



**FPInnovations**  
Wildfire Operations



# **Assessing Fuel Treatment Effectiveness:**

## A case study of the McDougall Creek wildfire encroachment on the West Kelowna communities of Rose Valley and Bear Creek Road



Authors:  
Andrew Stack, Researcher  
Steve Hvenegaard, Senior Researcher  
Greg Baxter, Senior Researcher  
Brandon MacKinnon, Senior Researcher  
Gregory Griffiths, Researcher

[www.wildfire.fpinnovations.ca](http://www.wildfire.fpinnovations.ca)  
[Wildfiregroup@fpinnovations.ca](mailto:Wildfiregroup@fpinnovations.ca)

May 2026

On August 17, 2023, the McDougall Creek Wildfire (K52767) impinged upon two wildfire risk reduction fuel treatments on the north side of West Kelowna. The fuel treatments were both exposed to extreme fire behaviour resulting from long term drought, high winds, and mountainous topography. Research was conducted at both sites to determine if fire behaviour was reduced relative to nearby untreated forests. Insight into fuel treatment design and suppression tactics during extreme fire behaviour are discussed.

Project number: 438 British Columbia Ministry of Forests  
2WO-BC-Fire fuel treatment FY27  
Report number: WF TR 2026 N5

#### **ACKNOWLEDGEMENTS**

We gratefully acknowledge the unceded traditional territories of the Westbank First Nation upon whose lands this research was conducted.

We gratefully acknowledge the financial support of the Province of British Columbia through the Ministry of Forests, BC Wildfire Service

#### **AUTHOR CONTACT INFORMATION**

Andrew Stack – Researcher, Wildfire Operations  
[Andrew.Stack@fpinnovations.ca](mailto:Andrew.Stack@fpinnovations.ca)

#### **REVIEWER**

Morgan Boghean  
Wildfire Prevention Officer, Fuel Management  
British Columbia Wildfire Service

#### **APPROVER CONTACT INFORMATION**

Razim Refai  
Manager, Wildfire Operations  
[Razim.Refai@fpinnovations.ca](mailto:Razim.Refai@fpinnovations.ca)

While every reasonable effort has been made to ensure the accuracy, correctness, and/or completeness of the information presented, FPInnovations does not make any warranty, expressed or implied, or assume any legal liability or responsibility for the use, application of, reliance upon, and/or reference to opinions, findings, analysis of data, conclusions, or recommendations included in this report or any product to which the information refers. FPInnovations has no control over the conditions under which the evaluated products may be used, and as such FPInnovations does not accept responsibility for product performance or its uses. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. Cover photo provided by the British Columbia Wildfire Service.

# Table of Contents

Introduction.....	1
Site Description .....	1
Fire Environment.....	2
Fuels.....	2
Weather.....	5
Topography.....	10
Fire Behaviour Analysis .....	12
Fire chronology.....	12
Fire progression.....	14
Continuous fuels.....	14
Landscape-level eddy rolls .....	15
Spot fires and ember transport .....	16
Fire severity .....	17
Rose Valley fuel treatment.....	17
Bear Creek Road fuel treatment.....	18
Stand-level topographic influences and tornadic winds .....	19
Fire Management Approach.....	21
Discussion .....	21
Implications of treatment unit design and implementation.....	21
Hot, dry, and windy conditions .....	21
Topographic influences on fire behaviour .....	22
Spotting and ember transport.....	23
Conclusion .....	23
Key Findings.....	25
References.....	26
Appendix A: Hourly Weather Observations .....	27

# List of Figures

Figure 1. Overview of the study locations.....	2
Figure 2. Bear Creek Road fuel treatment, July 2023. (Source: Google Streetview) .....	4
Figure 3. Drought conditions across western Canada during August 2023. ....	5
Figure 4. Stalled cold front over West Kelowna (red dot) at 2000 h local time. (Source: National Oceanic and Atmospheric Administration Weather Prediction Centre) .....	6
Figure 5. Hourly temperature, relative humidity, and wind speeds recorded at the West Kelowna Fire Weather station on August 17 and August 18, 2023. Arrows indicate recorded wind direction. The yellow bar indicates the time when the wildfire crested the ridge at Rose Valley.....	7
Figure 6. Hourly Fire Weather Index System values recorded at the West Kelowna Fire Weather station on August 17 and August 18, 2023. The yellow bar indicates the time when the wildfire crested the ridge at Rose Valley. HFFMC: Hourly Fine Fuel Moisture Code; HISI: Hourly Initial Spread Index; HFWI: Hourly Fire Weather Index.....	7
Figure 7. Hourly temperature, relative humidity, and wind speeds recorded at the Brenda Mines Fire Weather station on August 17 and August 18, 2023. Arrows indicate recorded wind direction. The yellow bar indicates the time when the wildfire crested the ridge at Rose Valley.....	8
Figure 8. Hourly Fire Weather Index System values recorded at the Brenda Mines Fire Weather station on August 17 and August 18, 2023. The yellow bar indicates the time when the wildfire crested the ridge at Rose Valley. HFFMC: Hourly Fine Fuel Moisture Code; HISI: Hourly Initial Spread Index; HFWI: Hourly Fire Weather Index.....	8
Figure 9. Looking north at pyrocumulus clouds observed from Highway 97 in West Kelowna, August 17, 2023, at 16:22 h. (Source: Publicly submitted).....	9
Figure 10. Abnormal, high-intensity fire behaviour, August 17, 2023, at 21:42 h. (Source: Publicly submitted).....	10
Figure 11. Percent slope (left) and elevation contours (right) of the study locations and surrounding area.....	11
Figure 12. Satellite view of the Rose Valley study location.....	11
Figure 13. Satellite view of the Bear Creek Road study location, with imagery from 2022.....	12
Figure 14. Fire growth timeline of the McDougall Creek wildfire, Walroy Lake wildfire, and Clarke Creek wildfire. ....	14
Figure 15. Continuous needle litter and dry grass understorey in the treated Rose Valley study location. ....	14
Figure 16. Stump and root system burnt out in the Rose Valley research site.....	15
Figure 17. Eddy rolls, as described by Schroeder and Buck (1970). ....	16
Figure 18. A spot fire (left) being drawn into the main convective column (to the right) on August 17, 2023, against the prevailing winds (toward the observer) .....	16
Figure 19. Spot fires igniting along the western slopes of Okanagan Lake.....	17
Figure 20. Eastern edge of the Rose Valley treatment adjacent to Bear Creek Road, looking at the buffer between the road and the treatment.....	18
Figure 21. The Bear Creek Road study location as the fire moved from untreated forest (right) into the fuel treatment area (left). ....	19

Figure 22. Location where tornadic winds were funnelled upslope and resulted in snapped and  
toppled trees, needle freeze, and tin roofing debris wrapped around a tree..... 20

Figure 23. A large fire whirl (indicated by the orange arrow) captured during a time lapse  
between 2100 and 2200 h next to a large multi-storey house on the Lake Okanagan  
shoreline (orange box) ..... 22

## List of Tables

Table 1. Bear Creek Road prescription ..... 5

Table 2. 90<sup>th</sup> percentile hazard conditions for the West Kelowna fire weather station ..... 10

Table A1. Hourly temperatures, winds, and Fire Weather Index System\* values for the West  
Kelowna fire weather station on August 17 and August 18, 2023 ..... 27

Table A2. Hourly temperatures, winds, and Fire Weather Index System\* values for the Brenda  
Mines fire weather station on August 17 and August 18, 2023 ..... 27

# INTRODUCTION

On August 15, 2023, the McDougall Creek Wildfire (K52767) was ignited approximately 5 km northwest of the city of West Kelowna. Over the following days, prolonged drought, complex mountain topography, and high winds created conditions for extreme fire behaviour. On August 17, 2023, the McDougall Creek wildfire impinged on two wildfire risk reduction treatments surrounding the communities of Rose Valley and Bear Creek Road. The fuel treatments were approximately 5 km apart from each other, but both experienced extreme fire behaviour that exceeded their design prescriptions. This wildfire was responsible for the ignition of the Walroy Lake and Clarke Creek wildfires by lofting embers across Okanagan Lake, which together formed the Grouse Complex. The Grouse Complex was responsible for the evacuation of more than 30 000 citizens, and more than 300 structures were impacted.

This case study examines how the two fuel treatments altered the wildfire's behaviour, and if the resulting change allowed fire crews to safely conduct suppression operations. Fuel management specialists in the British Columbia Wildfire Service (BCWS) have asked that the following questions be addressed:

1. Was there a change in fire behaviour resulting from the wildfire moving into the fuel treatment area?
2. What factors contributed to a change in fire behaviour?
3. Was there a change in suppression strategy and tactics based on the presence of the fuel treatment or a change in fire behaviour? Did the fuel treatment provide a strategic or tactical advantage in suppression operations?

Other fuel treatment case studies have been published include Stryen 9 near Lytton, B.C.; Nicomen, B.C.; West Shore Estates near Vernon, B.C.; Logan Lake, B.C.; and Rainbow Lake, AB. Information on how structures were impacted during the McDougall Creek wildfire can be found in: A wildland-urban post-fire case study: The Grouse Complex.

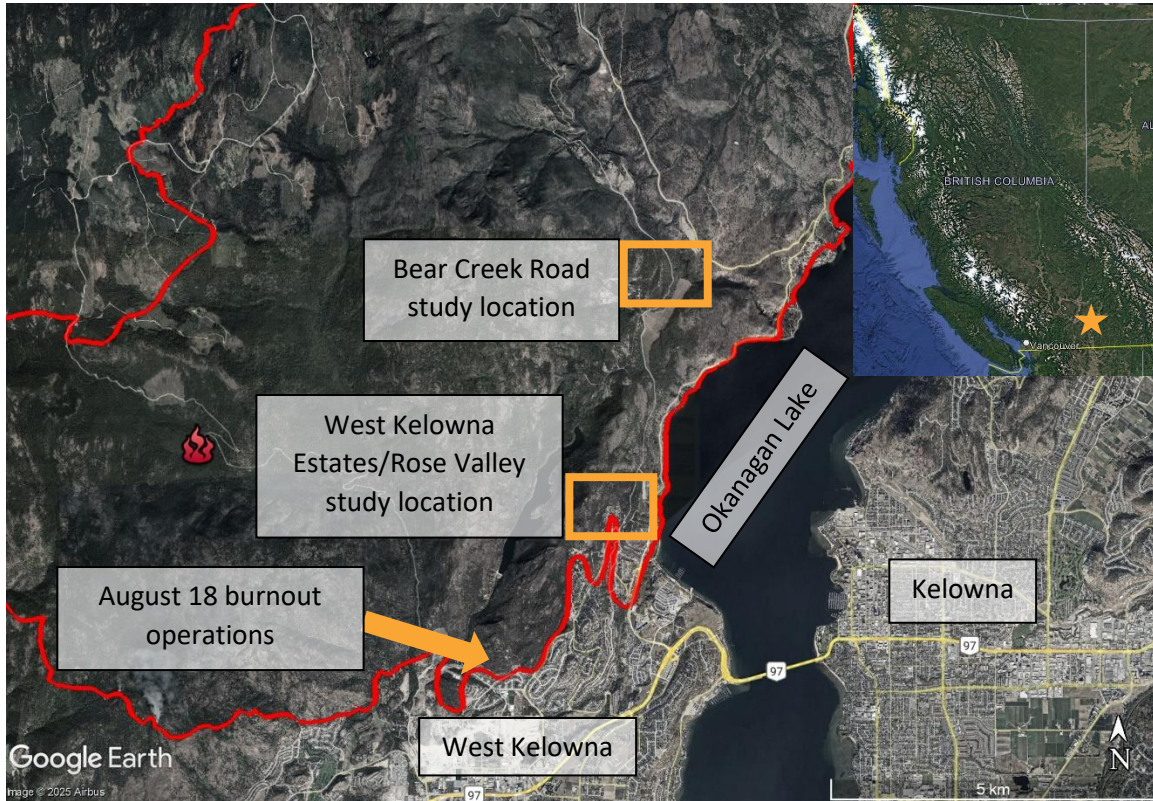
This series of reports has contributed to the creation of a larger framework and protocol for evaluating fuel treatment effectiveness that can be applied by other wildfire researchers and specialists. Data used in this study include:

- field observations
- photos submitted by the public and BCWS personnel
- news articles
- BCWS records (weather and fuels data, incident management documentation)
- fuel treatment prescription documents

# SITE DESCRIPTION

Research for this study was conducted in two locations on the west side of Okanagan Lake in the Regional District of Central Okanagan. This area is part of the greater Okanagan valley in British Columbia's southern interior (Figure 1). The first study location is just north of the community of West Kelowna Estates/Rose Valley in Rose Valley Regional Park, a hillside natural area overlooking Okanagan Lake that is intended for hiking and other recreational use. The second

study location is located along Bear Creek Road, approximately 5 km to the north of the first study location. Both study locations are accessible by road. Major values in these areas include residences, recreational trails, watersheds, and agriculture that takes advantage of the region's hot and dry climate.



**Figure 1. Overview of the study locations. The red fire icon indicates the ignition location of the McDougall Creek wildfire; the red line indicates the wildfire's final perimeter. Inset: Location of West Kelowna within the province of British Columbia.**

## FIRE ENVIRONMENT

### Fuels

The Rose Valley and Bear Creek Road study locations are in the transition zone between the Ponderosa Pine Very Dry Hot (PPxh1) and Interior Douglas-fir Very Dry Hot (IDFh1) biogeoclimatic (BEC) zones (Meidinger & Pojar, 1991). Both BEC zones are classified as natural disturbance type 4 (NDT4), which is defined by frequent, stand-maintaining fires with a 5- to 40-year recurrence interval, and rare stand-initiating fires ranging from 150–200 years or longer (Sorenson, 2024). In the study locations, the dominant tree species are Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*) in the overstoreys; understoreys are dominated by bunchgrasses and wheatgrasses. If regularly subjected to stand-maintaining fires, these environments will typically develop a several-meter fuel strata gap between surface fuels and crown fuels. Fire is typically of low to moderate severity, and consumes the understorey fuels, but overstorey tree mortality is low. Infrequent fires, or fires subject to suppression in

these areas, can allow understorey fuels to accumulate. This increases the chances of stand-initiating fire, which can result in extensive overstorey tree mortality and poor landscape recovery.

The Canadian Fire Behaviour Prediction (FBP) System fuel type in the study locations was predominantly C-7 (ponderosa pine–Douglas-fir) (Forestry Canada Fire Danger Group, 1992). The C-7 fuel type is an open canopy, conifer-dominated stand composed of mixed-age Douglas-fir and ponderosa pine trees, with an understorey of grasses and needle litter and a shallow to nonexistent duff layer. Fire in this fuel type occurs predominantly on the surface due to naturally occurring fuel strata gaps between the surface fuels and overstorey canopy. However, across British Columbia, this fuel type is considerably variable in terms of stand density, structure, and ladder fuels. This is further complicated because the C-7 fuel type is sometimes used to describe a formerly closed-canopy stand that has undergone wildfire risk reduction treatments, whereas treated C-7 fuels do not, themselves, have a treated alternative due to rigidity in the current FBP System (Perrakis et al., 2018).

In 2025, the city of West Kelowna released an updated Community Wildfire Resiliency Plan (CWRP) showing that over half the city's wildland–urban interface has been exposed to wildfire since 1922 (Magnan et al., 2024). The CWRP classified more than 2300 ha of land as either high or extreme wildfire threat according to the BCWS Priority Setting Field Card Local Risk Rating score, about half of which was recommended for wildfire risk reduction across 72 new fuel treatment units.

Wildfire risk reduction at the Bear Creek study location was completed in 2015 (Davies Wildfire Management, 2018). The 21-ha site lies downslope of a small community of private acreages that run along both sides of Bear Creek Road (Figure 2). The site was treated using manual thinning, pruning, and pile burning with the goal of “Develop[ing] natural barriers that reduce the continuity of forest fuel loads and wildfire risk to the adjacent community” (Westbank First Nation, 2014). This goal was met by:

- reducing layer 1 (> 17.5 cm dbh) trees to between 200 and 300 stems per hectare,
- reducing layer 2 (> 1.53m tall and < 17.5 cm dbh) to 50 stems per hectare to minimize ladder fuels,
- removing damaged and unhealthy stems less than 3 m tall,
- pruning retained trees to a height of 3 m (or 40% crown) to reduce ladder fuels and risk of crown fire,
- reducing surface fuel loading by piling and burning debris, and
- retaining and encouraging deciduous tree and shrub species to reduce wildfire behaviour and provide wildlife habitat.



**Figure 2. Bear Creek Road fuel treatment, July 2023. (Source: Google Streetview)**

The prescription for the treatment area is outlined in Table 1. Patches of healthy trees that were smaller than Layer 2 were prescribed to be retained, provided they were more than 3 m away from stems measured in Layer 1 or Layer 2. Surface fuel data were not disclosed in the prescription document, nor were post-treatment data for overstorey or surface fuel loading. The Rose Valley study location prescription could not be retrieved; however, the site was open canopy and grass dominated, with a far sparser overstorey than the Bear Creek Road site. The exact timing of the Rose Valley treatment could not be determined; however, treatment was completed prior to the release of West Kelowna's 2018 Community Wildfire Protection Plan.

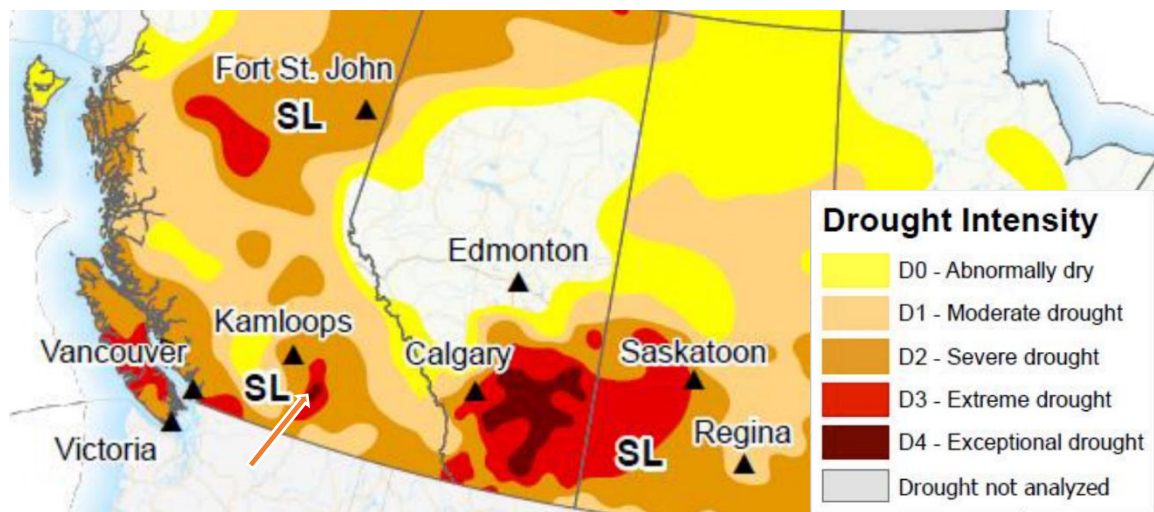
**Table 1. Bear Creek Road prescription**

	Stems per hectare		
	Existing	Cut	Leave
<b>Layer 1 (&gt; 17.5 cm dbh)</b>			
Fd* > 17.5 cm	270	130	140
Py > 17.5 cm	260	130	130
Total dead potential	25	25	0
Total live	530	260	270
Total Layer 1 all species	555	285	270
Total Layer 1 conifers only	555	285	270
<b>Layer 2 (&gt; 1.3 m tall and ≤ 17.5 cm dbh)</b>			
Py < 17.5 cm	170	150	20
Fd < 17.5 cm	140	120	20
Total Layer 2 all species	310	270	40
Total Layer 2 conifer only	310	270	40
<b>Total Layer 1 and 2</b>			
Total Layers 1 and 2 all species	865	555	310
Total Layer 1 and 2 conifer only	865	555	310

\*Fd: Douglas-fir; Py: ponderosa pine

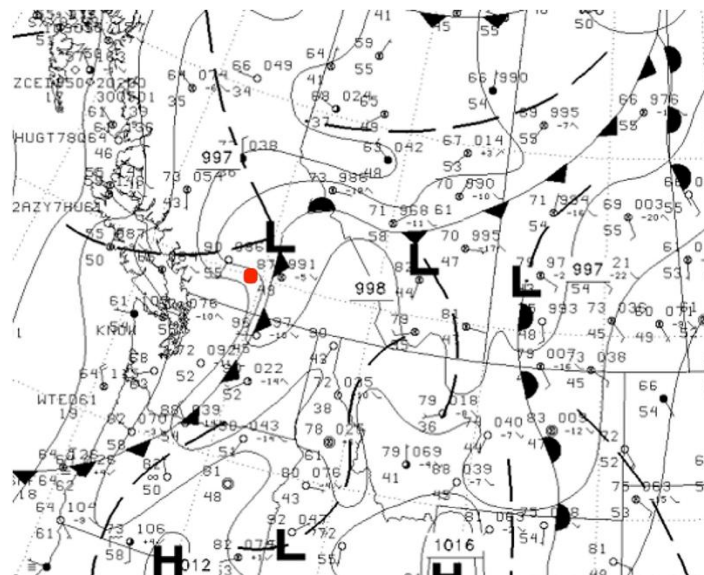
## Weather

Prior to the ignition of the McDougall Creek wildfire on August 15, 2023, the West Kelowna region was in the midst of its driest soil moisture levels on record. Nearby weather stations in Vernon and Penticton reported 2.1% and 5.1% of their typical monthly precipitation, respectively (Agriculture and Agri-foods Canada, 2023a). The region was classified as suffering from exceptional drought (Figure 3), which is a 1-in-50-year occurrence. Drought conditions persisted until October, when increasing rainfall eventually began trending toward normal and the area was upgraded to severe drought (Agriculture and Agri-foods Canada, 2023b).



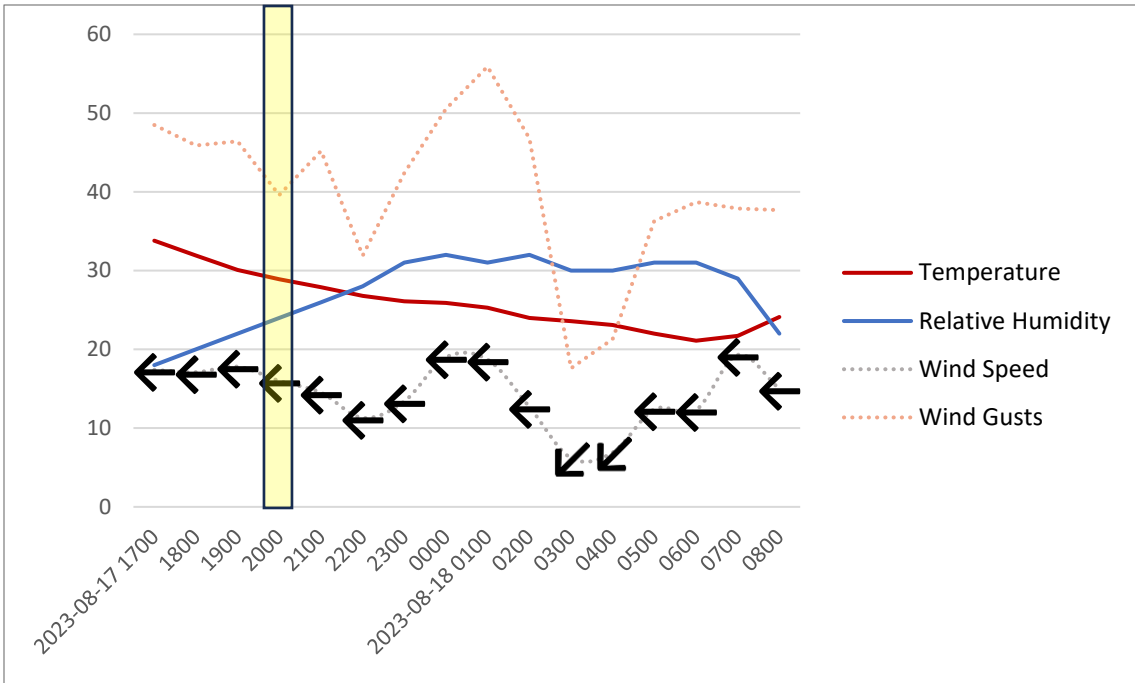
**Figure 3. Drought conditions across western Canada during August 2023. West Kelowna’s location is approximated by the orange arrow. (Source: Agriculture and Agri-foods Canada, 2023a)**

Ignition occurred on August 15, 2023, approximately 5 km northwest of West Kelowna and experienced moderate growth during the first two days; however, the most impactful growth occurred on August 17. Throughout the evening of August 17 and into the morning of August 18, the West Kelowna Fire Weather (FWx) station (located within the city limits, 650 m elevation) reported extreme Fire Weather Index (FWI) System values. On the day of the impingement, the West Kelowna FWx station reported a Duff Moisture Code of 202, a Drought Code of 1223, and a Buildup Index of 286 (Figure 6, Table A2).<sup>1</sup> During that time, a dry cold front moved through the region, stalled over the wildfire, and subjected it to sustained winds throughout the night, first starting in the south, then moving through the west, and ending from the northwest by the morning once the front had resumed its eastward track (Figure 4). It should be noted that the wind directions reported by the West Kelowna FWx station were reversed and showed winds originating from the east; one potential reason for this was surface-level turbulence caused by the passing cold front and local topography (Figure 5, Table A1). Data from the Brenda Mines FWx station, located approximately 30 km to the west of West Kelowna, were included in Figure 7 and Figure 8 to showcase variability in winds recorded on August 17 and August 18.

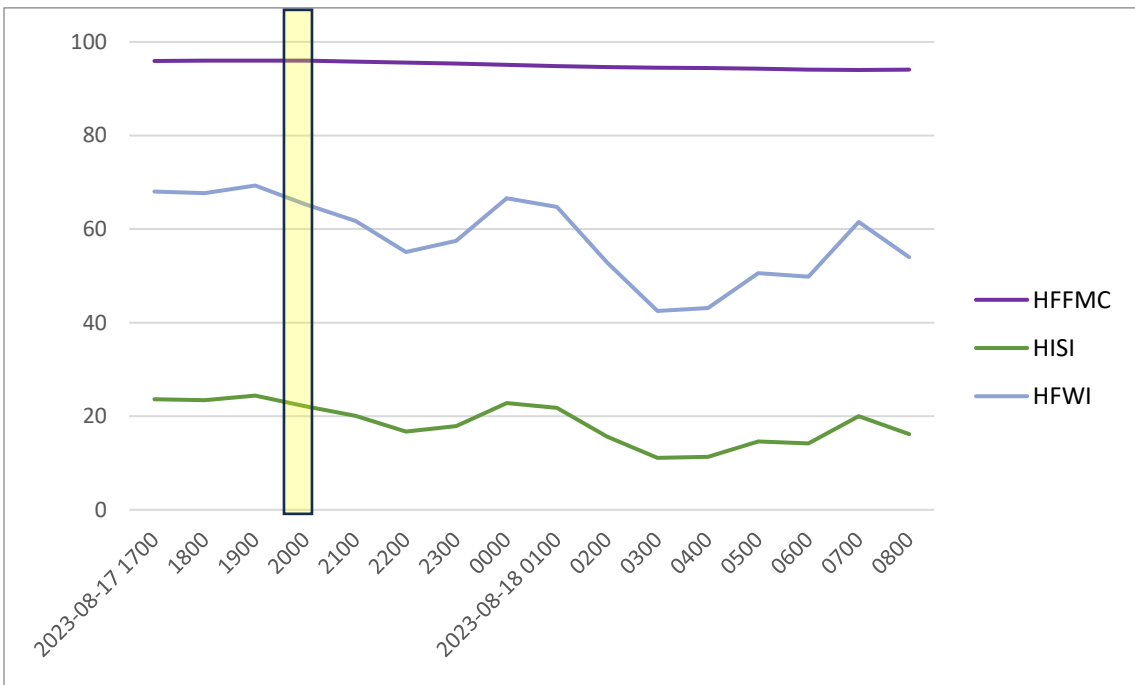


**Figure 4. Stalled cold front over West Kelowna (red dot) at 2000 h local time. (Source: National Oceanic and Atmospheric Administration Weather Prediction Centre)**

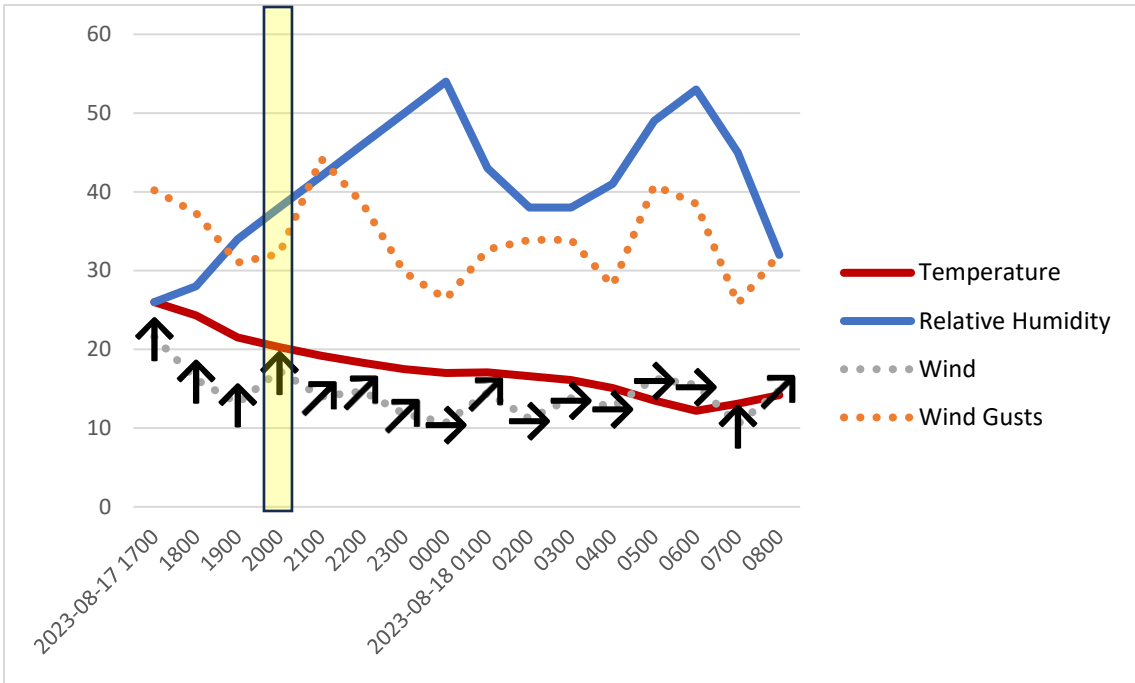
<sup>1</sup> Descriptions of the FWI System values and their implications are provided at <https://www.alberta.ca/fire-danger>



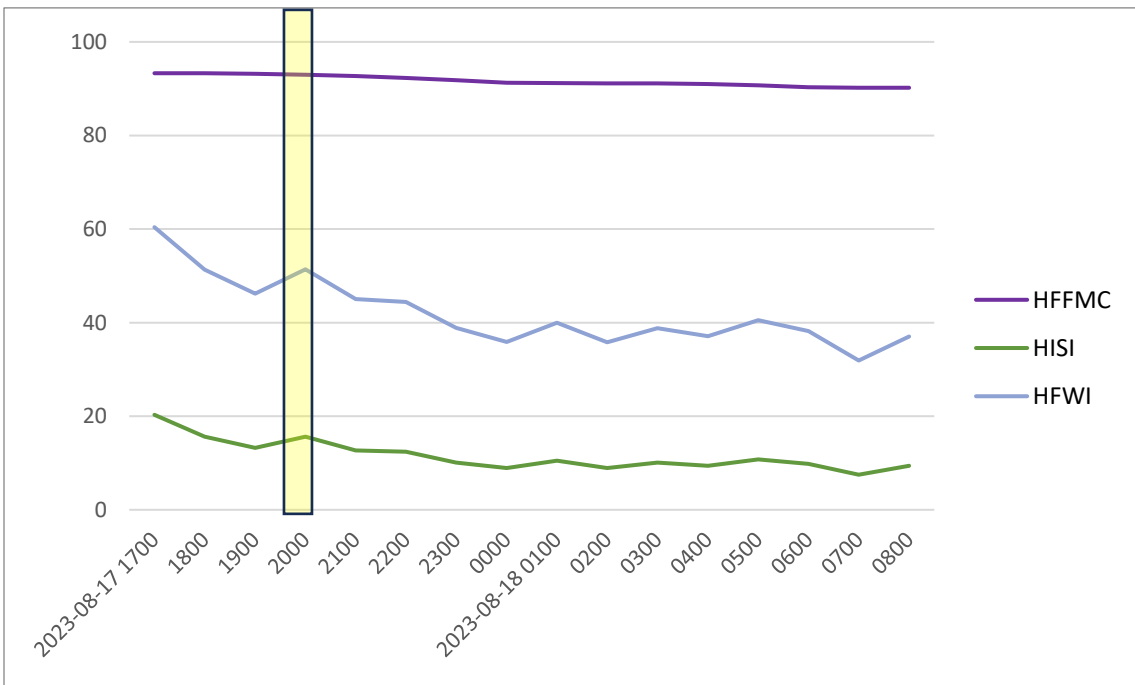
**Figure 5. Hourly temperature (°C), relative humidity (%), and wind speeds (km/h) recorded at the West Kelowna Fire Weather station on August 17 and August 18, 2023. Arrows indicate recorded wind direction. The yellow bar indicates the time when the wildfire crested the ridge at Rose Valley.**



**Figure 6. Hourly Fire Weather Index System values recorded at the West Kelowna Fire Weather station on August 17 and August 18, 2023. The yellow bar indicates the time when the wildfire crested the ridge at Rose Valley. HFFMC: Hourly Fine Fuel Moisture Code; HISI: Hourly Initial Spread Index; HFWI: Hourly Fire Weather Index.**



**Figure 7. Hourly temperature (°C), relative humidity (%), and wind speeds (km/h) recorded at the Brenda Mines Fire Weather station on August 17 and August 18, 2023. Arrows indicate recorded wind direction. The yellow bar indicates the time when the wildfire crested the ridge at Rose Valley.**



**Figure 8. Hourly Fire Weather Index System values recorded at the Brenda Mines Fire Weather station on August 17 and August 18, 2023. The yellow bar indicates the time when the wildfire crested the ridge at Rose Valley. HFFMC: Hourly Fine Fuel Moisture Code; HISI: Hourly Initial Spread Index; HFWI: Hourly Fire Weather Index.**

The combination of hot, dry, and windy weather conditions; exceptional drought-affected fuels; and rugged mountainous topography created ideal conditions for extreme fire behaviour. On

the afternoon of August 17, the fire produced its own pyrocumulus cloud and Intensity Class (Rank) 6 fire behaviour, which continued throughout the night (Figure 9, Figure 10). The intense convective energy created by the fire as it moved across the landscape lofted embers across Okanagan Lake and ignited two additional fires on the east side of the lake in Kelowna and Lake Country.



**Figure 9. Looking north at pyrocumulus clouds observed from Highway 97 in West Kelowna, August 17, 2023, at 16:22 h. (Source: Publicly submitted)**



**Figure 10. Nighttime high-intensity fire behaviour, August 17, 2023, at 21:42 h. (Source: Publicly submitted)**

Fuel treatments in British Columbia are designed to effectively reduce wildfire behaviour during an impingement up to the 90<sup>th</sup> percentile fire hazard based on a 10-year rolling average in the area of interest. The 90<sup>th</sup> percentile hazard for West Kelowna is shown in Table 2. Between August 17 and August 18, 2023, the Fine Fuel Moisture Code (FFMC), Initial Spread Index (ISI), and Buildup Index (BUI) all exceeded this threshold for more than 12 continuous hours.

**Table 2. 90<sup>th</sup> percentile hazard conditions for the West Kelowna fire weather station**

Fire weather station	FFMC	ISI	BUI
West Kelowna	94.7	14.4	263.1
Peak August 17 actuals	96.0	24.4	286.0

**FFMC: Fine Fuel Moisture Code; ISI: Initial Spread Index; BUI: Buildup Index**

## Topography

The topography around West Kelowna is highly complex and variable due to the area’s mountainous terrain (Figure 11). The Rose Valley study location is located on an east-aspect slope facing Okanagan Lake. The slope begins at the edge of the lake and rises 350 m at an average 30% incline but varies from 0% at a mid-slope bench to 50% at its steepest. The top of the slope is delineated by a ridge that runs roughly north–south at approximately 700 m elevation (Figure 12). Drainages in the study location form box canyons that are capable of funnelling convective heat and winds that produce extreme fire behaviour. These drainages also had higher fuel loading and tree densities relative to the treated area of Rose Valley.

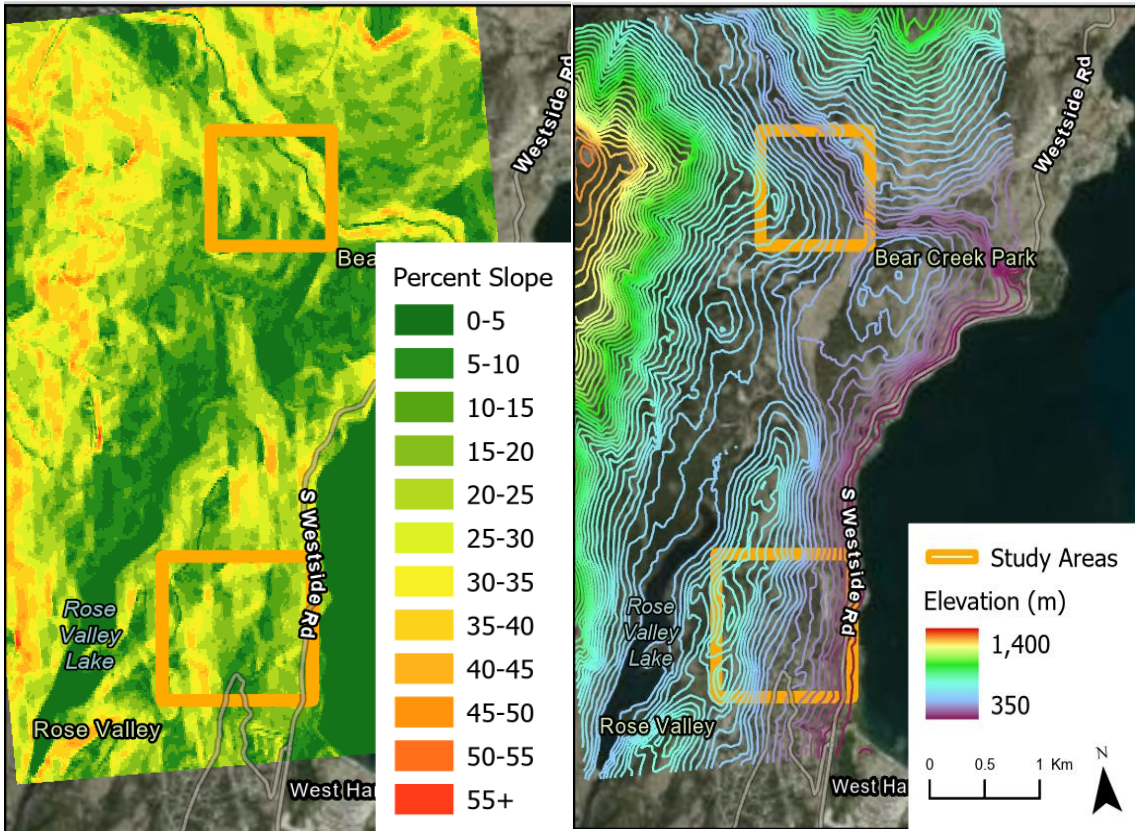


Figure 11. Percent slope (left) and elevation contours (right) of the study locations and surrounding area.

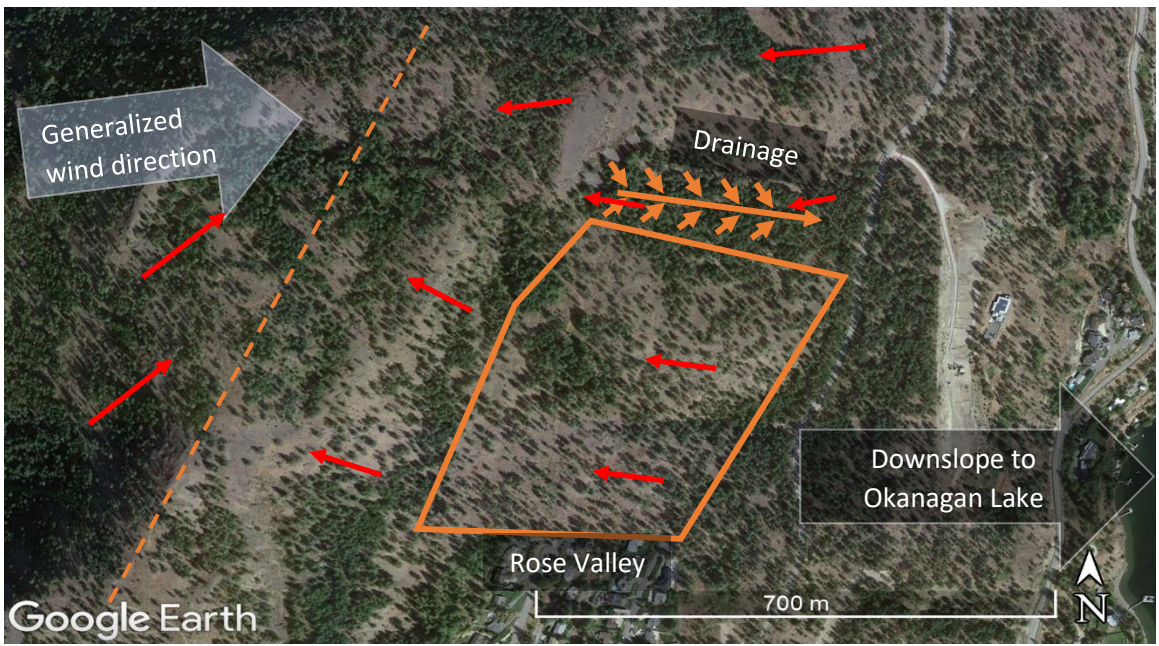
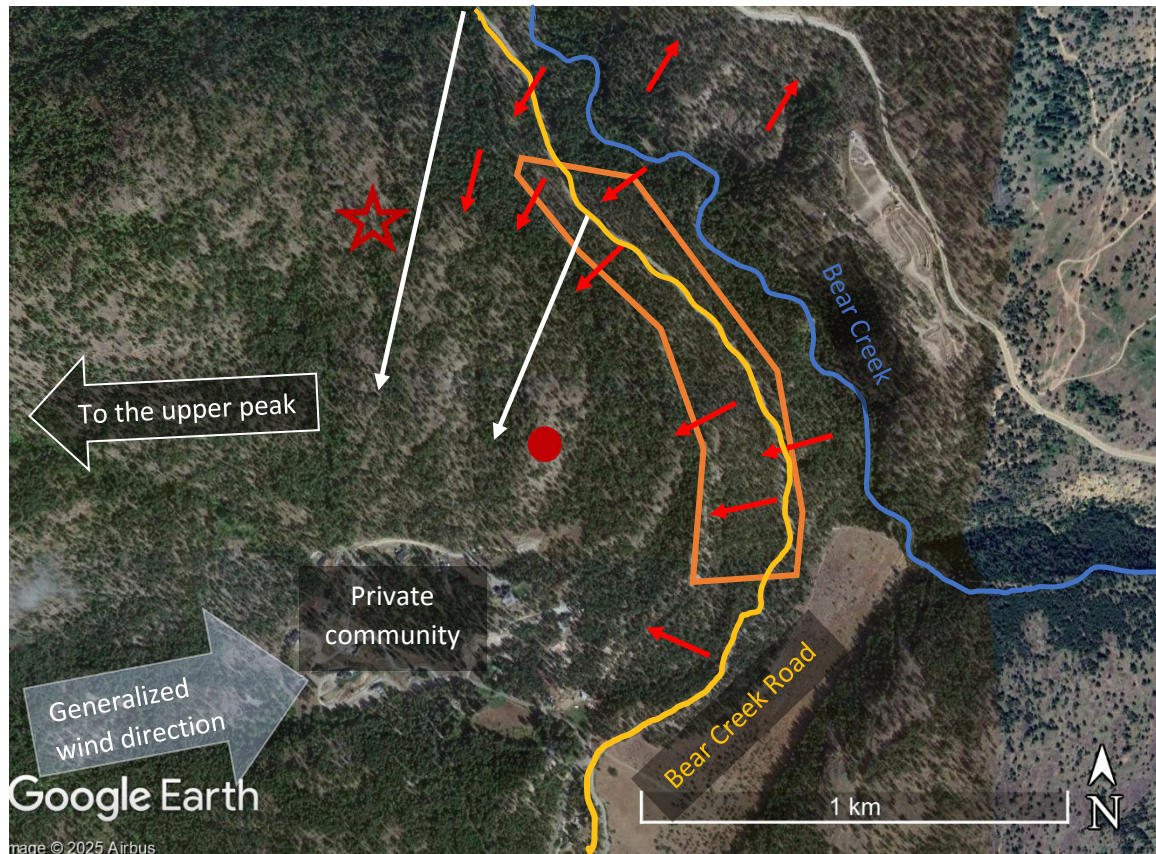


Figure 12. Satellite view of the Rose Valley study location. The fuel treatment area is approximated by the orange box. Red arrows indicate the direction of fire spread. The dashed orange line roughly indicates the location and orientation of the ridgeline at the top of Rose Valley Regional Park. The orange arrows show a drainage area, indicating the direction of downslope flow, which is opposite to the direction of fire growth.

The Bear Creek Road study location is located on a corner of a slope that transitions from a southeast aspect at the south end to a northeast aspect at the north end (Figure 13). The slope in this area averages 35% but exceeds 60% in some locations. From Bear Creek at the bottom of the valley to the local topographical high, the total elevation gain is approximately 200 m. A saddle is created by a mid-slope high, and a higher 1400-m peak to the west. The slope at the north end of the study location becomes concave for approximately 500 m. In this area, multiple mature trees were either uprooted or snapped, and pointed upslope, with their crowns oriented inward toward the midline of the feature.



**Figure 13.** Satellite view of the Bear Creek Road study location. The fuel treatment area is approximated by the orange polygon. The converging white arrows show the location of the concave slope section and saddle where snapped trees were documented. Tornadoic winds were recorded in the vicinity of the red star. The local topographic high is indicated by the red dot. Red arrows indicate the direction of fire spread.

## FIRE BEHAVIOUR ANALYSIS

### Fire chronology

Figure 14 shows the progression and growth of the McDougall Creek wildfire and resultant spot fires, the Walroy Lake wildfire and Clarke Creek wildfire. For a complete review of how the McDougall Creek wildfire moved into and through the communities on the west side of Okanagan Lake, refer to the Grouse Complex report published by the Institute for Catastrophic

Loss Reduction: A wildland-urban post-fire case study: The Grouse Complex. This case study focuses on the events leading up to and including the impingement on the study locations:

- August 15, 2023, at 1759 h: The McDougall Creek wildfire was first reported approximately 5 km northwest of West Kelowna at 49.9081 N, 119.6328 W.
- August 16, 2023: The fire grew to 63 ha to the east.
- August 17, 2023, at 1100 h: The wildfire had grown to an estimated 300 ha and was sending a distinct smoke column over Okanagan Lake.
- August 17, 2023, at 1325 h: A local state of emergency was declared. The first evacuation orders for 68 properties were enacted for the McDougall Creek wildfire (Central Okanagan Emergency Operations, 2023).
- August 17, 2023, at 1800–2000 h: The wildfire continued to rapidly grow and was now more than 1100 ha. Fire behaviour increased aggressively and was now an Intensity Class 6 crown fire with a mature pyrocumulus cloud.
- August 17, 2023, at 2000 h: The wildfire reached the Rose Valley ridgeline and Bear Creek (thick yellow line, Figure 14). Spot fires were seen starting in communities along Lake Okanagan and the east-aspect slopes of the study locations. Some spot fires that ignited on the east-aspect slopes were drawn upslope against the prevailing winds and into the convective column. Other spot fires were seen being drawn downslope toward the Okanagan shoreline. Direct attack on the fire's head was not possible due to elevated fire intensity; crews performed parallel attack, chasing the fire's advance along the fire's flank and extinguishing spot fires, and saving as many structures as possible through triage assessment.
- August 17, 2023, at 2130 h: A spot fire ignited the Walroy Lake wildfire on the east side of Okanagan Lake, north of Kelowna.
- August 17, 2023, at 2155 h: The wildfire reached the western shore of Okanagan Lake near Bear Creek. It continued to show extreme fire behaviour throughout the night, exhibited by aggressive growth, spot fires, continuous crowning, and large fire whirls.
- August 18, 2023, at 0746: The Clarke Creek wildfire was ignited by firebrands on the east side of Okanagan Lake in the District of Lake Country. By this point, the McDougall Creek wildfire was an estimated 6800 ha. The fire continued to expand and grow over the next several days before reaching a final size of 13 970 ha.
- August 18, 2023, morning: Crews began burnout operations along the south end of the Rose Valley fuel treatment to remove unburned fuel between the fire's perimeter and the downslope homes. This eliminated the fire's ability to take a second run into the neighbourhoods.
- October 18, 2023: The fire was officially declared out.



Figure 14. Fire growth timeline of the McDougall Creek wildfire, Walroy Lake wildfire, and Clarke Creek wildfire. Times are in Pacific Daylight Time. (Source: *A wildland-urban post-fire case study: The Grouse Complex* [used with permission])

## Fire progression

### Continuous fuels

The growth of the McDougall Creek wildfire on August 17, 2023 was influenced by continuous winds and sustained 40 km/h+ gusts from the dry cold front that stalled over the fire. The drought-stressed fuels between the ignition site, Rose Valley, and Bear Creek Road were effectively a continuous fuel complex of conifer overstorey with an ample understorey of cured grass and needle litter (Figure 15).



Figure 15. Continuous needle litter and dry grass understorey in the treated Rose Valley study location.

The fuels were highly receptive to ignition and sustained extreme-intensity burning. The extreme FWI System hazard at the time of the wildfire facilitated the C-7 fuels to become completely involved with full Intensity Class 6 crown fire. The high Buildup Index resulted in the consumption of old tree stumps and root systems left behind from the fuel treatment operations (Figure 16).



**Figure 16. Stump and root system burnt out in the Rose Valley research site.**

## **Landscape-level eddy rolls**

Topography significantly affected fire behaviour at the landscape level during the impingement. In one such effect, known as “eddy rolls”, winds flowing perpendicular to a ridge create horizontal vortices that run parallel to the ridgeline (Schroeder & Buck, 1970) (Figure 17). Throughout the night of August 17, 2023, prevailing winds from the west flowed roughly perpendicular over the north–south ridgeline of the east-aspect slopes of the Rose Valley study location (Figure 12). A local zone of low pressure created on the lee side of the slopes (facing Okanagan Lake) circulated air back upslope at the surface level, against the prevailing winds (Figure 18). This was documented throughout the night as spot fires ignited along the lower slopes and were drawn back into the convective column. It is important to highlight that this was just one aspect of fire behaviour observed on the night of August 17, 2023; the complex topography and environmental conditions created an array of conditions that generated both upslope and downslope fire growth.

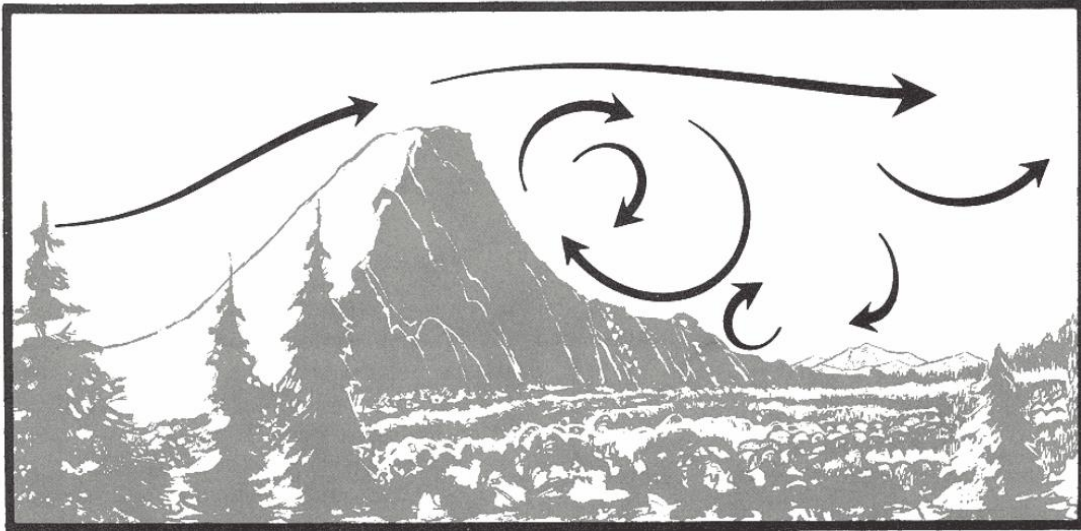


Figure 17. Eddy rolls, as described by Schroeder and Buck (1970).



Figure 18. A spot fire (left) being drawn into the main convective column (to the right) on August 17, 2023, against the prevailing winds (toward the observer). (Source: MGH Photography [used with permission])

## Spot fires and ember transport

Spotting was a major driver of fire growth throughout the night of August 17, 2023 (Figure 19). The cured grasses in the path of the wildfire were highly receptive to ignition by embers. The intense convective energy of the pyrocumulus cloud was ideal for lofting embers long distances and circumventing barriers to fire spread. The most dramatic instances of these were the

ignitions of the Clarke Creek and Walroy Lake wildfires after embers were carried across Lake Okanagan, which is over 2.5 km wide. The actual distance of ember travel, given the position of the wildfire on the western slopes at the time of ignition, and upslope winds induced by the landscape eddy rolls circulating air away from the lake, was likely 5 km or more.



Figure 19. Spot fires igniting along the western slopes of Okanagan Lake. (Source: Publicly submitted)

## Fire severity

Evidence in the fuel treated areas indicated that fire intensity was reduced both at the Rose Valley and Bear Creek Road study locations; however, the reduction was not enough for suppression resources to safely action the wildfire in those areas. Fuel reduction treatments in both study locations consisted of manual thinning, and the tree crowns were raised to 3 m off the ground by pruning. In both sites, the treatments were completed at least 5 years prior to the events of August 17, 2023.

## Rose Valley fuel treatment

In the Rose Valley study location, three sets of paired plots (six plots total) were established in treated and untreated stands at sites that had similar steepness, elevation, and slope shape to assess how fire behaviour evolved throughout: one pair in the lower third of the study location, one pair in the middle third, and one pair in the upper third. Fire growth direction was determined from char markings on tree stems, which indicated that the fire had originated at the bottom of the slope and moved upward. In all three paired plots, char heights on the stems of trees in the treated stands were lower than those in the untreated stands. As the elevation of the paired plots increased, so did the char height on tree stems in both the treated and untreated stands. The lowest-intensity fire behaviour was identified in the lower-third treated

plot, where stem char height (synonymous with flame height) averaged 1.7 m.<sup>2</sup> Surface fuel consumption was near total in all plots, regardless of whether they were treated or not. Tree mortality was higher in the untreated plots than in their treated pair, and overall tree mortality increased as the fire moved upslope. The eastern edge of the treatment at the base of the slope terminated approximately 30 m from Bear Creek Road, which created a visual buffer of untreated conifer (Figure 20).



**Figure 20. Eastern edge of the Rose Valley treatment adjacent to Bear Creek Road, looking at the buffer between the road and the treatment.**

## **Bear Creek Road fuel treatment**

Fire behaviour in the Bear Creek Road study location was similar to that in Rose Valley: wildfire behaviour decreased as the fire moved from untreated fuels into treated fuels (Figure 21), but it increased as the fire moved upslope. In untreated stands, all needles and some of the smaller branch wood in the canopies adjacent to and downslope of the treatment area were completely consumed by crown fire. Wildfire in the fuel treatment area was driven primarily by intense surface fire; however, the overall measured intensities within the treated stand, based on measurements of tree stem charring (8-m average flame height), would have still been too high for suppression personnel to safely operate, had they been available at the time. Fire behaviour also increased in intensity as the fire moved upslope, regardless of whether it was in treated or untreated areas. All surface fuels within the treatment area were effectively consumed during the fire's passage.

---

<sup>2</sup> Char height is indicative of observed flame height, which is not to be confused with flame length, the latter of which is an input of Byram's equation (1959) for fireline intensity.



**Figure 21. The Bear Creek Road study location as the fire moved from untreated forest (right) into the fuel treatment area (left).**

## **Stand-level topographic influences and tornadic winds**

The north end of the study location features a concave slope that funnels upward into a saddle between two peaks (Figure 13). Here, extreme fire behaviour occurred as the wildfire moved upslope from the valley bottom, which was identified by needle freeze and toppled trees pointing upslope (Figure 22). Mature trees with dbh<sup>3</sup> greater than 30 cm were toppled and snapped mid-stem, indicating wind speeds in this area exceeded 150 km/h (Virot et al., 2016). A corrugated steel sheet torn from the roof of an unidentified structure was found wrapped around a tree, farther upslope. Consumption of crown and surface fuels in this area was absolute, regardless of whether they were treated or not. Prevailing winds that moved west to east in this area were opposite to the direction of fire growth, which was northeast–southwest. The research team concluded that spot fires ignited in the valley bottom and were drawn upslope due to eddy rolls and the indraft of the approaching pyrocumulus cloud, which were further exacerbated by upslope convection from topographic compression and funnelling. The research team further concluded that the high winds that snapped the trees along the roadside occurred after the fire had moved upslope, as the needles had been frozen prior to the trees being snapped and were pointing into the ground. The snapped tree stems lying on the ground showed no signs of charring along the breaks, indicating they were broken after the fire’s passage. The research team’s conclusion generated some discussion; a local forest manager suggested that a wind event more than a day after the fire was the cause of the snapped stems; however, the research team maintains its theory that exceptionally strong indrafts immediately following the fire’s passage were responsible, and that the breaks in the tree stems remained unburnt because the surrounding fuel was consumed. The combined convection and indrafts, in addition to local wind turbulence, would theoretically generate faster winds than just local winds without a fire’s influence. Regardless of the exact timing of this event, the two theories demonstrate that fire growth reconstruction, without physically witnessing the event, is complicated.

---

<sup>3</sup> dbh: diameter at breast height, measured at 130 cm off the ground. This is the standard height used in silviculture surveys to measure the diameter of tree stems.



**Figure 22. Location where tornadic winds were funnelled upslope and resulted in snapped and toppled trees, needle freeze, and tin roofing debris wrapped around a tree.**

# FIRE MANAGEMENT APPROACH

The reduction in wildfire intensity in the fuel treated areas was not sufficient to allow direct suppression by firefighters on the night of August 17, 2023. This does not, however, mean that the fuel treatments were unable to provide tactical suppression opportunities. Successes were achieved using alternative tactics such as burnout operations to remove unburnt fuel in treatment areas adjacent to homes and the wildfire's perimeter, and parallel suppression along the fire's flanks that allowed structures to be saved where possible. Limited resources, due to the complexity and scale of the incident, required focus to be placed on tactical evacuations of residents to ensure that safeguarding human life was prioritized, followed by triaging suppression in an effort to save as many buildings as possible.

## DISCUSSION

### Implications of treatment unit design and implementation

Currently, fire crews across British Columbia do not have access to maps or easily accessible resources that show the locations of fuel treatments. A map layer, including the fuel type, treatment type, and year of treatment installation, paired with an online app such as ESRI Field Maps, could give suppression personnel an increased tactical advantage in the field because they would not have to rely on a GIS team to notify them about the locations of such treatments. Additionally, local governments and other organizations that complete fuel treatment work are not required to inform BCWS of a treatment location or completion. Ultimately, fire crews found the Bear Creek Road fuel treatment by accident. The tactical advantage of the Bear Creek Road fuel treatment is also worthy of discussion. The fuel treatment ended before being anchored to the community's edge, which left an island of untreated fuel between them. This "floating" treatment unit allowed the fire to move from the treated area into untreated fuels and to increase in intensity as it progressed toward the houses. An improved design would have extended the treatment to the edge of the community.

Along the eastern edge of the Rose Valley treatment unit, an untreated visual buffer of approximately 30 m separated the treatment boundary from the adjacent Bear Creek Road (not to be confused with the fuel treatment area of the same name). This had several tactical implications: crews needed to have prior knowledge of the extent of the treatment to know its location, and moving through untreated fuels to gain access to a treatment area presents a safety hazard for suppression crews. An improved design would have extended the treatment boundary to the edge of the road, which would have facilitated safer access to the site by crews.

### Hot, dry, and windy conditions

The three precursors of extreme fire behaviour were present on the night of the wildland–urban interface event in West Kelowna on August 17, 2023: high temperatures, high winds, and dry, receptive fuels. Overnight, temperatures remained above 21°C, and relative humidity never

increased more than 32%. Fuels continued to dry throughout the night, offering no relief to suppression efforts.

The research team concluded that the fuels, weather, and topography in the Rose Valley and Bear Creek study locations influenced fire behaviour such that conditions were unsafe for suppression resources to perform direct attack on the fire, even though fuel treatments had been conducted in both areas. A conservative calculation of a wildfire in 95% cured standing grass (FBP System fuel type O-1b) on the night of the impingement, which would be representative of the fuels in the treated Rose Valley study location assuming that the overstorey was not significantly involved, indicated that firefighters would have been exposed to fireline intensities in excess of 12 500 kW/m. Calculations for a full crown fire exceeded 100 000 kW/m. The intensity of the fire that moved through the fuel treated areas surpassed their design specifications, even using conservative estimates. Extreme convection and atmospheric instability were present throughout the night, which were documented in videos and photographs of blow-up fire behaviour and fire whirls (Figure 23).



**Figure 23.** A large fire whirl (indicated by the orange arrow) captured during a time lapse between 2100 and 2200 h next to a large multi-storey house on the Lake Okanagan shoreline (orange box). (Source: MGH Photography [used with permission])

## Topographic influences on fire behaviour

Topography played a significant role in fire behaviour at both the landscape and stand level. The eddy rolls and upslope indrafts from the pyrocumulus cloud created conditions where short-range spot fires moved against prevailing winds. The steep slopes in the study locations would have had an additive effect to fire spread rates and intensities from the eddy rolls reversing the winds at the terrain level. Slope-equivalent winds of 9–21 km/h in C-7 fuels and 11–26 km/h in open grasslands would have added to the already gusty weather conditions.

Fire behaviour would have been further exacerbated by convective heating. Localized funnelling of heat and wind up steep slopes and box canyons was prevalent in both the study locations. The research team debated extensively about whether the extreme winds generated at the Bear

Creek Road study location produced a tornado just northwest of the concave slope's location: the atmosphere was highly unstable, extreme winds in excess of 150 km/h were identified based on the presence of snapped tree stems, debris from destroyed structures wrapped around tree trunks, and potential evidence of vorticity was found from some tree trunks lying on the ground in a loosely circular pattern. However, without conclusive evidence of mesocyclone development in the atmosphere, which is a hallmark of tornado formation, the research team could not definitively say that a fire tornado had occurred. This highlights the challenges of reconstructing wildfire behaviour.

## Spotting and ember transport

Spotting was a key driver of the growth of the McDougall Creek wildfire and the greater Grouse Complex on both short- and long-range scales. Raining embers cast from the pyrocumulus cloud enabled the wildfire to jump landscape-level features that would otherwise function as a fire break, the most significant being Okanagan Lake. Short-range spotting ignited fires at the base of slopes on the west side of Okanagan Lake, which then grew against prevailing west-to-east winds upslope toward the main fire front. Embers were also the key drivers of structure loss during the wildland–urban interface events.

## CONCLUSION

The McDougall Creek wildfire occurred during a 1-in-50-year exceptional drought in the Okanagan area. Hot and dry conditions facilitated rapid fire spread when the wildfire interacted with a dry cold front that stalled over the area on the night of August 17, 2023. Overnight, the fire grew roughly 6000 ha and ignited two new fires by long-range spotting over Okanagan Lake. Collectively, this forced the evacuation of more than 30 000 people and impacted more than 300 structures. The research team found evidence of extreme fire behaviour with continuous crowning, including instances of fire-generated winds that exceeded 150 km/h at the stand level due to terrain-induced funnelling of convective heat.

Fire behaviour in the complex terrain of the Okanagan valley highlights the challenges associated with reconstructing the events of the impingement and the impacts of landscape-level and stand-level topography. Media submitted by the public highlight the complexity of reconstructing wildfire growth by capturing fire growing upslope, downslope, with, and against prevailing winds on the night of August 17, 2023. Firebrand transport played a significant role in the fire's growth, with short-range and long-range spotting enabling the fire to jump barriers to fire spread, including Okanagan Lake.

Further operational successes such as the August 18, 2023 burnout operations could have been achieved through improved treatment design and by requiring communities to report the locations of fuel treatment installations. Fuel treatments that are well anchored and are not “floating” away from the values they are intended to protect would have maintained a lower fire intensity as the fire approached the values instead of allowing it to increase in intensity as it returned to unmitigated wildlands. Visual buffers next to treatment boundaries should not be considered in treatment design because they present access challenges and safety risks to firefighters, and obscure where the fuel treatments begin and end. A map incorporated into a

data collection app that can be regularly updated with locations of fuel treatments would give fire crews a tactical advantage when they arrive at site where fuel treatments have been conducted. Lastly, maintaining an accessible fuel treatment database for firefighters requires up-to-date information. Fuel treatment installation and maintenance should be reported to the BCWS in order to maintain current records of mitigation work throughout the province.

FPInnovations was tasked with assessing two sites overlooking Okanagan Lake that had undergone fuel reduction treatments and were impinged upon by the McDougall Creek wildfire. The objective was to determine if the fuel treatments moderated fire behaviour in these areas to a degree that allowed suppression resources to either safely action the fire within the treated areas or modify their tactics at the incident level. Through qualitative and quantitative observations made at the Rose Valley and Bear Creek Road fuel reduction treatments, it was concluded that while fire behaviour was moderated as the wildfire passed through these areas, direct attack of the flaming front by ground resources was not possible for safety reasons. However, the night of August 17 and the following morning, objectives could still be achieved in the treated areas with burnout operations and parallel attack along the fire's flanks where fire behaviour was less intense.

## KEY FINDINGS

The McDougall Creek wildfire has contributed to the growing body of knowledge about the effectiveness of fuel treatments:

- In situations where direct attack is not possible when wildfire behaviour exceeds the design specifications of a fuel treatment, indirect and parallel attack may still be viable alternatives to achieve operational goals.
- Fuel treatment design should avoid the creation of visual buffers between access points and treatment boundaries, and should anchor directly adjacent to the values they are intended to protect.
- Firefighters should have facilitated access to wildfire risk reduction maps to better inform tactical decision-making for incidents of all sizes.
- Wildfire mitigation work should be reported to BCWS so wildfire crews and incident command teams can make better informed decisions to achieve operational goals.
- Topography affects how fire moves across the landscape in both treated and untreated fuels at the landscape and stand levels, which can generate extreme fire behaviour and allow the fire to move against prevailing winds, upslope, downslope, and can greatly accelerate winds through canyon funnelling.
- Post-fire reconstruction of wildfire growth is complex, and multiple scenarios can produce identical outcomes.
- Short- and long-range firebrands facilitated fire growth and allowed the McDougall Creek wildfire to bypass barriers to fire spread, such as roads and the entirety of Okanagan Lake.
- The C-7 (ponderosa pine–Douglas-fir) FBP System fuel type is widely varied and would benefit from being subdivided to account for natural or human-instigated structural changes.

## REFERENCES

- Agriculture and Agri-foods Canada. (2023a, September). *Canadian Drought Monitor: Conditions as of August 31, 2023*.  
[https://agriculture.canada.ca/atlas/data\\_donnees/canadianDroughtMonitor/maps\\_cartes/en/monthlyReport/2023/cdm\\_2308\\_mn\\_en.pdf](https://agriculture.canada.ca/atlas/data_donnees/canadianDroughtMonitor/maps_cartes/en/monthlyReport/2023/cdm_2308_mn_en.pdf)
- Agriculture and Agri-foods Canada. (2023b, November). *Canadian Drought Monitor: Conditions as of November 30, 2023*.  
[https://agriculture.canada.ca/atlas/data\\_donnees/canadianDroughtMonitor/maps\\_cartes/en/monthlyReport/2023/cdm\\_2311\\_mn\\_en.pdf](https://agriculture.canada.ca/atlas/data_donnees/canadianDroughtMonitor/maps_cartes/en/monthlyReport/2023/cdm_2311_mn_en.pdf)
- Byram, G. M. (1959). Combustion of forest fuels. In K. P. Davis (Ed.), *Forest fire: Control and use* (61–89). NY: McGraw-Hill. <https://doi.org/10.2307/1932261>
- Central Okanagan Emergency Operations. (2023, August 17). *McDougall Creek Wildfire Evacuation Alert expanded and Evacuation Order added*.  
<https://www.cordemergency.ca/updates/mcdougall-creek-wildfire-evacuation-alert-expanded-and-evacuation-order-added-thu-08172023-1325>
- Davies Wildfire Management. (2018, September). *Community Wildfire Protection Plan City of West Kelowna*.
- Forestry Canada Fire Danger Group. (1992). *Development and structure of the Canadian Forest Fire Behavior Prediction System*. Information Report ST-X-3.  
[https://www.frames.gov/documents/catalog/forestry\\_canada\\_fire\\_danger\\_group\\_1992.pdf](https://www.frames.gov/documents/catalog/forestry_canada_fire_danger_group_1992.pdf)
- Magnan, B., Stirling, B., Anderson, C., Luciw, J., Roberts, M., Hillis, R., Brolund, J., Broome, K., & Bevandick, L. (2024). *City of West Kelowna Community Wildfire Resiliency Plan 2025*.
- Meidinger, D. V., & Pojar, J. (Eds.). (1991). *Ecosystems of British Columbia*. B.C. Ministry of Forests, Research Branch.
- Perrakis, D. D. B., Eade, G., & Hicks, D. (2018). *British Columbia wildfire fuel typing and fuel type layer description*. Canadian Forest Service, Pacific Forestry Centre, Canadian Forest Service, Natural Resources Canada.
- Schroeder, M., & Buck, C. (1970). Fire weather: A guide for application of meteorological information to forest fire control operations. *USDA Forest Service: Washington, DC, 360, 236*.
- Sorenson, M. (2024). *2024 Fuel Management Practices Guide*. British Columbia Wildfire Service.  
[https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/wildfire-status/prevention/fire-fuel-management/fuels-management/2024\\_fuelmanagementpracticesguide1.pdf](https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/wildfire-status/prevention/fire-fuel-management/fuels-management/2024_fuelmanagementpracticesguide1.pdf)
- Virost, E., Ponomarenko, A., Dehandschoewercker, É., Quéré, D., & Clanet, C. (2016). Critical wind speed at which trees break. *Physical Review E, 93(2)*, 023001.  
<https://doi.org/10.1103/PhysRevE.93.023001>
- Westbank First Nations. (2014). *2014 WFN Prescription*. First Nations' Emergency Services.

# APPENDIX A: HOURLY WEATHER OBSERVATIONS

**Table A1. Hourly temperatures, winds, and Fire Weather Index System\* values for the West Kelowna fire weather station on August 17 and August 18, 2023**

Time	Temp (°C)	RH (%)	Wind speed (km/h)	Gust speed (km/h)	Direction (°)	HFFMC	HISI	HFWI
2023/8/17 1700	33.8	18	17.4	48.5	083	95.9	23.6	68.0
1800	31.9	20	17.1	45.9	102	96.0	23.4	67.7
1900	30.1	22	17.8	46.4	100	96.0	24.4	69.3
2000	28.9	24	16.0	39.6	084	96.0	22.1	65.3
2100	27.9	26	14.5	45.2	088	95.8	20.1	61.7
2200	26.8	28	11.3	31.9	072	95.6	16.7	55.1
2300	26.1	31	13.4	42.4	075	95.4	17.9	57.5
2023/8/18 0000	25.9	32	19.0	50.5	078	95.1	22.8	66.6
0100	25.3	31	18.7	55.9	084	94.8	21.8	64.7
0200	24.0	32	12.7	46.8	097	94.6	15.6	52.8
0300	23.6	30	6.2	17.6	059	94.5	11.1	42.5
0400	23.1	30	6.9	21.3	045	94.4	11.3	43.1
0500	22.0	31	12.4	36.3	072	94.3	14.6	50.6
0600	21.1	31	12.3	38.7	079	94.1	14.2	49.8
0700	21.7	29	19.3	37.9	091	94.0	20.0	61.5
0800	24.1	22	15.0	37.7	081	94.1	16.2	54.0

\*HFFMC: Hourly Fine Fuel Moisture Code; HISI: Hourly Initial Spread Index; HFWI: Hourly Fire Weather Index. The yellow row indicates the approximate time when the McDougall Creek wildfire began interacting with the Rose Valley and Bear Creek Road study locations.

**Table A2. Hourly temperatures, winds, and Fire Weather Index System\* values for the Brenda Mines fire weather station on August 17 and August 18, 2023**

Time	Temp (°C)	RH (%)	Wind speed (km/h)	Gust speed (km/h)	Direction (°)	HFFMC	HISI	HFWI
2023/8/17 1700	26.0	26	21.6	40.2	218	93.3	20.3	60.4
1800	24.3	28	16.2	37.3	228	93.3	15.6	51.3
1900	21.5	34	13.2	31.0	235	93.2	13.2	46.2
2000	20.3	38	17.3	32.1	222	93.0	15.6	51.4
2100	19.2	42	14.0	44.2	270	92.7	12.7	45.0
2200	18.3	46	14.7	38.5	257	92.3	12.4	44.4
2300	17.5	50	11.8	29.8	251	91.8	10.1	38.9
2023/8/18 0000	17.0	54	10.7	26.4	294	91.3	8.9	35.9
0100	17.1	43	14.5	32.7	285	91.2	10.5	40.0
0200	16.6	38	11.2	33.9	326	91.1	8.9	35.8
0300	16.1	38	13.8	33.9	303	91.1	10.1	38.8

0400	15.1	41	12.7	28.1	318	91.0	9.4	37.1
0500	13.5	49	16.3	40.8	296	90.7	10.8	40.5
0600	12.2	53	15.5	38.5	293	90.3	9.8	38.2
0700	13.1	45	10.5	25.8	243	90.2	7.5	31.9
0800	14.2	32	14.8	32.1	254	90.2	9.4	37.0

\*HFFMC: Hourly Fine Fuel Moisture Code; HISI: Hourly Initial Spread Index; HFWI: Hourly Fire Weather Index. The yellow row indicates the approximate time when the McDougall Creek wildfire began interacting with the Rose Valley and Bear Creek Road study locations.

[www.wildfire.fpinnovations.ca](http://www.wildfire.fpinnovations.ca)  
[Wildfiregroup@fpinnovations.ca](mailto:Wildfiregroup@fpinnovations.ca)

## OUR OFFICES

POINTE-CLAIRE  
570 Saint-Jean Blvd.  
Pointe-Claire, QC  
Canada H9R 3J9  
(514) 630-4100

VANCOUVER  
2665 East Mall  
Vancouver, BC  
Canada V6T 1Z4  
(604) 224-3221

QUÉBEC  
1055 rue du P.E.P.S.  
Québec, QC  
Canada G1V 4C7  
(418) 659-2647

EDMONTON  
11810 Kingsway Ave, NW.  
Edmonton, AB  
Canada  
T5G 0X5

