Wildfire Hazard and Risk Report for the Evergreen Estates
Kamloops Fire Center

Situation

There has been recent concern from the homeowners in the Evergreen Estates subdivision with wildfire risk to the community due to a partially completed Wildfire Risk Reduction (WRR) treatment. The Thomson River Natural Resources District is the administrator of this contract. This report will discuss the wildfire risk to the community from this partially completed WRR treatment.

Location

The Evergreen Subdivision is located approximately 18 km north of the city of Kamloops just off Highway 5. Figure 1 shows the location of the subdivision in relation to the city of Kamloops.

Figure 1 The location of the subdivision in relation to the city of Kamloops (not to scale).

Treatment area

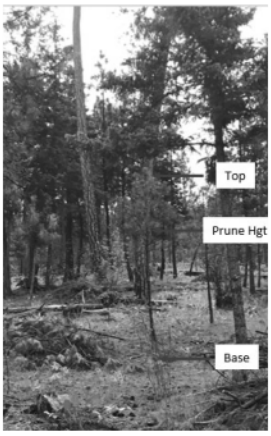
The total treatable area is 95.80 ha divided into five treatment units. Figure 2 shows a clip of the prescription map in relation to the properties and private land in the Evergreen Estates area. All thinning work has been completed in this area. The only work remaining Is the disposal of the piled material from the WRR treatment. The contractor performing the treatment estimated that there were approximately 4,000 piles on the site to be disposed of. Burning of piled material started early in 2022 until the piles started to spread to surrounding fuel. The prescription allowed for the pile to spread for a maximum of 2 meters from the pile. Currently there is an estimated 2,500 – 3,000 piles remaining on site.

Figure 2: The prescription map showing a relationship to the properties and private land in the Evergreen Estates area to the treatment units (not to scale) (total area listed on the map for each treatment unit).

Description of Treatment Units

Treatment Unit 1 – 8.2 ha

This treatment unit borders the private lands on the east and north sides of the Estates. This area has been previously treated and most of the work completed in this area was tree pruning to a height of 2-3 meters. It should be noted that the contractor attempted to prune all remaining trees to a height of 3 meters. The prescription stated:



"Pruning will be conducted on all conifers over three meters in height. Conifers will be pruned to 50% of tree height to a minimum of three meters to the lowest branch. The intention is to have a full three-meter gap between surface fuels and the coniferous tree crown, this may require higher stem pruning to account for branch droop or sweep."

The contractor pruned all trees in an attempt to give crown separation from the surface fuel, even trees less than 3 meters in height. This treatment could lead to mortality in a high percent of those trees (< 3.0 meters in height). This operation holds true in all treatment units.

A higher percentage of piles have been disposed of, but a percentage remains nearest to the private property.

Figure 3 – Example of excessive pruning on small trees

Treatment Unit 2 – 9.1 ha

This the most westerly treatment unit and borders on Highway 5. No unburnt piles were observed in this treatment unit.

Treatment Unit 3 – 12.5 ha

This treatment unit is located west of the power line right of way (ROW) east of treatment unit 2. The treatment unit is comprised mainly of Douglas fir and ponderosa pine regeneration. There is a small percentage of unburnt piles in this treatment unit.

Treatment Unit 4 – 32.5 ha

This treatment unit is located east of the power line right of way (ROW). It borders untreated fuel in the north and east of the total treated area. This area contains many piles with a very low percentage of piles having been burnt in this treatment unit. This treatment unit has a southwest (SW) to west (W) aspect leaving fuel in this area to the full effect of solar radiation drying the fuel during the day. The northeast (NE) portion of this treatment unit has steep slopes with a SW aspect.

Treatment Unit 5 - 33.5 ha

This treatment unit is located east of the treatment unit 1. It borders untreated fuel in the south and east of the total treated area. This area contains many piles with a very low percentage of piles have been burnt in this treatment unit. This treatment unit has a west (W) aspect, leaving fuel in this area to the full effect of solar radiation drying during the day. The east (E) portion of this treatment unit is sloped in an eastward direction toward the height of land of the treatment unit. The southeast (SE) corner contains areas where thinning and pruning have occurred, but the operation of piling this debris has not been completed. This leaves dispersed surface fuel to enhance wildfire spread.

Composition of the Unburnt Piles

The piles are constructed from debris from the thinning and pruning operations. The bulk of the material is less than 7 cm in diameter. Most of the material is recently cut material (green) but there is some residual dead material from previous treatments and tree mortality.

Using an estimation of 2,500 to 3,000 unburnt piles of the site, the following calculation was derived:

> Using the formulas found in Wright 2010, the best estimation of pile volume was using a half ellipsoid where Volume = (Pi X Height X Width X Length) ÷ 6. Using this formula, the following volume weas derived:

PI	H (cm)	W (cm)	L (cm)	cm^3	m^3/ pile	x 2500 piles (m^3)	x 3000 piles (m^3)
3.141592	125	200	200	2617993	2.617993	6544.98333	7853.98

Table 1. Calculation of pile volume on site.

The volume of the unburnt piles on the treatment area is between 6,544 – 7,853 m^3, which is a large amount of fuel possible available to a spreading wildfire in this area.

Assessment of Wildfire Behaviour Potential

An assessment of this treated area will be examined in two methods; the ability of a wildfire to ignite, spread and consume the forest fuel in the area known as wildfire threat, and in terms of wildfire risk, the ability of a wildfire in the area to impact the values at risk in the area (i.e., private property and homes in Evergreen Estates)

Wildfire Threat

The forest fuel will be examined to see if the fuel is susceptible to ignition during the wildfire season of 2022 (June- October). Using the BC Wildfire Service 90th Percentile Calculator, average values were determined for this area using three surrounding weather stations (Afton, East Barriere and Cahilty) for a 10 year period. Calculations can be found in Appendix 1. The following values were calculated:

Fine Fuel Moisture Code (FFMC) - 93.07

Buildup Index (BUI) – 136.23

Initial Spread Index – 11.38

These values are used as they best describe wildfire potential. Will a wildfire ignite (FFMC), will it consume fuel (BUI- drought indicator) and will it spread (ISI – function of fine fuel burning and wind pushing the wildfire)?

Using these values, the probability of ignition was calculated for this area. The method to calculate this value comes from the publication "Probabilities of sustained flaming ignition: lodgepole pine, interior Douglas-fir and white spruce-subalpine fir forests" (Dalrymple, Lawson 1996). Figure 4 showing this calculation from the table in this publication. There is a high probability of ignition in this area (99%).

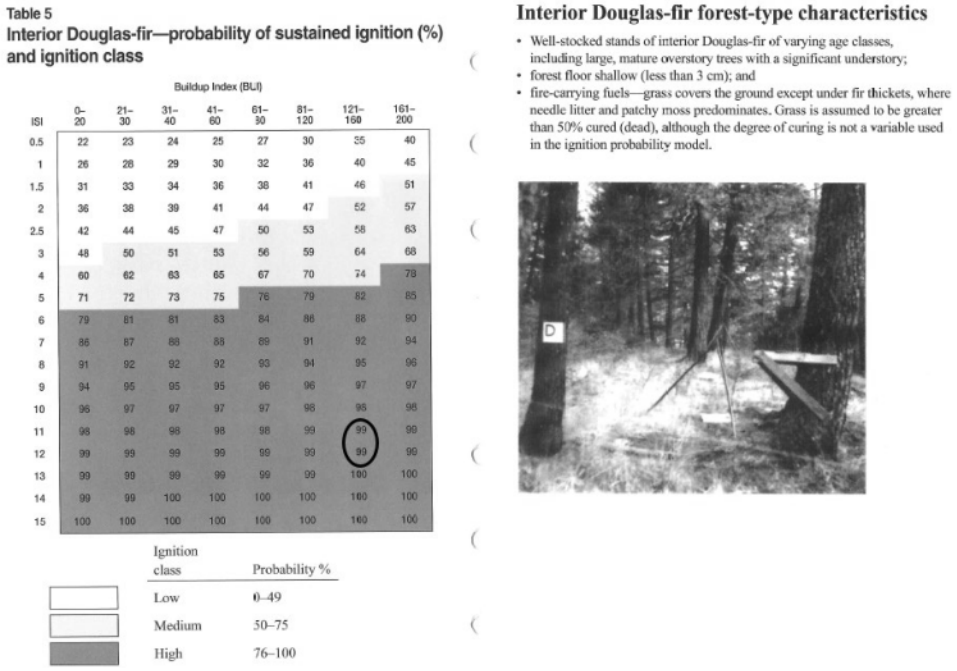


Table 5
Interior Douglas-fir—probability of sustained ignition (%) and ignition class

Buildup Index (BUI)

ISI	0–20	21–30	31–40	41–60	61–80	81–120	121–160	161–200
0.5	22	23	24	25	27	30	35	40
1	26	28	29	30	32	36	40	45
1.5	31	33	34	36	38	41	46	51
2	36	38	39	41	44	47	52	57
2.5	42	44	45	47	50	53	58	63
3	48	50	51	53	56	59	64	68
4	60	62	63	65	67	70	74	78
5	71	72	73	75	76	79	82	85
6	79	81	81	83	84	86	88	90
7	86	87	88	88	89	91	92	94
8	91	92	92	92	93	94	95	96
9	94	95	95	95	96	96	97	97
10	96	97	97	97	97	98	98	98
11	98	98	98	98	98	99	99	99
12	99	99	99	99	99	99	99	99
13	99	99	99	99	99	99	100	100
14	99	99	100	100	100	100	100	100
15	100	100	100	100	100	100	100	100

Ignition class	Probability %
Low	0–49
Medium	50–75
High	76–100

Interior Douglas-fir forest-type characteristics

- Well-stocked stands of interior Douglas-fir of varying age classes, including large, mature overstory trees with a significant understory;
- forest floor shallow (less than 3 cm); and
- fire-carrying fuels—grass covers the ground except under fir thickets, where needle litter and patchy moss predominates. Grass is assumed to be greater than 50% cured (dead), although the degree of curing is not a variable used in the ignition probability model.

Figure 4 Clip of the table showing this calculation in this publication.

To quantify wildfire spread potential of forest fuel in this area, two fuel types will be used from the Canadian Forest Fire Behaviour Prediction System, C-7 (Ponderosa Pine and Douglas Fire) and O1b (standing grass 80% cured). The following wildfire behaviour outputs were calculated:

Fuel Type	Fire Type	Rate of Spread	Flame Length	Head Fire Intensity	60 min fire size
C-7	surface	4.0 m/min	3.31 meters	3511 kW/m	2.5 ha
O1b	surface	21.0 m/min	2.69 meters	2225 kW/m	43.1 ha

Note: both Head Fire Intensity values are beyond ground crew capability

Table 2. Wildfire behaviour potential for fuel types

To quantify spread potential towards the community, there must be a calculation of spotting potential of the forest fuel and unburnt piles. It is worthwhile to note that almost 100% of home loss to wildfire comes from spotting (ember attack).

The method used to calculate the spotting potential for piles can be found in the document "Maximum Spot Fire Distances for Burning Piles and Wind Driven Surface Fires in Non-canopied Fuel Types based on Albini's Models" Alexander, M.E., 2006. Using the Table 3 adapted from this document, the spotting distance would be between 300-400 meters (black circle) using flame length from above or if you factor in the fact that the piles are 1.25 meter in height the spotting distance could be as much as 500-600 meters (red circle). Given the sheer number of piles and the proximity of piles to each other, pile to pile ignition will happen. Multiple ignitions are the main cause of extreme fire behaviour phenomenon such as fire whirls (fire tornado)

Maximum Spotting Distance for Non- Canopied Fuel Types

Maximum spotting distances (km, assuming a receptive fuelbed, for wind driven surface fires in non-canopied fuel types (grass, shrublands and slash) over level terrain as a function of a continuous steady flame length and wind speed

Flame Length (m)	10 m Open Wind Speed									
	5 km/h	10 km/h	15 km/h	20 km/h	25 km/h	30 km/h	35 km/h	40 km/h	45 km/h	50 km/h
1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.5	0.5
2	0.2	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.8	0.8
3	0.2	0.4	0.5	0.6	0.7	0.8	0.8	0.9	1.0	1.1
4	0.3	0.4	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
5	0.3	0.5	0.7	0.8	1.0	1.1	1.2	1.3	1.4	1.5
6	0.4	0.6	0.8	0.9	1.1	1.2	1.4	1.5	1.6	1.8
7	0.4	0.7	0.9	1.1	1.2	1.4	1.5	1.7	1.8	1.9
8	0.5	0.7	1.0	1.2	1.3	1.5	1.7	1.8	2.0	2.1
9	0.5	0.8	1.0	1.3	1.5	1.6	1.8	2.0	2.2	2.3
10	0.5	0.8	1.1	1.3	1.6	1.8	2.0	2.2	2.3	2.5
11	0.6	0.9	1.2	1.4	1.7	1.9	2.1	2.3	2.5	2.7
12	0.6	1.0	1.3	1.5	1.8	2.0	2.2	2.4	2.6	2.8
13	0.6	1.0	1.3	1.6	1.9	2.1	2.4	2.6	2.8	3.0
14	0.7	1.1	1.4	1.7	2.0	2.2	2.5	2.7	2.9	3.2
15	0.7	1.1	1.5	1.8	2.1	2.3	2.6	2.9	3.1	3.3
16	0.7	1.2	1.5	1.9	2.2	2.5	2.7	3.0	3.2	3.5
17	0.8	1.2	1.5	1.9	2.3	2.6	2.8	3.1	3.4	3.6
18	0.8	1.3	1.7	2.0	2.4	2.7	3.0	3.2	3.5	3.8
19	0.8	1.3	1.7	2.1	2.4	2.8	3.1	3.4	3.6	3.9
20	0.9	1.4	1.8	2.2	2.5	2.9	3.2	3.5	3.8	4.1
25	1.0	1.6	2.1	2.5	3.0	3.3	3.7	4.1	4.4	4.7
30	1.1	1.8	2.4	2.9	3.4	3.8	4.2	4.6	5.0	5.4

Adapted from "Maximum Spot Fire Distances for Burning Piles and Wind Driven Surface Fires in Non-canopied Fuel Types based on Albini's Models" Alexander, M.E., 2006

Table 3 Chart showing the spotting distance for non canopied fuel/ piles

Also, a concern in these treatment units is the piling practise that was used. Many piles are near over hanging branches of the remaining trees which could cause the aerial fuel of those trees to ignite into a crown fire. This would enhance the wildfire behaviour potential of these areas exponentially as well.

Figure 5 Larger pile near multiple trees

To give reference to this picture, if this pile was ignited it would interact with 6-7 standing trees, causing them to torch the canopy fuel. This is a common occurrence across the site and has already occurred in areas where pile burning has occured in much less volatile conditions (Figure 6).

Figure 6 Scorned trees near a burnt pile

The fire behaviour computer program, RedApp, was used to calculate standing tree spotting potential. The inputs used were: 10 km/h wind speed, 10.0 meter trees, and 10 trees torching, the output was spotting distance of 230 meters. Allowing for a 15 km/h wind speed pushes the spotting distance to 350 meters.

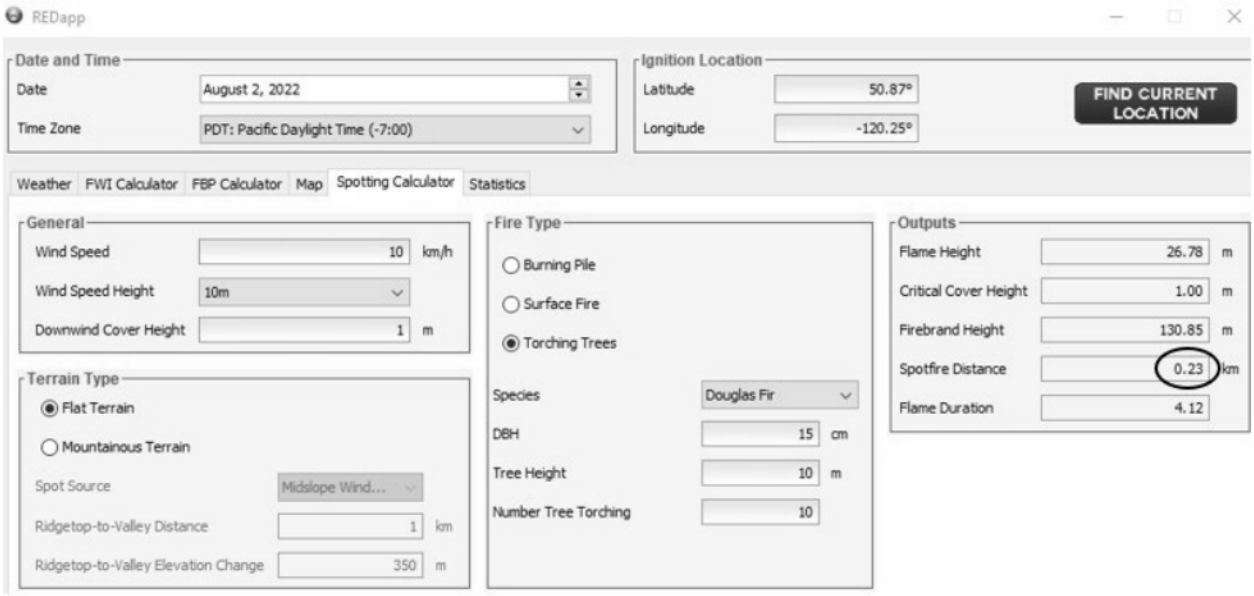


Figure 7 Screen of the program RedApp showing the spotting calculation

This calculation is for spotting on flat terrain. Spots that are lofted from piles or trees which are located on the mid or upper portion of the slopes above the homes, will tend spot longer distances (500-700 meters). This ability allows for spots from any part of the treatment to impact the homes below the area. Figure 7 shows the minimum distance that a spotting ember could impact the home in the Evergreen Estates.

The fuel consumption for this area is driven by the Buildup Index (BUI). Given the 90th percentile BUI of 136, most fuel under 7.0 cm would be consumed in a wildfire situation (flaming front and smoldering combustion).

Wildfire Risk

Now that wildfire threat has been examined, the next piece to examine is the potential for a wildfire to impact the values at risk (homes) in the Evergreen Estates.

Based on an average distance of 400 meters from the community (homes to mid point of treatment units) and using the rates of spread found in Table 2, a wildfire spreading through forest fuel (C-7) could impact the community in 100 -120 minutes. If the grass fuel type (O1b) is used, the wildfire could impact the community in 20-30 minutes. A spotting ember from a pile could impact the community almost immediately after ignition.

Spotting of embers into the community is examined by using the same 400-meter point of reference as the rate of spread. From this point, embers will impact the community. Figure 8 shows an area where embers could be generated from to impact the community.

Figure 8. An ember/spotting impact map showing the depth into the treatment units where a spotting ember could impact the community (red area is 300 meters from the community, the black is 400 meters from the community).

The black area corresponds to an area of high pile density. It is worthwhile to note that these areas are higher in elevation (treatment units) compared to the community and embers can float or loft further than the calculated distance to a lower point (community).

Summary

Following a visit to the site and the presentation of the information in this report, I feel there is an increased wildfire threat to a wildfire igniting and spreading in and outside of these treatment units. The rationale to complete this treatment was reduce the wildfire threat by managing the fuel on the site. As this work is not completed, the threat which was in the canopy fuel of the standing forest has been placed on the ground, making it more available for a spreading wildfire to consume, thus increasing the wildfire threat. Given the proximity of this treatment to the community of Evergreen Estates and the increased wildfire threat, the risk of a wildfire impacting this community has also increased.

Given the amount of debris left on the site and the location of many of the piles (under the canopy of standing trees), removal of this threat would be expensive and cause damage to the treated stand. The only plan of action for this wildfire season is to manage the threat and risk on the site and ensure the debris is managed after the wildfire season.

The estimate for the amount of on-site debris used in this report I felt were on the conversative side. It could be argued that there is a larger amount of debris on this site that would increase the threat and risk from this treatment.

Recommendations to Wildfire Risk Reduction Program

I would also present the following recommendation to the Wildfire Risk Reduction Program;

1. Debris be an ongoing part of the treatment. s.13 s.13 If possible, break up the area into treatment units (such as this project) and manage the debris in that unit before moving to the next unit.
2. The contractor should present a plan to manage the debris as part of a workplan.
3. s.13

Dana Hicks

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References

Lawson, B.D.; Armitage, O.B. 2008. Weather guide for the Canadian Forest Fire Danger Rating System. Natural Resources Canada, Canadian Forest Services, Northern Forestry Center, Edmonton, AB.

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Perrakis D.B., Eade, G., Hicks, D. 2018. British Columbia Wildfire Fuel Typing and Fuel Type Layer Description. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, British Columbia. Information report BC-X-444. 45 p.

Canadian Forest Fire Behaviour Prediction (FBP) system, Natural Resources Canada, Canadian Forest Services

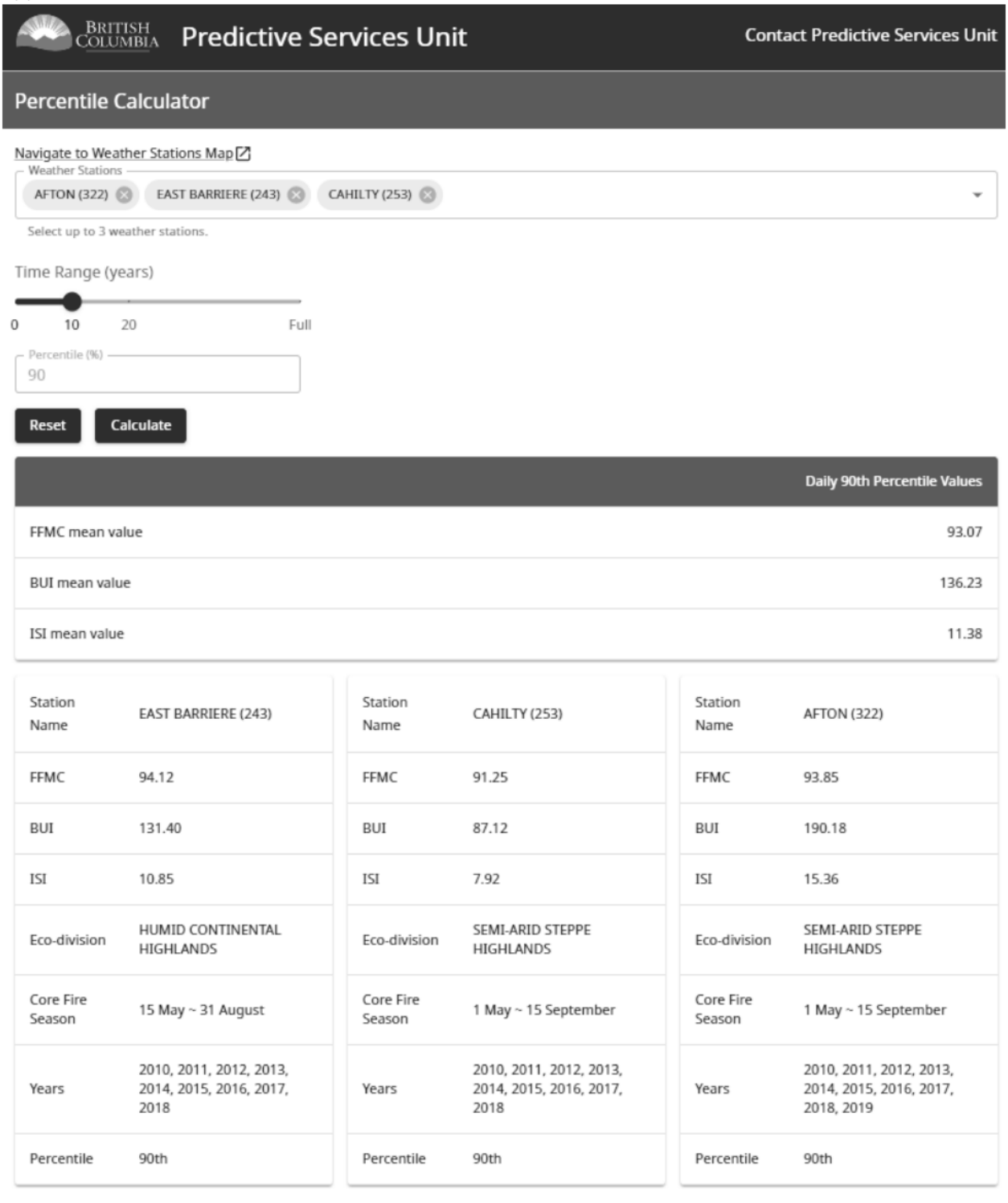
RedApp – Universal Fire Behaviour Calculator

Alexander M. E., 2006. Maximum Spot Fire Distances for Burning Piles and Wind-driven Surface Fires in Non-canopied Fuel Types based on Albini's Models

1996. Lawson, B.; Dalrymple, G.N. Probabilities of sustained flaming ignition: lodgepole pine, interior Douglas-fir, and white spruce-subalpine fir forests. Supplement to Field guide to Canadian forest fire behaviour prediction (FBP) system. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, BC. FRDA Handbook 012 supplement, published by the BC Ministry of Forests.

Morrow B, Wildfire Risk Reduction Prescription 2021

Appendix 1 – 90th Percentile Calculation



BRITISH COLUMBIA Predictive Services Unit — Contact Predictive Services Unit

Percentile Calculator

Navigate to Weather Stations Map

Weather Stations: AFTON (322) | EAST BARRIERE (243) | CAHILTY (253)

Select up to 3 weather stations.

Time Range (years)

0 10 20 Full

Percentile (%): 90

Reset | Calculate

	Daily 90th Percentile Values
FFMC mean value	93.07
BUI mean value	136.23
ISI mean value	11.38

Station Name	EAST BARRIERE (243)
FFMC	94.12
BUI	131.40
ISI	10.85
Eco-division	HUMID CONTINENTAL HIGHLANDS
Core Fire Season	15 May ~ 31 August
Years	2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018
Percentile	90th

Station Name	CAHILTY (253)
FFMC	91.25
BUI	87.12
ISI	7.92
Eco-division	SEMI-ARID STEPPE HIGHLANDS
Core Fire Season	1 May ~ 15 September
Years	2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018
Percentile	90th

Station Name	AFTON (322)
FFMC	93.85
BUI	190.18
ISI	15.36
Eco-division	SEMI-ARID STEPPE HIGHLANDS
Core Fire Season	1 May ~ 15 September
Years	2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019
Percentile	90th

Burnt out stump from Spring 2022 pile burning, good sign of drought conditions carried through the winter

Larger debris pile found on the site

Good example of the number of piles on the site

Debris yet to be piled