3
18. Recreational use	***Infrequent*** 1	Frequent use (adjacent) 2	High use (trails, etc) 3
19. Risk of accidental ignition	***Low*** 1	Medium 2	High 3
20. Values at risk	Undeveloped wildland area 0	Solid development Fire potential on perimeter 2	Scattered development Fire potential throughout 4

Total = 39 points = Fire Danger Rating

Hazard Rating Classes	<21 points	= Low (safe)	**Hazard Rating Class…..**
	21-31 points	= Moderate	
	32-35 points	= High	
	>35 points	**= Extreme**	