Lower North Thompson Community Forest

WILDFIRE RISK MANAGEMENT PLAN

FINAL REPORT

March 25, 2020

Lower North Thompson Community Forest Society

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Acknowledgements

Forsite would like to acknowledge the Planning Team assembled for this project for their significant contributions of time and knowledge of the project area. This includes Mike Francis, RPF (LNTCF Manager), Harley Wright (LNTCF Board Chairman), and Brian Bondar, RPF (LNTCF Director).

Forsite would also like to thank the attendees of the Values Workshop for their insights and participation:

- Michael Bragg, RPF – Tolko;
- Melanie Stutt – Simpcw First Nation;
- Ashley Wohlgemuth - Barriere Fire Department;
- Brita Pedersson, FIT - MFLNRORD;
- Krista Barton, PAg - MFLNRORD;
- Mayor Ward Stamer - District of Barriere;
- Michael Aldred, RPF, Kelly Osbourne, RPF, and Dana Hicks – BCWS; and
- Norm Fennell, RPF – Woodlot Owner.

Expert insight and feedback towards the management strategies was also provided by Bob Gray (RW Gray Consulting Ltd) and Bruce Morrow (Bruce Morrow Forest Consulting, Ltd).

Executive Summary

In British Columbia, wildfire is an important natural disturbance posing considerable risks to values and resources. Significant consecutive wildfire seasons (2017 & 2018) have underscored the need to prepare for the unexpected. Wildfire risk management is a key step that organizations are using to support an understanding of threats and opportunities associated with wildfire and how best to balance ecological, economic, and social values in wildfire planning.

The Lower North Thompson Community Forest (LNTCFCF) Wildfire Risk Management Plan was initiated in September of 2018 and involved the following key steps:

- Development of a Terms of Reference;
- Documentation of the internal and external context to wildfire risk management;
- A Risk Assessment, including risk identification, analysis and evaluation;
- Development of Management Strategies in response to the risks identified; and
- Development of the Final Report.

The risk management process was directed by a Planning Team that included representatives from the Lower North Thompson Community Forest Society and Forsite Consultants Ltd. Planning was also guided through collaborative conversations with key government officials and regional stakeholders.

The risk of fire was analyzed using a modified burn probability. This probability was combined with a strategic review of values on the landscape that are either threatened by or could benefit from fire. Spatial layers were developed that reflect the four (4) provincial Resource Strategic Wildfire Allocation Protocol (RSWAP) categories: (1) Human Life and Safety, (2) Critical Infrastructure, (3) High Environmental and Cultural Values, and (4) Resource Values.

The assessment identified a range of wildfire risks across the landscape. Key areas of higher wildfire risk included corridors of human presence and development on the southern and northern margins of the Plan Area. Although wildfire risk exists across the entire plan area, the particular combination of forest vegetation, fire behavior potential, ignition density, values at risk, topography, and weather patterns is such that these areas have the highest relative risk.

To respond to these risks, management strategies were developed to enhance the resilience of the Plan Area to wildfire. These strategies were designed to address both threats and opportunities associated with wildfire, as this natural disturbance process can have both a positive and negative effect on values in the plan area. Strategies were developed by considering a range of factors and available tools for managing wildfire, including but not limited to fire ecology, the results of modified burn probability, historical fire patterns, climate change scenarios, topography and weather, operational realities, fire suppression considerations, and forest health. A summary of the relevant considerations for each management strategy was identified, including particular values at risk, rationale, additional forest management context, risk reduction objectives, actions, responsibilities, partners, and resources.

The management strategies outlined in this plan can be broadly classified into the following five (5) categories:

- Wildfire Management Zones;
- Silviculture;
- Strategic harvesting;
- Prescribed fire; and
- Collaborative Planning

Although implementing each management strategy could have value across the entire plan area, specific "Wildfire Management Zones (WMZ)" were identified to prioritize implementation of the remaining four (4) strategies. Areas with high relative risk and/or where strategies are likely to have the greatest positive impact were selected for delineation as a WMZ.

This LNTCF WRMP is a current assessment of wildfire-related risks throughout the Plan Area. An annual progress report is recommended that documents progress against the plan. This plan was developed with a term of five (5) years, and a plan renewal process should be initiated in 2024. Although wildfire risk can never be eliminated, the information and strategies communicated in this WRMP are intended to provide a roadmap for the LNTCF for enhancing their resilience to wildfire in the long term.

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1 Introduction

Wildfire is an essential natural disturbance process in British Columbia's ecosystems, and a key driver of landscape resilience (Agee 1998; Turner 2010). Wildfire also represents a specific threat to human life, property and a range of other values. For over a century, forest management practices, effective fire suppression, and the displacement of indigenous peoples who traditionally utilized fire as an ecological tool have altered forests and grasslands such that large, severe wildfires are more likely in many regions of western North America (Hessburg et al. 2016, 2019; Prichard et al. 2017). This altered fuels landscape is compounded by a changing climate and an expanding wildland-urban interface (WUI) [1], making fire management in British Columbia increasingly complex and challenging. As this dynamic continuously evolves, multiple agencies and organizations are tasked with balancing ecological objectives with a wide range of social, cultural, and resource values that could be impacted by wildfires.

This report represents the implementation of a risk management process in the forest tenure areas of the Lower North Thompson Community Forest (LNTCF) and the surrounding area (Plan Area); referred to hereafter as the LNTCF Wildfire Risk Management Plan (WRMP).

High-level direction and context for this WRMP and Plan Area came from the mandate of the LNTCF Community Forest, the strategic initiatives of the BC Wildfire Service (BCWS), and from recommendations of documents such as the *BC Wildland Fire Management Strategy* (2010).

The LNTCF WRMP is based on the CAN/CSA-ISO 31000-10 *Risk Management – Principles and Guidelines* as summarized in Figure 1. The risk management process involves the following key steps:

- Development of a **Terms of Reference**;
- Documenting the **Context** to wildfire risk management;
- Conduct a **Risk Assessment**, including **Risk Identification, Analysis and Evaluation**, with a focus on spatial representation of fire probability and values in support of the risk assessment;

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[1] As defined in the FireSmart manual, the wildland urban interface (WUI) is any area where combustible forest fuel is found adjacent to homes, farm structures, or other outbuildings. This may occur at the interface, where development and forest fuel (vegetation) meet at a well-defined boundary, or in the intermix, where development and forest fuel intermingle with no clearly defined boundary. See BCWS Wildfire Glossary: https://www2.gov.bc.ca/gov/content/safety/wildfire-status/about-bcws/glossary. In a fuel management context, treatments designed to address fire hazard in the WUI are generally focused within 2km of communities and developed areas.

- Development of Management Strategies in response to the risks identified, including the threats and opportunities associated with wildfire; and
- Development of a **Final Report** for endorsement by the LNTCF WRMP Planning Team.

A risk management framework is currently being developed for the BCWS. Renewal of the LNTCF WRMP in the future should consider this emerging process or framework.

1.1 PLAN OBJECTIVES

The LNTCF WRMP objectives as defined by the Planning Team are:

OBJECTIVE 1 – DEFINE STRATEGIES AND PRIORITIES FOR WILDFIRE PREVENTION AND MITIGATION

- Define values and model wildfire risk in a manner that reflects the particular context of the LNTCF;
- Use the planning process to generate priority areas with higher wildfire risk, and strategies to support wildfire risk response;
- Develop a comprehensive fuels treatment/strategic harvest strategy that addresses short- and long-term goals for management of the community forest; and
- Engage with and be informed by other forest, land, and resource planning processes.

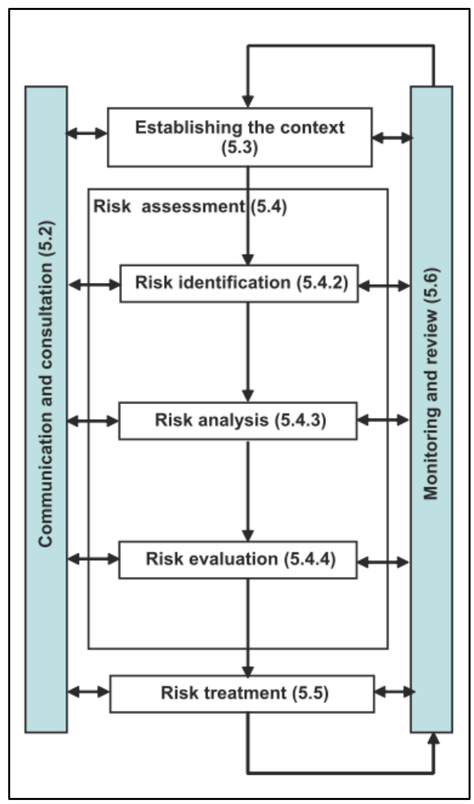

Figure 1: CAN/CSA-ISO 31000-10 Risk Management Process

OBJECTIVE 2 – SUPPORT INFORMED WILDFIRE MANAGEMENT DECISIONS AND PLANNING

- Provide support for informed decisions, which further supports due diligence and justification for response tactics;

- Provide detailed information on values at risk and mitigation activities completed on the land base to provide support for Incident Command decisions;
- Support Fire Analyses within BCWS and MFLNRORD; and
- Support the coordination of wildfire planning with First Nations, appropriate regulatory agencies, governments, and stakeholders.

OBJECTIVE 3 – IDENTIFY WILDFIRE-RISK-RELATED OPPORTUNITIES

- Identify where and how the use of fuels treatment alternatives and strategic harvest—particularly when designed to emulate historical disturbance—can provide ecosystem services to benefit the long-term management of the LNTCF;
- Support the use of fire as a tool on the landscape; and
- Consider the full range of treatment approaches and contemporary research findings in designing fuels treatments and landscape-scale strategies.

OBJECTIVE 4 – SUPPORT AN OPEN AND TRANSPARENT UNDERSTANDING OF WILDFIRE RISKS AND OPPORTUNITIES

- Engage with First Nations, communities, appropriate agencies, and major stakeholders in the planning process;
- Inform involved parties about risks, including public and shared risks; and
- Use the WRMP to foster materials that can be used to support ongoing engagement with the public, landowners, and communities.

1.2 SCOPE AND DELIVERABLES

The key deliverable of the wildfire risk management process is a plan that identifies, analyses, and evaluates wildfire-related threats and opportunities across the Plan Area, and identifies key **Management Strategies** in response to those risks. Principle components include:

- Review of pertinent legislation, regulation, reports and plans to capture relevant objectives and values;

- Engagement with a range of governmental stakeholders within and outside of the MFLNRORD to identify and confirm objectives and values;
- Use of an integrated risk management approach to ensure risks are thoroughly identified, analyzed, and evaluated;
- Description of the key management strategies that should be considered in response to the risks identified; and
- Development of a series of reports, including the **Terms of Reference, Values at Risk Inventory**, and **Management Strategies**, that together make up the LNTCF WRMP.

The wildfire risk management process itself is central to the development of all deliverables, and included:

- A range of appropriate risk management methodologies and tools for identifying, assessing, evaluating, and responding to wildfire related risk;
- Consideration of both wildfire threats (values negatively impacted by wildfire) and opportunities (values positively influenced by wildfire);
- Spatial distribution of wildfire threats, opportunities and associated values, and where fitting, management strategies;
- A general discussion of the management strategies in response to identified risks (threats and opportunities). Detailed plans associated with these management strategies will not be a part of the LNTCF WRMP, but will be addressed through other programs and processes (e.g. FireSmart Program, FESBC, and CRI);
- Results including maps, background regarding data, and methods used; and
- Maps that display the spatial distribution of the wildfire risk for operational use.

1.3 TIMELINE

The development of the LNTCF WRMP process began in September 2018, with the completion of a final report scheduled for February 1, 2020. An extension to the end of March, 2020 was agreed upon to ensure adequate review time of draft management strategies from the Planning Team and a presentation to the LNTCF Board of Directors on March 12, 2020.

The plan was developed with a five (5) year term, with progress against recommended management strategies reported annually. A detailed review of the plan will occur after five (5) years to support a risk assessment update, and will be led by The Lower North Thompson Community Forest Society (LNTCFS).

1.4 PLANNING TEAM

In support of the overall risk management process, a Planning Team was established for the LNTCF WRMP that included the following representatives:

- Mike Francis, RPF – Managing Forester – Lower North Thompson Community Forest Society;
- Harley Wright – Board Chairman – Lower North Thompson Community Forest Society;
- Julie Maxwell, RPF – Project Lead – Forsite Consultants Ltd. (up to January 31, 2020);
- Garnet Mierau, RPF – Project Support – Forsite Consultants Ltd.; and
- Alexandra Pogue, MSc, FIT – Project Lead and Support – Forsite Consultants Ltd.

The Planning Team met on a regular basis throughout the project to provide input and direction.

2 Context

Establishing planning context is at the foundation of the risk management process. The context identifies the current environment and situation within which the wildfire risk management plan will be implemented. The Planning Team was supported by discussions with a range of internal and external stakeholders that help develop the overall context for the risk management process. This planning environment is summarized in the sections below.

2.1 PLAN AREA

The LNTCF WRMP Plan Area includes the Lower North Thompson Community Forest Area (CFA) of 8,254ha, and a buffer ranging from 1 to 23km to reflect the landscape context of the CFA. The lands adjacent to the CFA are included in the planning process due to the potential influence of wildfires outside the CFA and the potential for values in this area to influence wildfire response. To incorporate these adjacent risks and values, a buffer delineated by topographic features and travel corridors was applied to the CFA boundary to represent the total Plan Area of 83,895 ha (Figure 2).

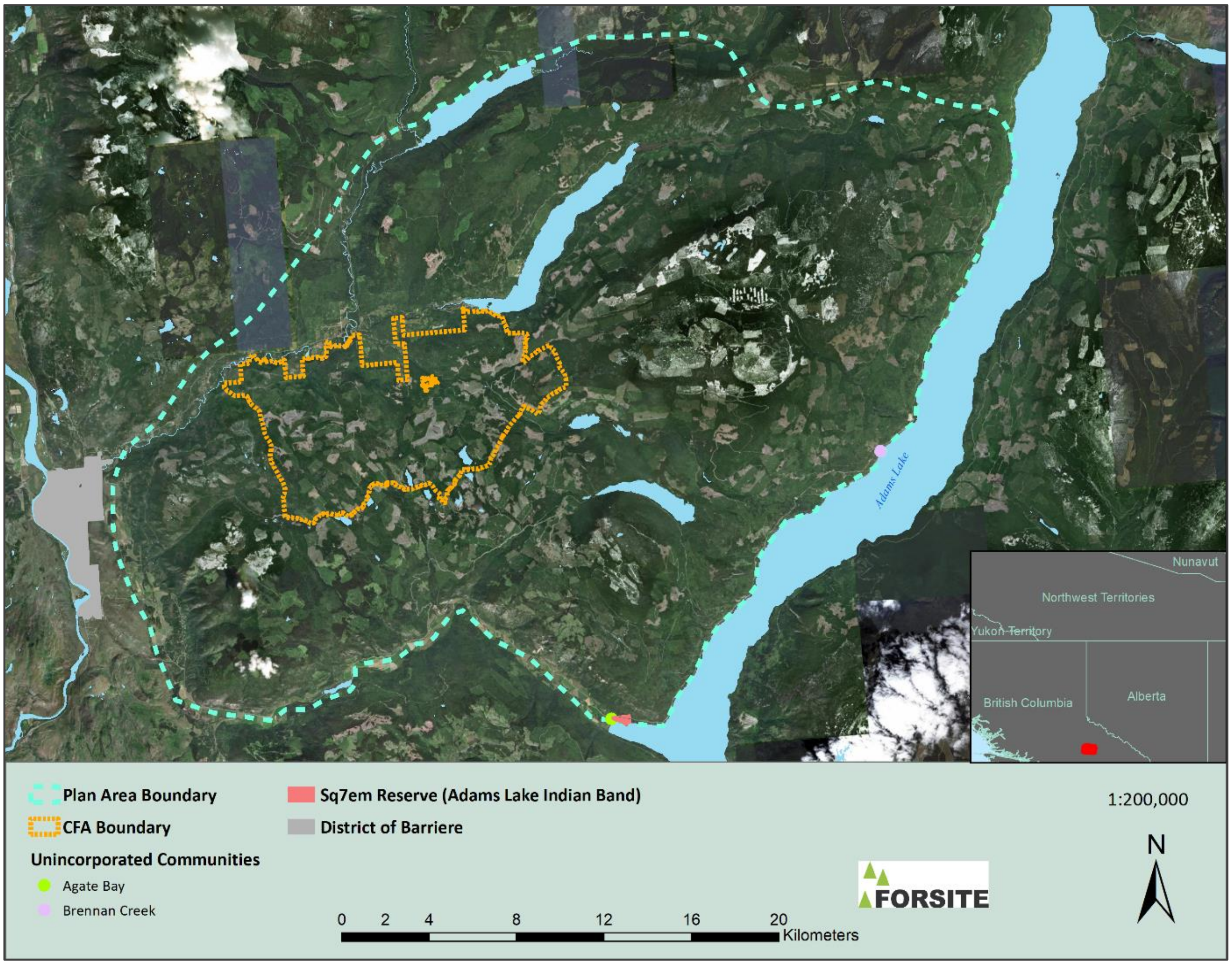

Figure 2: Plan Area Overview

2.2 ADMINISTRATIVE CONTEXT

The Plan Area includes a range of other administrative areas or jurisdictions, including:

- Thompson Rivers Regional District;
- Populated community areas;
- Private land; and
- Tenured forest land including the LNTCF, First Nations woodland licenses, woodlots, and forest licensee operating areas.

It is within this diverse land use situation that a collaborative approach was fostered in the development of the LNTCF WRMP.

2.3 LEGISLATIVE AND POLICTY CONTEXT

The BCWS has the responsibility and authority to manage wildfire in the province. A series of strategic plans and guidance documents (policy) are in place that provide direction as to how the BCWS operates. These documents provide guidance to everyday operations as well as more strategic level planning exercises such as this LNTCF WRMP. The key legislative and policy context includes:

- The BC Wildfire Act[2] and BC Wildfire Regulations;
- Wildfire Management Branch Strategic Plan (2012-2017)[3] ;
- BC Wildland Fire Management Strategy (2010)[4]; and
- Canadian Wildland Fire Strategy (2016)[5].

2.4 PLANNING CONTEXT

In addition to the legislative and policy context, direction and expectations are also realized through other BC land use and planning processes. The planning context includes:

- Provincial Government Core Policy & Procedure Manual, Chapter 14 Risk Management (2018)[6];
- Addressing the New Normal: 21st Century Disaster Management in British Columbia (April 2018)[7];
- LNTCF Community Forest, Draft Forest Stewardship Plan (2019);

[2] http://www.bclaws.ca/civix/document/id/complete/statreg/04031_01

[3] http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/wildfire-management/governance/bcws_strategic_plan_2012_17.pdf

[4] http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/wildfire-management/governance/bcws_wildland_fire_mngmt_strategy.pdf

[5] http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/37108.pdf

[6] https://www2.gov.bc.ca/gov/content/governments/policies-for-government/core-policy/policies/risk-management

[7] https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/emergency-preparedness-response-recovery/embc/bc-flood-and-wildfire-review-addressing-the-new-normal-21st-century-disaster-management-in-bc-web.pdf

- Fire Management Stocking Standards Guidance Document (2016)[8];
- Sendai Framework for Disaster Risk Reduction (2015)[9];
- Risk Management Guideline for the BC Public Sector (2012)[10];
- Climate Change and Fire Management Research Study (2009)[11];

2.5 ORGANIZATIONAL CONTEXT

The mandate and structure of the BCWS framed the approach taken to wildfire risk and its management in the development of this plan. The ISO-31000 standard and principles were used to direct the planning process; however the BCWS is currently creating a provincial risk framework which will provide important guidance once completed. The LNTCF will continue to work with BCWS to integrate the updated provincial standard into any wildfire-risk-management efforts in the LNTCF. This may entail updates to the LNTCF WRMP in future iterations.

2.6 SOCIAL AND ECONOMIC CONTEXT

The social and economic context for the LNTCF WRMP refers to general factors or prevailing conditions in the greater region that influence wildfire risk management *within* the Plan Area.

2.6.1 SOCIAL CONTEXT

The LNTCF WRMP is a diverse region in landform and vegetation, as well as human use with significant residential, industrial, and recreational development throughout the region. Wildfire risk management will involve different approaches in response to this diversity, with specific attention being given to First Nations and stakeholders with interests in the land and how it is managed.

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[8] http://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/land-based-investment/forests-for-tomorrow/fire_management_stocking_standards_guidance_document_march_2016.pdf

[9] https://www.unisdr.org/we/coordinate/sendai-framework

[10] http://www.bcucipp.org/sites/bcucipp.civicwebcms.com/files/media/ERM_Guideline.pdf

[11] http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/wildfire-management/governance/bcws_climate_change_research_strategy.pdf

2.6.2 ECONOMIC CONTEXT

The LNTCF WRMP Plan Area includes economic interests in the following sectors:

- First Nations cultural and traditional uses;
- Utilities – electricity transmission, gas pipelines;
- Forestry/Timber – forest tenures and additional crown forested lands;
- Grazing/Ranching – Crown land, integrated with adjacent private lands;
- Recreation – dispersed, concentrated, private and public;
- Tourism; and
- Railways and Transportation – provincially-significant roadways, CN railway.

2.7 ENVIRONMENTAL CONTEXT

The environmental context of the Plan Area includes the ecosystems, natural disturbance regimes, climate, topography, and other natural features of the landscape that have implications for wildfire resilience and risk. This information is useful in understanding the type and frequency of events that may occur in the Plan Area, and implications for mitigation efforts.

2.7.1 BIOGEOCLIMATIC SETTING AND VEGETATION

The LNTCF and the surrounding area are located in the North Thompson Valley in the Shuswap Highlands of the Interior Plateau of British Columbia, between the Cariboo Mountains to the west and the Monashee Mountains to the east. This biodiverse region is dissected by steep and complex river canyon topography that encourages variability in vegetation composition and structure. Many of the landforms in the region are volcanic in origin, and the Wells Gray-Clearwater Volcanic Field is located the north of the Plan Area. The geological history and composition of the region is such that steep rocky outcrops, mid-elevation plateaus, lakes with elongated shapes along deeply incised valleys and canyons, and cliffs are common features.

Ecosystems in the Plan Area are classified within the Interior Douglas Fir (IDF) (23.5%), Englemann Spruce-Subalpine Fir (ESSF) (11.5%), Montane Spruce (MS) (6%), and Interior Cedar Hemlock (ICH) (59%)zones of the biogeoclimatic ecosystem classification (BEC) system for BC[12].

Prevailing vegetation is a mosaic of multi-story mixed conifer and broadleaf forests that vary in composition and structure based on aspect, elevation, and past disturbance. Forests on drier sites and aspects are dominated by Douglas-fir (*Pseudotsuga menziesii var. glauca)* while wetter sites and aspects are often dominated by a mixture of western redcedar *(Thuja plicata),* Douglas fir, and several other conifer and broadleaf species. Common associated conifer species include hybrid spruce (*Picea glauca x engelmannii*), lodgepole pine *(Pinus contorta)*, subalpine fir *(Abies lasiocarpa*), and western hemlock *(Tsuga heterophylla*). Common broadleaf associates include paper birch *(Betula papyrifera)*, black cottonwood *(Populus balsamifera ssp. Trichocarpa)*, and trembling aspen *(Populus tremuloides*). Riparian corridors, drainages, and disturbed areas generally have higher proportions of broadleaf species.

Forest structures across the Plan Area are often complex and multi-storied, reflecting differential growth rates and shade tolerances among component species and variable disturbance history. These forests exhibit a high degree of horizontal and vertical fuel continuity, and are thus highly capable of propagating crown fires when fuels are sufficiently dry to be continuously available. Past harvesting and natural disturbances such as fire, windthrow, and insect and disease outbreaks have also created a patchwork of younger stands in the earlier stages of development across the landscape. Regenerating stands created by harvest activities are generally densely stocked plantations with variable brush loads depending on silvicultural treatments, and often have higher surface fuel loads than would be typical of young stands created by fires. Brush loads are generally higher on moister sites and aspects.

Understory composition is variable across the Plan Area and surface fuels are highly continuous except on xeric and/or rocky microsites. Drier and more exposed microsites are generally dominated by pinegrass and dry-climate brush species, and surface fuels in these stands are typically available under more moderate weather conditions. Moister and more sheltered microsites are commonly dominated by mosses and herbaceous species, which are generally less volatile and have higher average moisture content. Surface fuels in these stands are thus typically only available to burn following periods of prolonged drying and/or under very hot and dry conditions. Needlecast and fine dead timber litter debris (e.g. branches and stems) are very continuous in many stands across the Plan Area, on both dry and moist sites, given the prevalence of closed-canopy structures. Coarse woody debris loads vary throughout the Plan Area, and are generally higher in more productive stands on moist sites and

[12] Descriptions of each BEC zone and information about the system's development can be found at: https://www.for.gov.bc.ca/hre/becweb/. BEC System citation: Meidinger, D. and J. Pojar. 1991. Ecosystems of British Columbia. BC Ministry of Forests, Victoria, BC.

aspects. Areas that have experienced past harvesting, insect and disease outbreaks, and/or windthrow also exhibit locally higher surface fuel loadings.

Overall the productive nature of the forests in the Plan Area is such that fuels loadings are very high and continuous, both vertically and horizontally. The relatively moist climate and predominantly closed forest canopies across the region often keep both aerial and surface fuels sufficiently moist to limit their ability to burn under average conditions. However, when conditions align such that fuels are widely available, the structure of these forests is such that crown fires can be easily propagated, and large, aggressive wildfire growth is possible—particularly with a changing climate.

2.7.2 FIRE REGIME CLASSIFICATION AND DESCRIPTION

Classifying fire regimes in transitional and interior wet belt forest types such as those found in the North Thompson region is challenging, and few fire history studies have been conducted in similar forests across western North America. Research suggests that available classification schemes in BC may inadequately capture the fire regime variability in these complex forest types (Marcoux et al. 2013). Fire regime classification in southern British Columbia is currently based on local BEC subzone variants using the following two systems:

- Natural Disturbance Type (NDT) classification system[13], and
- Historical Natural Fire Regime (HNFR) system (Blackwell and Gray 2003).

The HNFR system was primarily utilized to understand fire patterns in the AOI, though classifications under both systems are reported.

Based on biogeoclimatic subzone and variant, the historical fire regimes within the Plan Area are generally mixed severity, meaning both stand-replacing and stand-maintaining fire effects have tended to occur in most locations. However, the relative proportion of low, moderate, and high severity, and typical fire frequency has and will continue to vary considerably in both space and time across the landscape. Portions of the Plan Area within the IDF BEC zone are classified as being subject to either HSFR I or II, representing a fire regime of low to mixed severity with a return interval of 0 – 35 years. Under NDT, these ecosystems are classified as NDT4, representing frequent stand-maintaining events. Areas within the ICH zone are classified as either HSFR II or IV, or V, representing a mixed severity fire regime with frequencies ranging from 0 – 35 years to 35 – 100 years, depending on aspect and topography. Under NDT, these areas are classified as NDT2 or NDT3, infrequent to frequent stand-initiating events. Within the ESSF, fire regimes in the Plan Area are classified among HSFR V, VI and VII,

[13] BC Forest Practices Code, Biodiversity Guidebook. https://www.for.gov.bc.ca/hfd/library/documents/bib19715.pdf.

representing mixed to high severity fire regimes at frequencies ranging from 35 – 200+ years, and NDT 1 and 3, representing frequent to rare stand-initiating events.

The distribution of these classifications can generally be understood based on aspect and elevation gradients in prevailing vegetation and fuel moisture. Historical fires would have generally been more severe and less frequent on wetter aspects and at higher elevations where summer conditions tend to be more moderate, forests are more productive, and prevailing species are less resistant to fire. Historical fire severity would generally have been lower and fires would have been more frequent on drier aspects and at lower elevations, where summer conditions are more favorable to fire growth, species tend to be more fire adapted, surface fuels are more conducive to fire spread and widely available to burn, and overall fuel loadings tend to be lower.

Generally the majority of historical fires within the Plan Area would have been small and burned with mixed severity within a single event, exhibiting both surface and crown fire behavior due to the local variability in vegetation and topography. These fires would have left behind a mosaic of burned and unburned areas, and generated a complex patchwork of different forest types across the landscape. A smaller subset of historical fires—primarily in drier areas of the Plan Area—would have burned purely as surface fires, removing understory trees not yet large enough to be resistant, pruning low branches that act as ladder fuels, and reducing the buildup of surface fuels. Frequent surface fires tend to promote spaced stands with high a canopy base height and low surface fuel loadings that are generally more resistant to crown fires. Such stands would have been most common in the Plan on southerly aspects at lower elevations. Particularly in these areas, fire exclusion may have allowed forests to become more dense and continuous, increasing the crown fire risk. Another subset of fires, particularly those burning under more extreme conditions at higher elevations and on moister sites, would have been large and burned with primarily stand-replacement severity, promoting even age regeneration and denser stand structures.

Across all fire regime types in the Plan Area, fire exclusion may have altered the forest mosaic such that aerial and surface fuels are far more continuous than they would have been historically, and fuel loading may be elevated in some areas—particularly drier areas historically subject to more frequent fires. Although forest harvesting has created a patchwork a younger stands across the landscape, these activities generally produce a much higher residual fuel load than is typical of burned areas. While higher-severity fires would have primarily left behind fire-hardened tree boles in larger size classes, logging slash often consists of debris in both fine and coarse sizes, and produces an excellent fuelbed for ignitions by both lightning and humans. While a landscape that includes past fire scars tends to resist the flow of future large fires and moderate burn severity (Stevens-Rumann et al. 2016; Prichard et al. 2018), a landscape mosaic primarily created by harvesting may not act as a barrier to fire spread in the same manner (Stone et al. 2008).

Land managers in the region will need to incorporate historical fire regimes and climate change predictions into their planning to best enhance and maintain the ecological resilience of this landscape and mitigate wildfire risks to the many values present within the Plan Area.

2.7.3 OTHER NATURAL DISTURBANCES AND INTERACTIONS

In addition to fire, insects, pathogens, and windthrow also impact forests within the Plan Area. These disturbances can interact with fire in a significant and sometimes unpredictable manner. Other disturbances can increase fire risk by augmenting fuel loads and surface fuel drying, and fire can contribute to other disturbances by creating favorable or unfavorable conditions and altering forest structure and composition.

In mixed-species stands containing lodgepole pine, outbreaks of the mountain pine beetle *(Dendroctonus ponderosae)* (MPB) have caused pockets of significant mortality where susceptible trees were located in sufficient density. As impacted trees died and fell to the surface, canopy gaps of varying sizes were formed, increasing light penetration and surface fuel drying in affected areas. Downed logs created by MPB attack have also acted to increase surface fuel loading of needles and coarse woody debris. The Plan Area is also increasingly affected by outbreaks of the Douglas fir bark beetle (*Dendroctonus pseudotsugae)* (DFB), and these impacts are expected to increase with climate change (Woods et al 2010). DFB generally targets weakened or dying Douglas fir trees, though may also opportunistically target healthy mature trees when conditions are favorable. Outbreaks of DFB can increase fuel drying and surface fuel loading in a similar manner to MPB outbreaks, as well as decrease forest resilience by targeting large diameter trees that are generally most resistant to fire.

Root diseases are also a significant concern within the Plan Area, and affect multiple coniferous species including Douglas-fir and western redcedar. Mortality associated with pathogens can have a similar impact to fuel loadings as that associated with insect outbreaks, and also has major implications for harvest and fuel treatment methodologies. Strategies to reduce the risk of root disease following fuel treatment are discussed in the **Management Strategies** provided with this plan under separate cover.

Windthrow in the Plan Area is most common on wetter sites with shallow-rooted species such as western redcedar and hybrid spruce. Areas that have experienced significant windthrow generally exhibit high surface fuel loadings of coarse woody debris, and may exhibit larger canopy gaps that accelerate surface fuel drying and encourage grass growth. Windthrow risk must also be considered when planning fuel treatments and any partial-retention harvesting within the Plan Area.

2.7.4 FIRE HISTORY

Although the location of future ignitions is difficult to predict with accuracy, a review of historical fire ignitions and spread can reveal patterns with implications for management decisions.

Historical fire polygons shows that significant fires have been largely absent from the Plan Area since the 1950s (See Figure 3). While ignitions data (Figure 4) show that 393 fires have started in the Plan Area since that time, nearly all have been immediately suppressed. No fires larger than 100ha have occurred in the Plan Area since 1974, with the largest fire since that time being a 68.5 ha human-caused fire in 2006. Recent fires (2015-present) have all been successfully suppressed prior to exceeding 1ha in size.

The most significant fire to occur in the region in recent history was the McClure fire of 2003 (large brown polygon bordering the Plan Area boundary to the southwest, which ignited down canyon in the community of McClure and burned 27, 137ha, progressing primarily north along the North Thompson

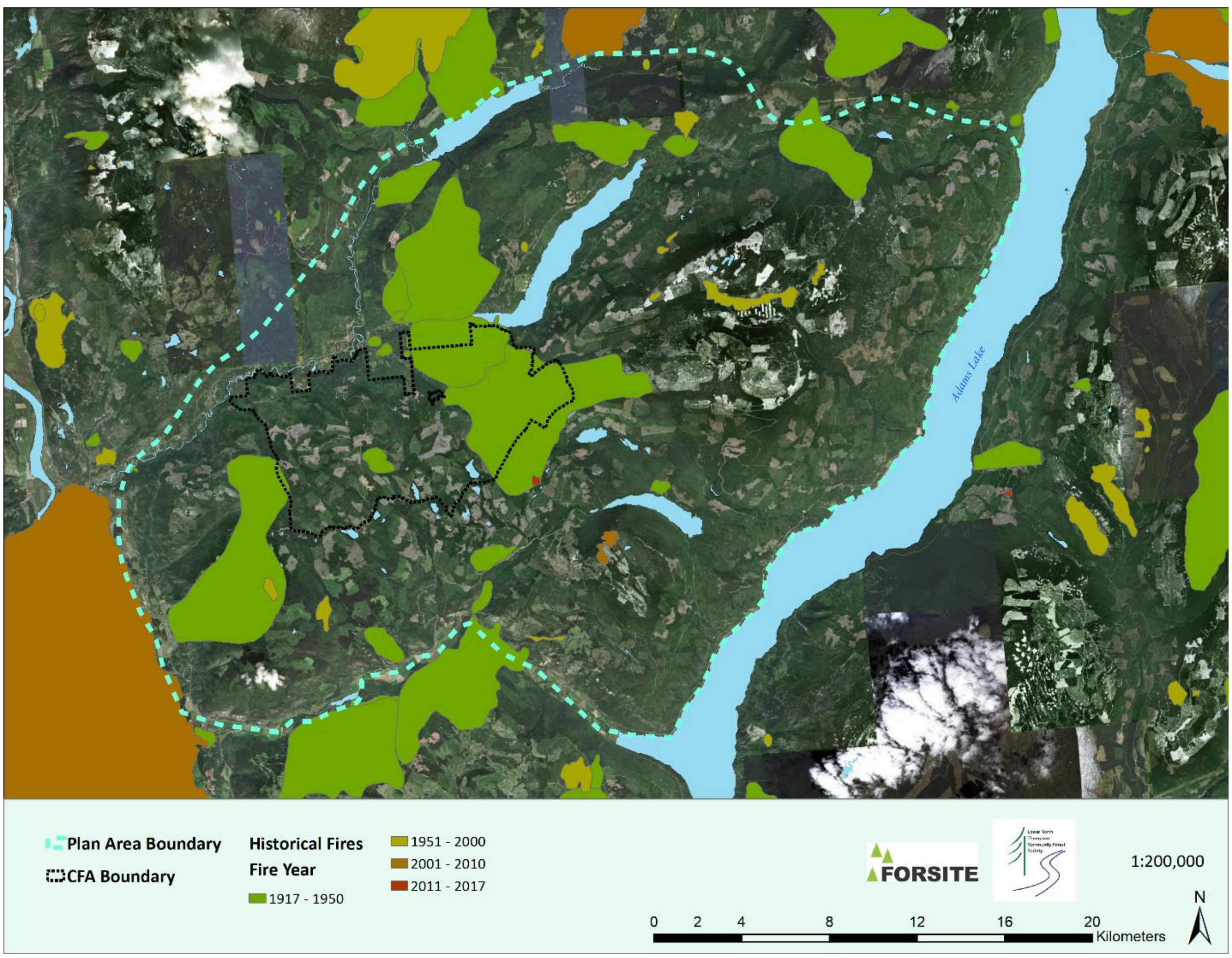

Figure 3: Historical Fire Polygons by Fire Year

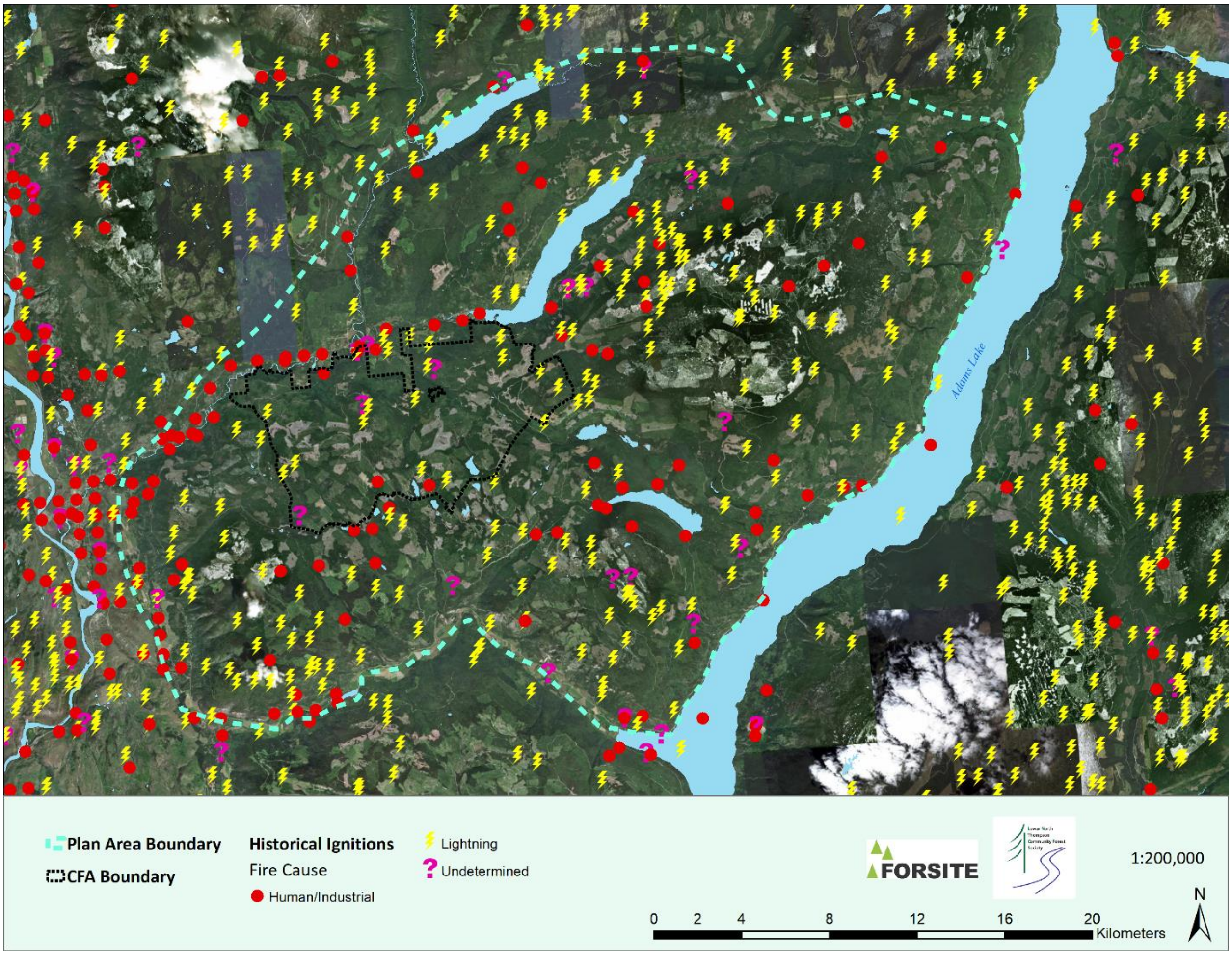

Figure 4: Historical Ignition Points by Cause

River valley. This fire triggered multiple evacuations, traffic closures, and power outages, and burned with high severity in many areas. Although this fire did not impact the Plan Area, its burn scar has the potential to influence the incidence and spread of future fires in the region. The daily fire progression patterns of this event can also speak to the effect of winds and topography on fire behavior in the North Thompson area.

Fires in the Plan Area have historically been caused by both lightning (62%)[14] and human activities (38%), and ignitions of both types have occurred across nearly the entire Plan Area. Human-caused fires, however, have been most frequently ignited in valley bottoms along development corridors, suggesting that the western and southern edges of the Plan Area—along Highway 5 and Adams Lake Rd, respectively—and the road corridor leading to East and North Barriere Lakes are at the highest risk for

[14] Percentages given are for the subset of fires for which a cause was determined. A cause was not determined for 21 of the 393 fires recorded in the Plan Area since 1950.

human-caused fires. Lightning densities within the Plan Area are most concentrated at upper elevations on exposed ridges and plateaus, particularly in the section of the Plan Area to the east of East Barriere Lake. Lightning and human-caused ignitions are also common in the greater region outside the Plan Area, with particularly high densities of human-caused ignitions along Highway 5 and railway lines.

Together these data suggest that fire starts may be most likely in the western half and northeastern corner of the Plan Area, though ignitions are possible throughout. Relationships between the ignition data described here and the fire weather patterns described in the following section were considered when developing the **Management Strategies** associated with this Plan (provided under separate cover). Ignition densities are also a component of the modified burn probability process used to spatially analyze wildfire risk across the Plan Area (Section 3.1).

2.7.5 FIRE WEATHER

Patterns in multiple variables can be used to evaluate fire weather in the Plan Area. Depending on the composition, size distribution, and arrangement of fuels, the weather conditions leading up to and at the time of an ignition will determine whether fuels are sufficiently dry ("available") to burn. The availability of fuels to burn across a landscape is a major driver of subsequent fire behavior and ignition probability. Temperature and relative humidity are particularly important determinants of fuel moisture, and thus critical variables to consider. Wind patterns relative to topography can also play a driving role in fire behavior and the direction of fire spread: fires tend to spread most rapidly and readily upslope and downwind, due to physical properties of combustion. This phenomena is of particular relevance in the Plan Area, as the topography is generally steep and strongly-defined by deep river canyons that also funnel winds.

The BCWS employs the Canadian Forest Fire Weather Index (FWI) System to characterize raw weather data into meaningful ratings and understand changing fire behavior potential throughout the season[15]. The FWI is comprised of 5 component indices which combine to determine the final FWI ranking on a given day. Of these, the Fine Fuel Moisture Code (FFMC), Build-up Index (BUI), and Daily Severity Rating ("Danger Rating") are particularly useful for understanding relative fire danger as it varies across the season. The FFMC is a numeric rating of the moisture content of litter and other cured fine fuels. This code is an indicator of the relative ease of ignition and the flammability of fine fuel. The BUI is a numeric rating of the total amount of fuel available for combustion. It combines the Duff Moisture Code (DMC) and the Drought Code (DC)—indicators of moisture levels in deeper ground layers—and can be useful for understanding how available larger surface fuels, duff and ground fuels, and aerial fuels might be to

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[15] https://cwfis.cfs.nrcan.gc.ca/background/summary/fwi.

burn on a given day. The Danger Rating is a numeric rating of the difficulty of controlling fires. It is based on the final FWI value but more accurately reflects the expected efforts required for fire suppression.

The typical fire season in the Plan Area lasts from April – October at lower elevations and June through October at higher elevations, and thus this weather discussion is limited to values from these months. The timeframe of analysis was also generally limited from 1996/2000 (wind/temp, RH, FWI respectively) to 2019, to reflect modern weather conditions and utilize data obtained with the latest instrumentation. All weather and FWI values reported below were obtained from the East Barriere and Cahilty weather stations. The East Barriere station is located at 671m in elevation in the northern portion of the Plan Area, in an east-west-running valley near East Barriere Lake. Wind patterns at this station are influenced heavily by this topographic position, and tend to be funneled by the valley walls. Temperatures, relative humidities, and FWI associated with this station are most representative of lower elevation portions of the Plan Area. The Cahilty weather station is located on a high plateau south of the Plan Area at 1615m elevation. Wind patterns at this station are more exposed to prevailing regional patterns, and temperatures, relative humidities, and FWI recorded at this station are most representative of higher elevation regions of the Plan Area, and topographic positions above valley and canyon slopes.

Fire weather in the Plan Area is generally most critical in July and August, when temperatures are at their highest and relative humidities are at their lowest (see Figure 5). August also tends to be the driest month, with the lowest average daily precipitation amounts, and the most days without precipitation at both low and high elevations. FFMC, BUI, and Danger Ratings are also most frequently above critical thresholds set by the BCWS[16] in these months—though critical fire weather does occur in all months of the fire season at lower elevations, and from May – October at higher elevations.

A review of Fire Season (April – October) ISI Roses[17] for both weather stations revealed that critical winds (those associated with high Initial Spread Index (ISI) values) most frequently originate from the west through southeast in the Plan Area (see Figure 6), and secondarily from the northwest, though winds were recorded from all directions over the analysis period. This pattern is common in this region of the province, as larger-scale weather systems often originate over the Pacific Ocean and produce winds that begin from the west and south, eventually swinging around to the northwest as systems

[16] Schedule 2[am. B.C. Reg. 206/2005, s. 15.] Fire Danger Class (Section 6); Danger Region 1.

[17] Developed by the BCWS and available from https://www.for.gov.bc.ca/ftp/HPR/external/!publish/Website/ISI%20Roses/. Accessed January 8, 2019.

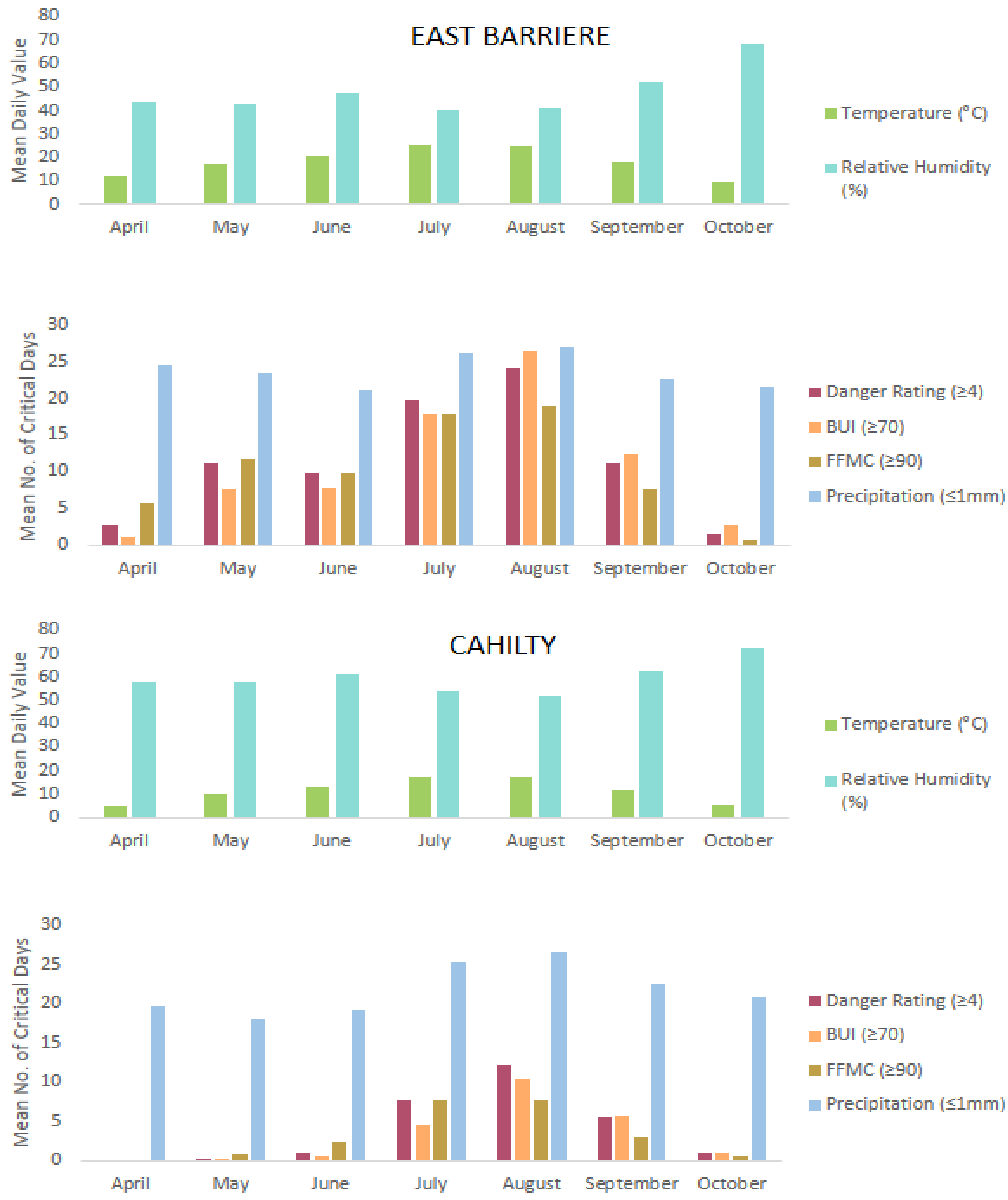
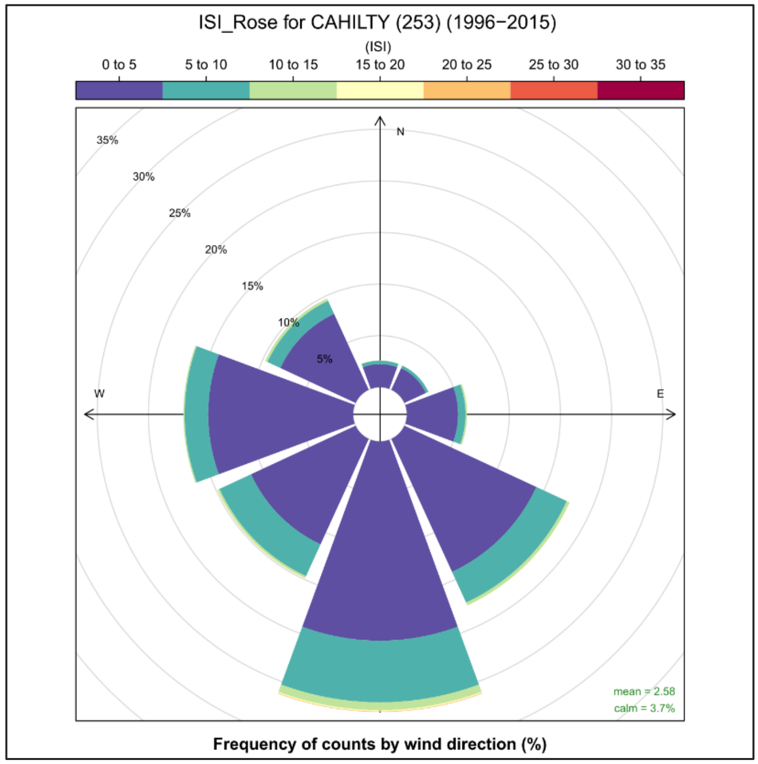


Figure 5: Weather Data Summary

move on. Locally, as these winds interact with the topography, they can become funneled and directed by pronounced features, sometimes producing very strong winds that align with the axis of river canyons and larger valleys. This pattern is evident at the East Barriere station: the prevailing winds in the area are re-directed by the east-west valley in which the station is situated, translating into winds being predominantly recorded from the west, and less frequently from the east or off-axis directions. At the Cahilty station, in contrast, a greater variety of observations are recorded, though the prevailing and critical pattern is for winds from the west through southeast.

Daily ("diurnal") winds may also have an influence on observed rose patterns and fire behavior. Although relatively predictable on their own, these winds can also interact with those generated by larger regional-scale weather events in complex ways. Caused by differential solar heating across the landscape relative to topography, diurnal winds are typically described in inland locations by a pattern of mild to moderate "slope" and "valley" breezes. In the absence of a larger overriding weather event like a cold front or a thunderstorm, morning winds in rolling and mountainous terrain tend to be downslope and down-valley, and will eventually switch by mid-day to being upslope and up-valley until evening. After the sunset as temperatures cool, downslope and down-valley flow resumes. This pattern is also evident in the Hourly ISI Roses available for



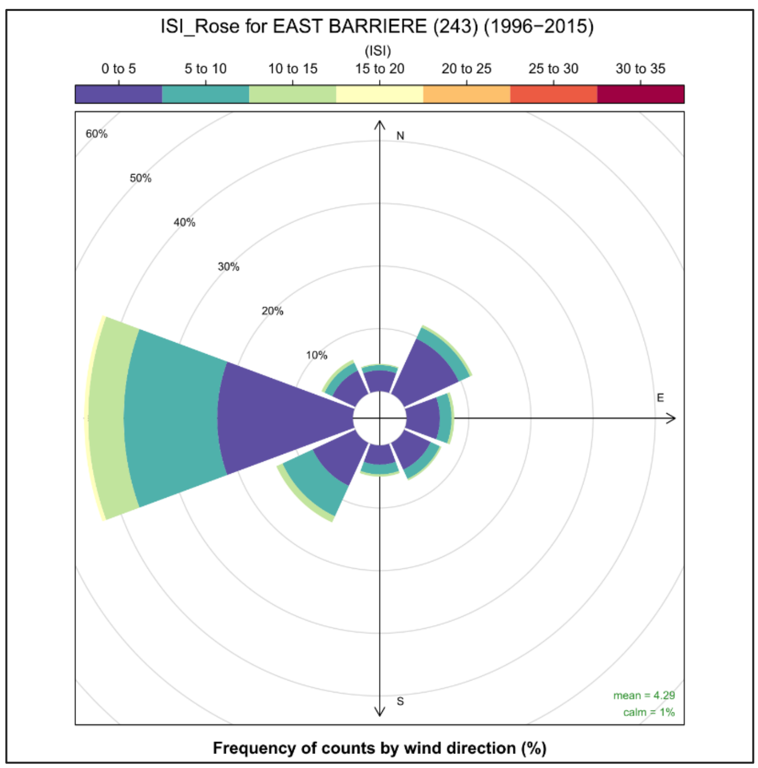


Figure 6: Fire Season ISI Roses

both weather stations. Wind directions and ISI values recorded in the mornings and evenings at both stations tend to differ from those recorded at mid-day, and these patterns align with valley and slope orientations at both locations.

At a regional scale, large scale “synoptic” weather events such as cold fronts and large thunderstorm systems are often those responsible for producing the strongest winds and driving large fire growth (Werth et al 2016). In the south-central interior of BC, critical fire weather is often associated with 1) a long drying period while high pressure systems sit over the region, beginning typically in June, followed by 2) the breakdown of the this “upper ridge,” in the fall, allowing storms from the west to pass through the area, often bringing strong winds and dry lightning (Johnson et al 1990). Thunderstorms and smaller weather systems can also bring strong, erratic winds and lightning to the region throughout the season. It is important for local fire suppression resources and first responders to become familiar with local critical fire weather patterns, to best anticipate periods when fire danger is likely to be elevated and aggressive fire behavior is possible.

Overall, wind analysis for the Plan Area indicates that large fire spread is most likely to progress from south to north and upwards along canyon and valley axes. An ignition within any portion of the Plan Area also has the potential to impact values in the remainder of the AOI, given that winds of all compass directions are typically recorded each month, and fires have the capability to back against and flank along the prevailing wind direction and slope, though typically with less intensity and speed as when wind and slope align. Although this wind data can provide valuable insights as to wind patterns in the Plan Area, it is also important to note that local winds are likely to vary considerably across the landscape and over time, given the incised and complex nature of the topography and a changing climate. Daily slope and valley wind patterns will interact with larger-scale regional weather systems to produce the observed winds at a particular location at any given time, and the future may hold vastly different patterns than those observed today.

2.7.6 CLIMATE CHANGE

Climate change has the potential to significantly increase the frequency, size, and severity of fires within the Plan Area and threaten forest and community resilience. According to the BC Climate Risk Assessment completed by the Ministry of Environment and Climate Change Strategy in 2019[18], severe wildfire seasons are currently among the highest-rated risks to the province. The report found that an increase in severe seasons is likely and the consequences will be major to catastrophic. Confidence in these predictions is high.

[18] https://www2.gov.bc.ca/assets/gov/environment/climate-change/adaptation/prelim-strat-climate-risk-assessment.pdf

Across BC, the most critical predicted impacts of climate change on forest ecosystems include but are not limited to:

- Increased occurrence of severe moisture stress and insect infestations which may lead to increasing tree mortality and reduced resilience (Woods et al. 2010);
- Shifting of climatic envelopes faster than currently present tree species can adapt and migrate their ranges, potentially resulting in reduced forest productivity and resilience (Hamann and Wang 2006); and
- Longer and more severe fire seasons associated with hotter and drier conditions, more extreme weather events, and increased thunderstorm activity (Wang et al. 2016).

Within the Plan Area, Global Climate Model (GCM) predictions for the Thompson-Nicola region generally indicate that summer conditions will grow hotter and drier over the coming decades[19]. Mean temperature is predicted to increase by 1.8 °C by 2050, and summer precipitation is predicted to decrease by 8%. These changes mean that forest fuels will likely become dry enough to burn more frequently, increasing the likelihood of large fire growth and higher fire severity. The longer predicted dry period could also increase the length of fire seasons, stretching the capacity and endurance of first responders and emergency response budgets. Changes to the soil water balance associated with hotter temperatures, reduced precipitation, and longer dry seasons could also reduce forest resilience by pushing trees outside their climatic envelope, making them more susceptible to insect-, disease-, and drought-related mortality, creating a positive feedback loop.

A study conducted in forest types similar to those found in the Plan Area (Riley and Loehman 2016) found that mid-21 century climate change scenarios are likely to increase area burned, increase individual fire size, reduce the number of years between large fire events, and increased the incidence of high fire danger days, which are often associated with large fire growth and aggressive fire behavior. Similarly Wang and colleagues (2016) found in their study of the Thompson – Okanagan region of BC (south of the Plan Area) that climate change was likely to significantly increase burn probability due to an increase in fire starts and fire-conducive weather conditions.

Many forests in the Plan Area are very productive and large amounts of biomass are present across the landscape. The incidence of large aggressive wildfires is currently limited, however, by the relatively moist climate, despite the presence of substantial amounts of continuous fuels. As the climate shifts, this dynamic is likely to change, and the incidence of time periods when these fuels become dry enough to burn will increase. Once the scales are tipped such that large portions of the Plan Area are available to burn simultaneously, large and extremely destructive wildfires could result. This potential was well illustrated by the McClure Fire of 2003, which caused large-scale evacuations and made substantial runs

[19] Pacific Climate Impacts Consortium (PCIC) Plan 2 Adapt tool. https://www.pacificclimate.org/analysis-tools/plan2adapt. Report generated December 4, 2019.

over its duration. Future large fires could exceed the historical range of variability in both size and severity, and challenge suppression efforts at great financial, ecological, and human cost.

Fire and forest managers responsible for the Plan Area and their regional partners should not delay in enacting wildfire risk mitigation activities simply because large wildfires are presently uncommon. The current incidence and behavior of fires may greatly underrepresent the risk that is present on this landscape, and mitigation activities take substantial time to enact. A proactive approach that does not wait for the climate to shift is strongly encouraged. This WRMP is an important step towards a more resilient landscape, but creation of the plan alone cannot mitigate the risk without subsequent action.

2.8 KEY TRENDS

A series of key trends will influence wildfire risk management in the Plan Area in the next 5 years:

- Fire exclusion and forest health epidemics have altered forest fuels such that there may be an increased incidence of larger and more severe wildfires;
- Climate change may influence wildfire frequency and behavior;
- Fire management paradigms may shift to increasingly utilize wildland fire as a strategic tool in the management of ecosystem resilience and landscape-level wildfire risk;
- Land use and population levels may continue to increase across the Plan Area both within and outside of existing communities; and
- Forest management activities may continue to have a significant impact on the structure and composition of wildland fuels within the Plan Area.
- Collaboration and partnership may be increasingly required to deal with complex landscape-level wildfire risk conditions.

3 Risk Identification

The LNTCF WRMP follows the principles of risk management found in the *CAN/CSA-ISO 31000-10 Risk Management – Principles and Guidelines*. Risk identification is a component of the risk assessment that considers both the *likelihood* and the *impact* of wildfire through modeling. Multiple spatial data analyses were used to support Risk Identification for this WRMP, and these are detailed in the sections below. All spatial data and digital information pertaining to Risk Identification was provided to the LNTCF as a deliverable of the WRMP.

Defining and communicating the meaning of risk as it applies to the LNTCF WRMP underpins a common understanding of the process utilized and the development of appropriate management strategies that flow from risk assessment. In the context of this WRMP, risk management:

- Identifies and protects value;
- Is part of decision-making;
- Explicitly addresses uncertainty;
- Is based on the best available information;
- Is transparent and inclusive; and
- Is dynamic, iterative, and responsive to change.

3.1 MODIFIED BURN PROBABILITY

The LNTCF WRMP process utilized a modified burn probability methodology to support the analysis of wildfire risk. This approach combined an ignition probability analysis with the headfire intensity (HFI) layer from the Provincial Strategic Threat Analysis (PSTA) dataset[20] to determine the modified burn probability for the Plan Area.

A kernel density analysis of fire history data was partially used to determine ignition probability. This distance-dependant tool is limited in its ability to account for other independent variables and relationships[21]. In addition, a robust burn probability model differs from fire history data analysis due to its dependence on spatial and temporal factors[22]. It is for this reason the analysis was referred to as a “modified” burn probability.

[20] Ver. 2019; provided by the BCWS.

[21] https://koreauniv.pure.elsevier.com/en/publications/estimating-the-spatial-pattern-of-human-caused-forest-fires-using

[22] https://www.sciencedirect.com/science/article/pii/S0378112705000563

3.1.1 IGNITION PROBABILITY

Ignition probability was determined using a 20 x 20 meter (0.04 hectare) raster analysis in ESRI ArcGIS. Ignition probability was analyzed using the following three (3) inputs (sub-components of ignition probability):

1. Lightning-Caused Fires – from the Provincial Fire Starts dataset, lightning-caused fire starts from 1950 to 2017 were analyzed with a kernel density analysis[23].
2. Human-Caused Fires – from the Provincial Fire Starts dataset, human-caused fire starts from 1950 to 2017 were analyzed with a kernel density analysis[24].
3. Proximity to Roads and Motorized Trails – this was analyzed using a series of distance based classes from the spatial indicator (Table 1).

The ignition probability for a particular area was determined by calculating the weighted sum of these sub-components (fire starts and proximity to roads). Each of these sub-components have a different

DATA SOURCE	CATEGORY BY PROXIMITY CLASS				SUB-COMPONENT WEIGHT
	0-100	100-250	250-500	500+	
MOTI ROADS	10	8	6	4	40
PERMITTED ROADS	8	8	6	4	30
OTHER ROADS	8	8	6	4	20
TRAILS	6	6	6	2	10

Table 1: Road Proximity Framework

[23] https://pro.arcgis.com/en/pro-app/tool-reference/spatial-analyst/how-kernel-density-works.htm

[24] Both human- and lightning-caused wildfire kernel density layers are then normalized from 1 through 10. Normalization does not change the kernel density results, instead it allows the many GIS analysis layers to be combined evenly for systematic incorporation in the broader model.

influence on ignition probability and therefore were weighted based on this relationship. Ignition potential based on fuel type was not incorporated into the analysis. For the Plan Area, it was assumed that represented forest types have a similar probability of ignition based on data for fire weather days from representative weather stations and historical fire patterns.

3.1.2 HEADFIRE INTENSITY

Headfire intensity (HFI) is a subset of the PSTA data provided by the BCWS[25]. This layer incorporates provincial weather station data, fire weather index, elevation, and Fire Behaviour Prediction fuel types to determine the intensity of a fire during peak burning season weather conditions. Headfire Intensity is the predicted energy output at the fire front measured in kilowatts per meter (kw/m). At 2,000 kw/m fire intensity surpasses the capabilities of ground crews, with 4,000 kw/m being the threshold for air attack effectiveness. At 10,000 kw/m heavy water bombers become ineffective for fire suppression[26].

The HFI was normalized into 10 distinct classes in order to be combined with the ignition probability. The PSTA datasets defined HFI into classes, however some of these classes were not present within the Plan Area. Therefore, the source HFI dataset was reclassified into 10 distinct classes and as a result, the HFI classes used in this analysis are not reflective of the PSTA data classes. This resulting HFI layer was used as a measure of fire behavior, with the assumption that a more intense fire front would have a greater negative impact on values at risk.

3.1.3 ANALYSIS

A modified burn probability was generated for the Plan Area through the combination of the ignition probability data and HFI layer described above (Table 2 summarizes this approach). Ignition probability data made up 60% and HFI 40% of calculated probabilities. The rationale for this weighting scheme was based on the understanding that ignition density and frequency are often more significant drivers of burn probability than expected fire intensity. To confirm this approach, a sensitivity analysis was completed using two (2) additional model runs: 1) equal weighting (50/50), and 2) HFI-driven (60% HFI, 40% ignition). After review with BCWS, the ignition-probability-driven approach (60% ignitions/40% HFI) was determined to be the most appropriate.

[25] For more information on the headfire intensity layer see the BCWS PSTA overview at: https://www2.gov.bc.ca/gov/content/safety/wildfire-status/prevention/fire-fuel-management/psta

[26] http://iopscience.iop.org/article/10.1088/1748-9326/aa7e6e/pdf

COMPONENT WEIGHT (%)	SUB-COMPONENT WEIGHT	DESCRIPTION	DATA SOURCE
IGNITION PROBABILITY (60)	LIGHTNING-CAUSED FIRES (30)	Kernel density of lightning-caused fire-ignition points	BCWS Ignition points dataset
	HUMAN-CAUSED FIRES (50)	Buffered distance from roads and trails based on proximity class	See Table 1
HEADFIRE INTENSITY (40)	HEADFIRE INTENSITY (100)	PSTA Headfire Intensity Classes	Ver. 2019 BCWS PSTA Dataset

Table 2: Modified Burn Probability Analysis Framework

3.1.4 RESULTS

The results of modified burn probability analysis for the LNTCF WRMP are shown in Figure 7. These results represent **relative** modified burn probability within the Plan Area, and are not comparable to burn probability calculated using different methods, for a different analysis area, or at different scales—including any future provincial-level modelling.

3.2 IMPACT TO VALUES AT RISK

Consequences or impacts to values were evaluated for the four (4) BCWS RSWAP categories: (1) Human Life and Safety, (2) Critical Infrastructure, (3) High Environmental and Cultural Values, and (4) Resource Values. Spatial indicators of each of these value components were identified by the Planning Team. Impact criteria were then applied to these spatial indicators to estimate the maximum impact that could be realized across the Plan Area, in relation to the presence of these values in the event of wildfire.

Impact weightings were developed by the Planning Team in conjunction with BCWS based on the description and (where applicable) quantification of environmental, economic, social and operational consequences.

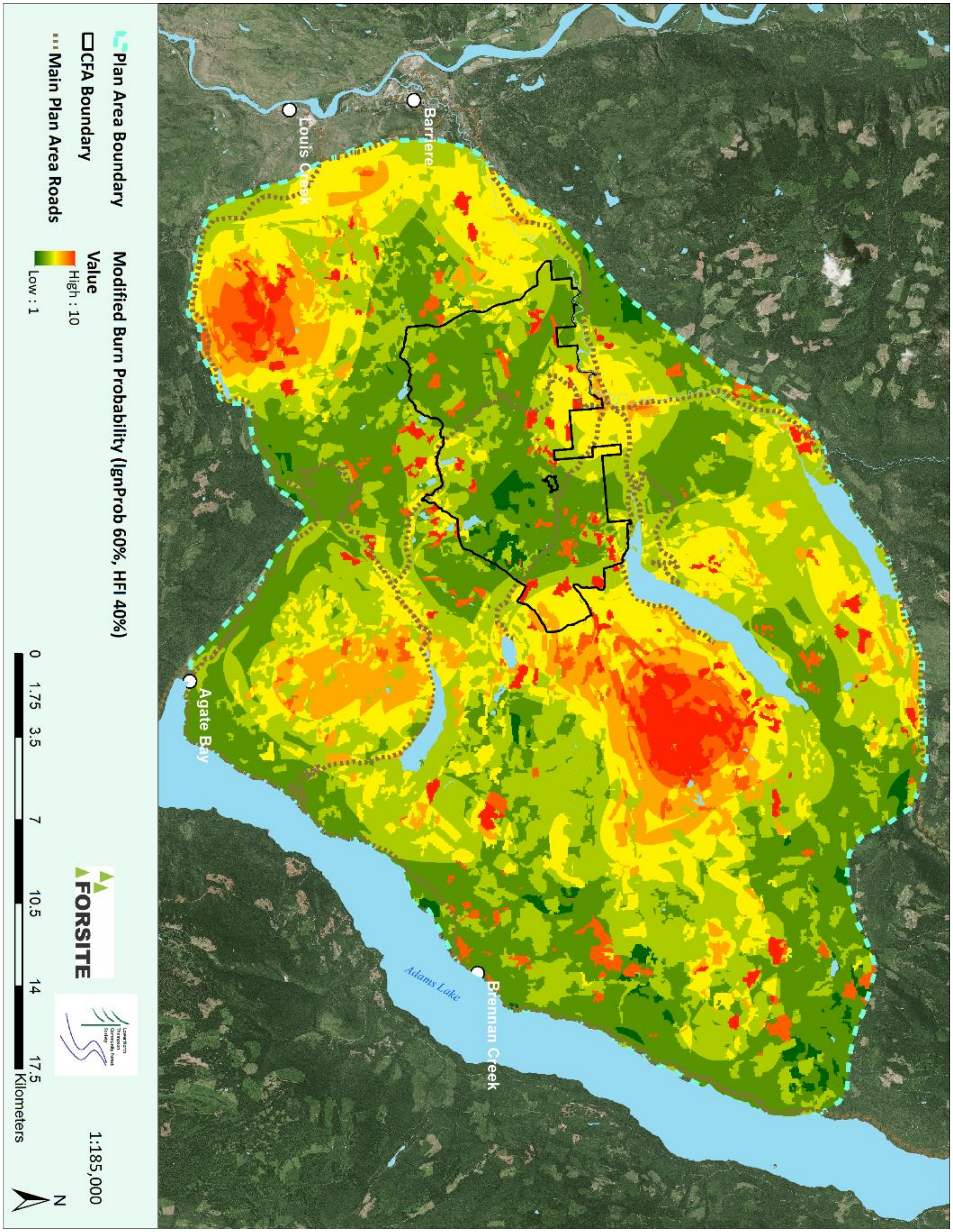


Figure 7: Modified Burn Probability Analysis for the Plan Area

1.1.1 IMPACT CRITERIA

The impact (consequence) of a wildfire can be described as "the outcome of the wildfire incident on objectives". The following was developed in conjunction with BCWS to determine the relative impact of a wildfire on a spatial indicator. The LNTCF WRMP and associated management strategies focused on "Highest", "Higher", and "Moderate" impacts (Table 3). This impact criteria table was used to support the Planning Team in identifying and analysing values at risk across the Plan Area, and applying a spatial indicator rating to each identified value in the analysis.

3.3 VALUES AT RISK IDENTIFICATION

Consequences or "Values at Risk" were identified for the LNTCF WRMP. The potential impacts to threatened values (those potentially negatively impacted by wildfire) were weighted ('ranked') as shown in Table 3.

The weighting of values was facilitated by a **Values Workshop (August 14, 2019)** that brought together local specialists in the areas of wildfire, biodiversity, range, ecology, First Nations, and land management. The workshop session identified subcategories for each of the four (4) RSWAP categories,

Level	Temporal Modifier	Spatial Scale	Spatial Indicator Rating	Key Words/Descriptions
Highest	Permanent	Regional	**10**	Irreversible; critical; permanent; extreme social, environmental, and/or economic impacts; substantial losses; large scale
	Long/Moderate	Regional/Local	**9**	
	Short	Local	**8**	
Higher	Long	Regional/Local	**7**	Extensive; threatened; long term; requires urgent intervention; disruption; major social, environmental, and/or economic impacts
	Moderate	Regional/Local	**6**	
	Short	Local	**5**	
Moderate	Long	Regional/Local	**4**	Reversible; manageable with time/effort; localized; significant social, environmental, and/or economic impacts.
	Moderate	Regional/Local	**3**	
	Short	Local	**2**	
Lower	NA	Local	**1**	Short term; reversible; temporary
Lowest	Immediate	Local	**0**	Insignificant; temporary

Table 3: Impact Criteria

and within these identified spatial indicators that could be used to represent these values. The importance of each of the indicators and the corresponding subcategories was then identified through a consensus-based weighting process that was generally based on the following factors:

- Perceived importance of the value to the public;
- Susceptibility of the threatened value to wildfire;
- Likelihood that the value or indicator would influence wildfire risk response; and
- Availability and scale of spatial data being used to reflect the value.

Spatial datasets that were represented by a point (e.g. residence) or a line (e.g. travel corridors) were buffered by 500 metres in the analysis to account for the area immediately adjacent to the value.

Through the workshop the group ranked each indicator's significance with a value between 0 and 10. This rank assigned to the individual indicators allowed for the recognition of the relative significance of one indicator when compared to another.

3.3.1 ANALYSIS

The rating of individual impacts (to values at risk) was used to estimate the consequence of wildfire occurring in a particular area. The values potentially threatened by wildfire were incorporated into a "values roll-up" that involved a GIS overlay of the individual spatial indicators. This values roll up represents potential impacts to values at risk. Two (2) layers were generated, maximum and cumulative values, to represented values at risk for use in the analysis and to support decision making within the Planning Team.

The "maximum values roll-up" shows the maximum value rating for a given raster cell regardless of total values represented within that area. For example, if an area had a residence with a rank of 8 and was within a trail corridor with a rank of 5, that area was given a ranking of 8. In addition, a "cumulative values roll-up" was created based on the cumulative rating of all values at risk within a particular area. In the previous example, this would result in a total ranking of 13 (8 + 5). Both of these "values roll-ups" were included in the wildfire risk analysis to support the Planning Team in evaluating risk and in determining which risks to respond to.

3.3.2 RESULTS

The results of the values roll-ups are shown in Figure 8 (maximum) and Figure 9 (cumulative). Based on the maximum value roll-up, key areas with values at risk tend to be identified where people reside

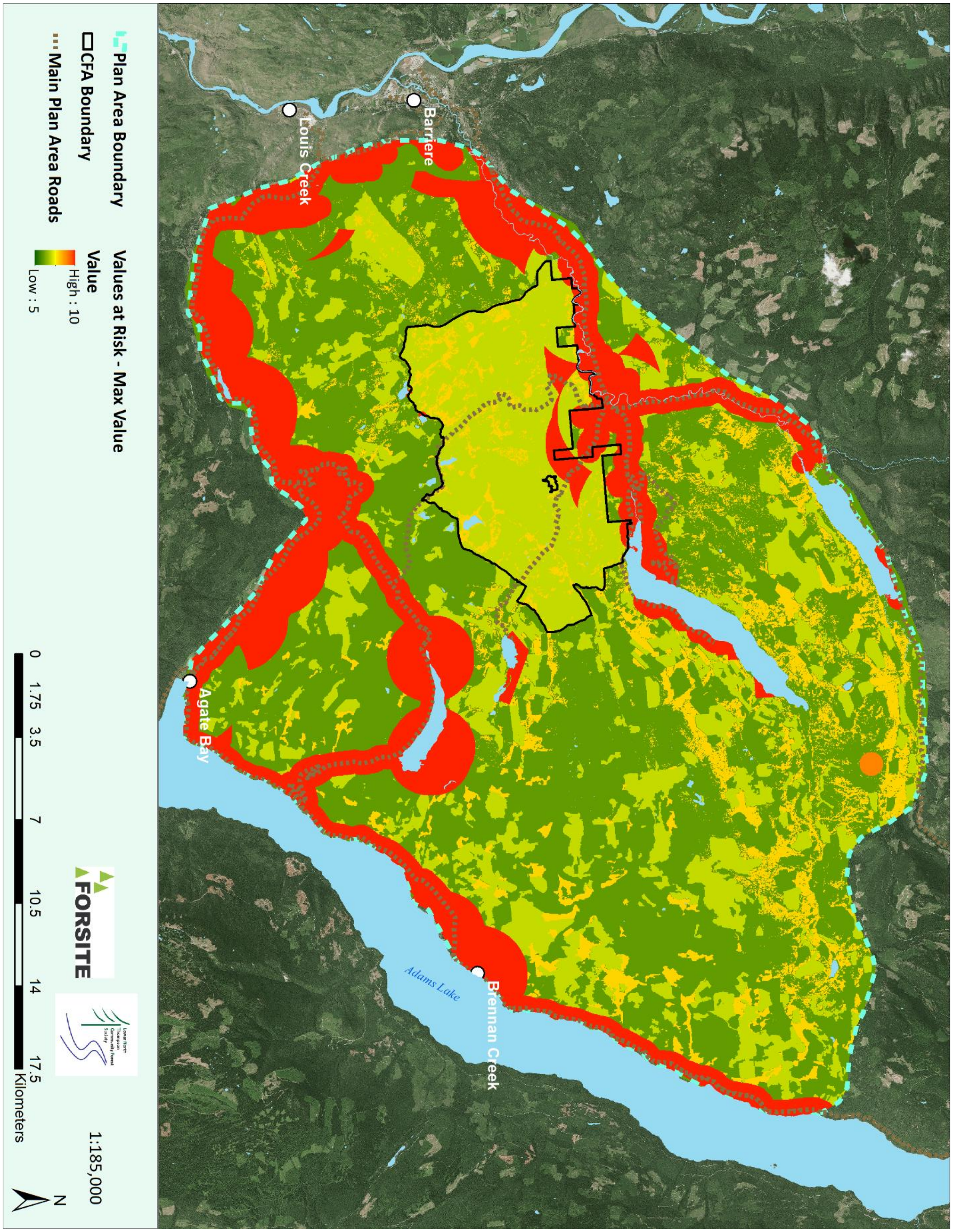


Figure 8: Values at Risk – Maximum Value Roll-Up

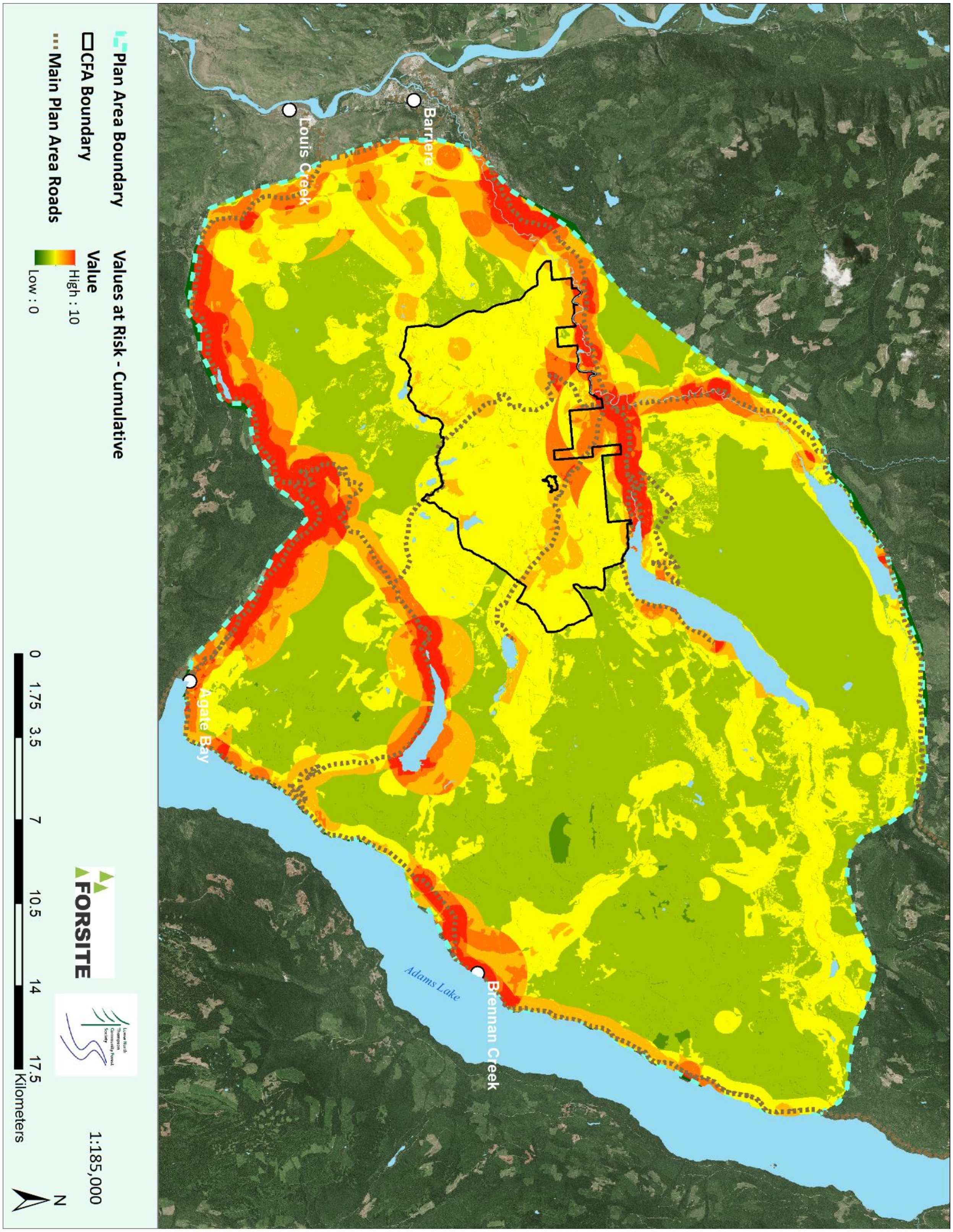


Figure 9: Values at Risk - Cumulative Values Roll-Up

(structures and residences) and along travel corridors. In the Plan Area, these are located along the west, south, and east margins, where road corridors access East and North Barriere Lakes, and Adams Lake. A major travel corridor of high values also exists along the access to Johnson Lake via forest service roads originating from the south and east edges of the Plan Area.

3.4 WILDFIRE RISK

Wildfire risk is the combination of the consequences (impacts) with the burn probability in accordance with the risk matrix (Table 4). This risk matrix equally combines the modified burn probability with the values at risk (50/50) to identify the overall wildfire risk for the Plan Area. For example, an area with "highest" modified burn probability and the "lowest" values at risk would result in a "moderate" wildfire risk. The risk matrix is colour coded based on the risk classes defined in Table 5 that documents the general acceptability and proposed response to the identified risk. This approach is based on the relative risk of one area compared to another, as opposed to a numerical classification scheme.

This process was completed using both the "maximum values roll-up" as well as the "cumulative values roll-up" to produce two wildfire risk maps (maximum and cumulative) to support the Planning Team in their evaluation of wildfire risk and to inform development of management strategies.

Values at Risk	Modified Burn Probability				
	Lowest	←		→	Highest
Highest					
↑					
↓					
Lowest					

Table 4: Risk Matrix

Colour Schema	Risk Classes
Highest	Highest – risk reduction should be considered
Higher	Higher – risk reduction should be considered
Moderate	Moderate – risk reduction may be considered
Lower	Lowest – risk may require no further treatment

Table 5: Risk Classification

1.1.2 RESULTS

The resulting wildfire risk is shown in Figure 10 where the maximum value roll-up was used, and in Figure 11 based on the cumulative value roll-up. While the maximum value roll-up provided support for the Planning Team in analysing and evaluating risks, the cumulative value roll-up (and subsequently the cumulative wildfire risk) was chosen to identify areas of focus for the recommended management strategies. The cumulative values roll-up represents all values within a particular area, therefore it is an additive process where the resulting values at risk shows the total impact of a wildfire occurring in that area. In contrast, the maximum value roll-up displays the maximum rating applied to an area but does not necessarily account for multiple values being present (and potentially impacted) in that area.

3.5 FIELD RECONNAISANCE AND SAMPLING

Field reconnaissance was conducted for this WRMP from July - September 2019 to complement spatial data analysis and assist in the development of management strategies. Forsite team members visited areas identified as having a high wildfire risk to ground-truth the risk analysis results and assess local fuel characteristics. A helicopter flight (July 3, 2019) was utilized to better understand how topography, fuels, and weather interact in the Plan Area, and to identify potential landscape corridors for fire spread.

Field sampling was also conducted to better understand how wildfire hazard and decomposition rates associated with harvest debris varied across the Plan Area according to elevation and aspect. Forsite team members completed assessments of 17 cutblocks of varying ages (0 – 15 years) and topographic positions. Results suggest that fuel hazard associated with residual harvest slash remains elevated for approximately 10 years or more in the Plan Area across aspects and elevations. This field sampling was limited and qualitative in nature, however, and thus results should only be considered a rough assessment of decay rates and their relationship to fire hazard. A more formal scientific process would be necessary to understand this dynamic with greater certainty. Details on field sampling methods and the complete results are found in Appendix A.

3.6 WILDFIRE OPPORTUNITY

The LNTCF WRMP analysis sought to identify areas or instances (opportunities) where benefits from wildfire could be realized. As a historically important disturbance process, wildfire (and/or management activities designed to emulate its effects) can provide valuable ecosystem services and enhance landscape resilience when managed appropriately.

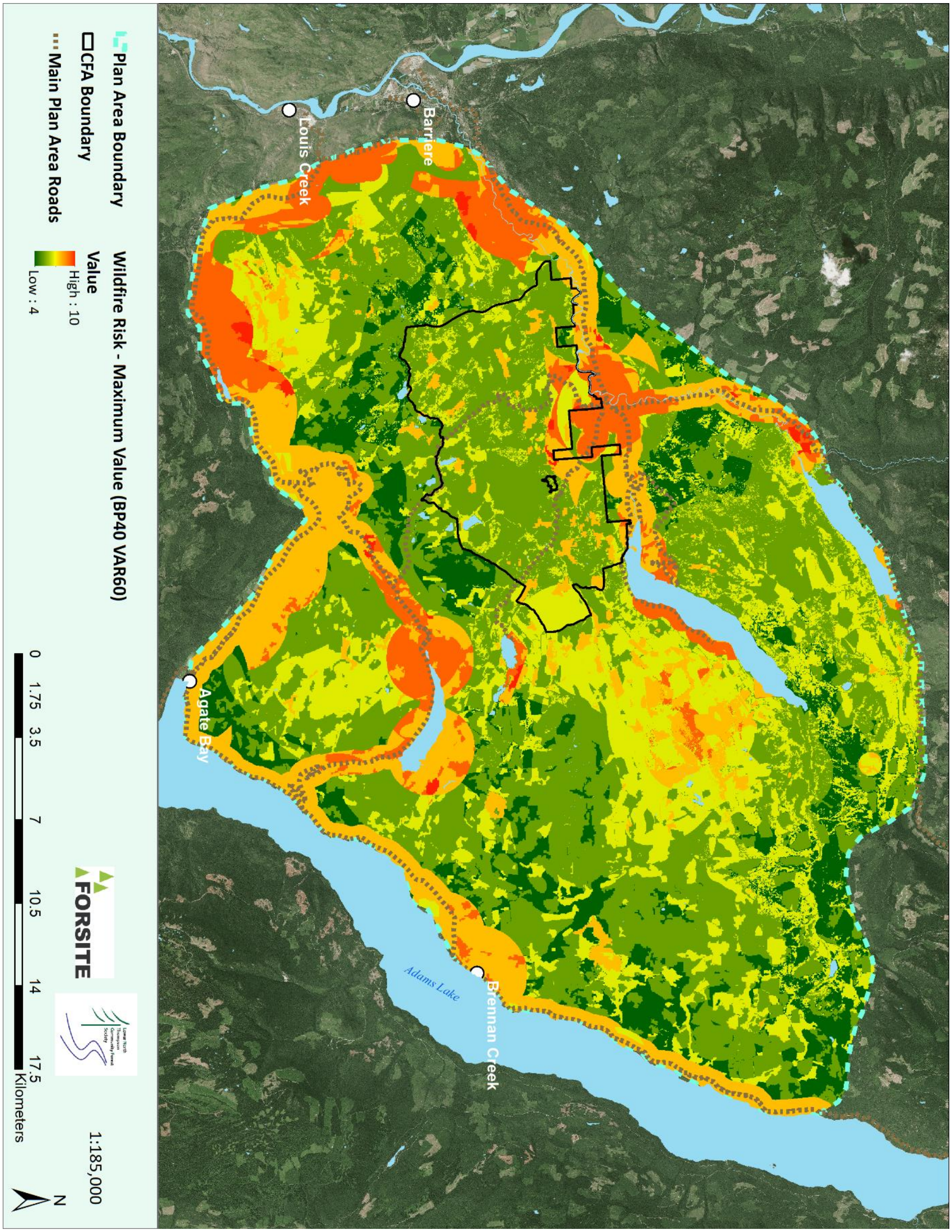


Figure 10: Wildfire Risk - Maximum Values Roll-Up

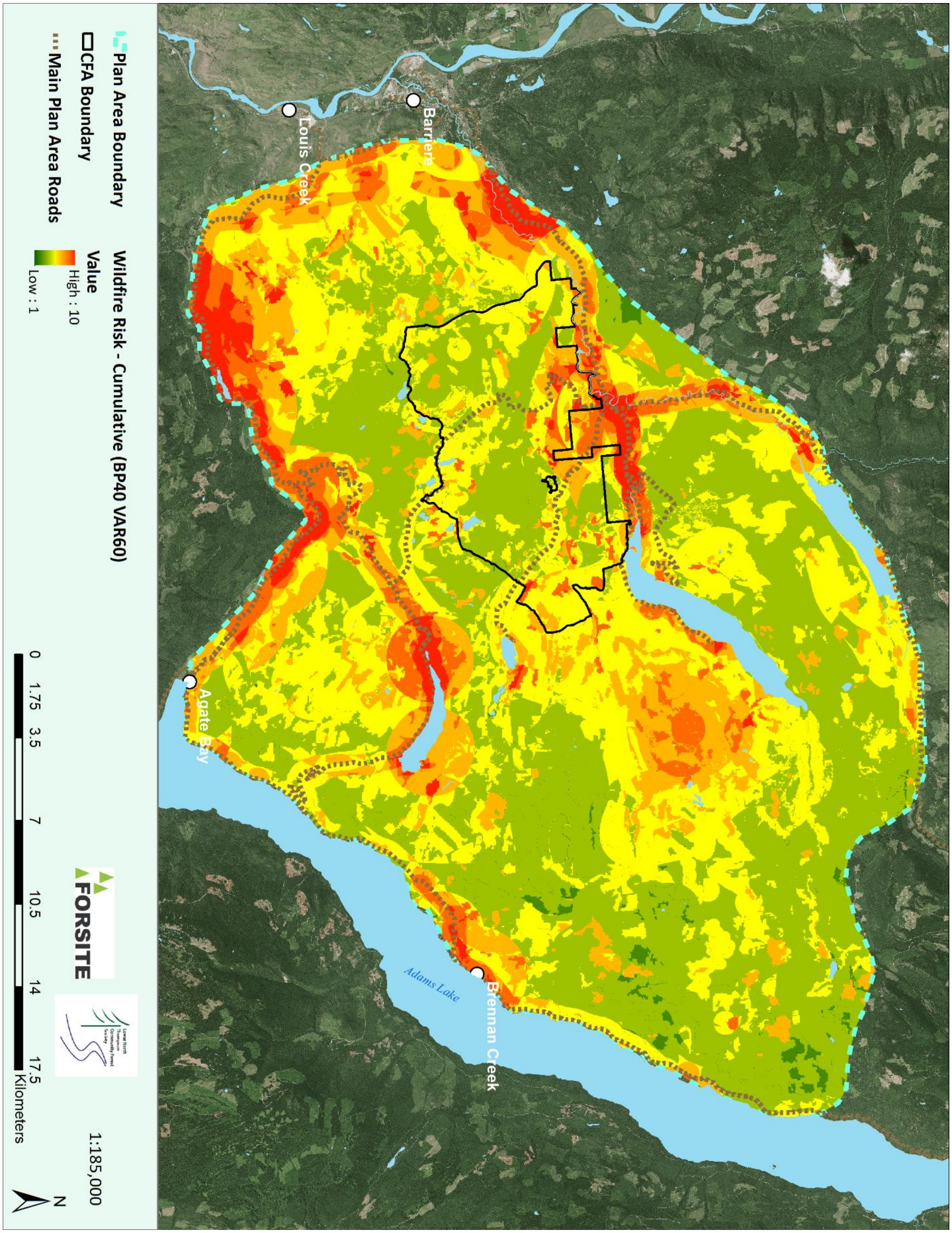


Figure 11: Wildfire Risk - Cumulative Values Roll-Up

Identifying wildfire opportunities requires careful consideration of site-specific factors at multiple scales. Land attributes such as historical fire regimes, current forest structure and composition, expected fire behavior, wildlife and invasive species considerations, proximity to values, cultural factors, and management objectives are some of the factors that may influence the decision to implement wildfire or a surrogate in a particular area.

Specific wildfire opportunities identified within the Plan Area are discussed in Section 5: Risk Response.

4 Risk Evaluation

Risk evaluation is a key component of the risk assessment. The Planning Team explored the risks that were identified by the modified burn probability analysis through structured discussions carried out over a series of Planning Team meetings. These discussions involved the following concepts and questions:

- Assess contributing factors:
    - What is causing the model to identify the risks as it did?
    - What are the contributing factors to the identified risks?
- Confirm risk based on local knowledge:
    - The model may have identified the risks, but does local knowledge confirm or refute this risk?
    - Does local knowledge elevate or reduce the risk classification?
- Determine if the risk level is acceptable:
    - Some risks may be significant enough to warrant a response. In other cases risks may be low enough that general monitoring/ existing continuous improvement measures are adequate.
- Identify how we can influence the risk:
    - Can we influence the risks that have been identified?

- Can we influence the wildfire events from happening (change the likelihood) or if the wildfire events happen, can we interrupt the impacts from being realized (change the consequence)?
- Can we share the risk?
- Can we avoid the risk?
- Should we accept or retain the risk by choice?

The Planning Team identified specific locations and a number of risks (threats and opportunities) that existed across the Plan Area that warranted specific response or attention. Mitigations to address these findings are discussed in the following section.

5 Risk Response

The Planning Team developed five (5) **Management Strategies** in response to the wildfire risks identified. These recommendations encompass approaches and activities that can be utilized by land managers within the Plan Area to reduce wildfire risk and increase resilience. The content of these strategies is tailored to the priorities discussed by the Planning Team and based on the significance of the risks identified, the feasibility of reducing those risks, and the ability of organizations within the Plan Area to implement the activities given current operational realities. Ongoing evaluation and tracking of wildfire risk across the Plan Area will ensure that priorities and actions adapt over time with changing wildfire risk conditions. Additional risks may exist across the Plan Area that are significant and may require additional response in the future.

The management strategies developed in response to the wildfire risks are briefly summarized in the sections below. These are detailed in full in a stand-alone *Management Strategies* document provided under separate cover. Although not documented here, the following elements of each strategy are explicitly defined in the *Management Strategies* document:

- **Action** – the steps required to implement the management strategy;
- **Responsibility** –organization responsible to move the strategy and associated actions forward;
- **Partners** – those expected to be involved in management strategy implementation;
- **Primary Risk Goal** – what is the risk response goal (risk reduction, risk transfer, etc.).

5.1 WILDFIRE MANAGEMENT ZONES

Wildfire Management Zones (WMZ) were delineated to assist the LNTCF in prioritizing locations within the CFA in which to implement the remaining four (4) management strategies. Areas with high relative risk and/or where strategies are likely to have the greatest positive impact were selected for delineation as WMZ. These are not intended as landscape fuel breaks, but rather strategic locations where implementing wildfire risk mitigation measures would have particular benefit to the resilience of the CFA.

5.2 SILVICULTURE

The recommendations in the silviculture management strategy speak to interventions and approaches that could be utilized within the CFA to enhance the resilience of targeted stands while still meeting tenure obligations. These approaches include alternate “fire management” stocking standards, juvenile spacing/thinning, and pruning.

5.3 STRATEGIC HARVESTING

The strategic harvesting strategy describes harvest methods and debris management considerations designed to mitigate wildfire risk. These include overstory and surface fuel modification, understory treatments, surface fuel removal/disposal, and slash management approaches. The term “strategic harvesting” is used in lieu of “fuel management” to highlight that a range of approaches could be employed to reduce wildfire risk, including those that include an economic objective or harvest conducted using conventional logging equipment. Thus strategic harvesting within the CFA and Plan Area could take the form of fuel management treatments designed with primarily a fire objective in mind (e.g. as in Agee and Skinner 2005) and/or commercially-oriented harvest also designed to incorporate particular wildfire risk reduction considerations. This strategy includes the delineation of **Strategic Harvesting Zones** which refine the WMZ into proposed contiguous units within which to apply the approaches described.

5.4 PRESCRIBED FIRE

This strategy describes how prescribed fire—specifically post-harvest broadcast burning—could be utilized as a management tool within the Plan Area to enhance wildfire resilience and reduce fuel hazard. Recommendations are given in the context of current operational and legal realities, and the LNTCF is encouraged to partner with the BCWS and a certified burn boss to develop their prescribed fire program. The factors described in the strategy include cutblock design, firing methods, and planning considerations to guide implementation.

5.5 COLLABORATIVE PLANNING

This strategy discusses shared risks across the Plan Area and opportunities to increase resilience at a landscape scale through collaboration among regional land managers and authorities. Considerations related to evacuation, communication, suppression planning, and cooperation among adjacent tenure holders are particularly emphasized.

6 Next Steps

The Lower North Thompson Community Forest Society and partnering organizations will collaborate to implement the management strategies identified above. Work plans, including funding applications (where applicable), will be created in the coming months to ensure progress in the risk reduction efforts and confirm priorities. Progress against the plan will be reported annually and consideration of plan renewal will be made in 2025 or earlier, as appropriate.

The Planning Team presented the WRMP to the LNTCF Board of Directors on March 12, 2020. Following this presentation, the LNTCF Board is encouraged to develop a plan for engaging First Nations, regional partners, and stakeholders. Significant risks identified for areas outside the CFA by this WRMP should be promptly communicated as a foundation for landscape-scale collaboration.

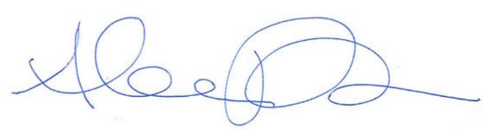
7 Professional Signatory

Signature(s) of Qualified Registered Professional(s) Responsible for report findings

Garnet H. Mierau, RPF #2952

Senior Planning Forester

I certify that I have reviewed this document and while I did not personally supervise the work described, I have determined that this work has been done to standards acceptable of a Registered Professional Forester.



25/March/2020

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Wildfire Specialist

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Appendix A: Cutblock Field Sampling

This section describes the field sampling process used by the Forsite team to better understand harvest debris ("slash") decay rates and associated fire hazard in the Plan Area.   The methods and results described here were developed for the purposes of informing management strategies, and were not intended as a formal scientific study to obtain statistically significant results. This process was also not intended to generate estimates of slash loading amounts (e.g. weight in tons/ha) across the Plan Area. The plot stratification utilized was intended to estimate the average length of time following harvest during which slash creates an elevated fire hazard on the landscape. A separate field sampling program would be required to better understand the average amount of residual slash loading in cutblocks across the Plan Area, and this sampling would need to account for a range of factors including harvest method, slope angle, access, and forest type. Such as study was beyond the scope of this WRMP.

METHODS

Cutblocks harvested after 2004 (most recent 15 years from the time of analysis – September, 2019) within the Plan Area were selected from the provincial RESULTS[27] Reporting System database and analyzed for slope aspect and elevation using LiDAR and TRIM data. Cutblocks were then classified based on age, elevation, and aspect as follows:

- Cutblock age (based on harvest year identified in RESULTS):
  - 1 – 5 years
  - 6 – 10 years
  - 11 – 15 years
- Elevation:
  - High: 1101 – 1800m; and
  - Low: 400 – 1100m.
- Aspect:
  - Cool: 316 - 60°;

[27] Reporting Silviculture Updates and Land Status Tracking System (RESULTS)

- Moderate: 271 - 315°; and
- Warm: 136 - 270°.

This stratification scheme resulted in 18 possible permutations (e.g. 1-5/High/Warm, 6 – 10/Low/Cool, etc) (hereafter "cutblock types"). Candidate cutblocks of each type were then selected based on feasibility of access within the time constraints of the project. Cutblocks were only included as candidates if they appeared to be located within 1 km of an active (based on recent high quality aerial imagery). When multiple options were available for a particular cutblock type, effort was taken to ensure that candidate blocks were distributed across the Plan Area.

A total of 17 cutblocks were sampled, representing one sampling point for each type except the 6 - 10 year age/low elevation/moderate aspect permutation. All candidate blocks of this type were not accessible within the timeframe of the project due to access roads either being blocked or deactivated. A map of sampling points and associated cutblocks is shown in Figure 12.

Cutblocks were sampled in September, 2019 and rated qualitatively according to the following scheme:

- **Decay level** as an indicator of potential volatility and availability to burn:
    - Minimal: wood is relatively sound, rot is not readily visible; material still represents an elevated fire hazard;
    - Moderate: wood has some areas that are sound and some areas where rot is visible; material still represents an elevated fire hazard but material would burn less vigorously or require more prolonged drying than undecomposed debris;
    - High: wood is mostly rotten; material has a relatively reduced fire hazard; would burn less vigorously or require more prolonged drying than minimally or moderately-decomposed debris.
- **Fines continuity** (e.g. debris <7.5cm in diameter) as an indicator of the relative ease of fire spread and ignition potential:
    - Low: fine slash very discontinuous, bare mineral soil or herbaceous layer present; fire spread would likely be impeded by lack of fuel continuity;
    - Moderate: fine slash overlaps in some areas; bare mineral soil sparse to nonexistent; herbaceous layer intermittent; continuity would be sufficient to carry fire, particularly with wind;

- High: fine slash extensively overlapping; virtually no bare mineral soil exposed; herbaceous layer sparse to absent; fire would be readily carried.

- **Brush growth** as an indicator of relative surface fuel shading, moist leaf litter addition to surface fuels, and overall surface fuel moisture retention (which influence ignition potential and fuel availability):
  - Low: little to no brush layer present; minimal shading, leaf litter, and moisture retention provided;
  - Moderate: brush layer more developed; some intermittent shading, leaf litter, and moisture retention provided;
  - High: vigorous brush growth; notable shade, leaf litter additions, and moisture retention provided to slash fuels beneath brush layer.

The BEC Subzone and estimated fuel loading of each sampled cutblock was also noted for analysis purposes.

RESULTS

All cutblocks of 10 years of age or younger still exhibited an elevated fire hazard based on slash decay level and fines continuity. While many of these blocks displayed vigorous brush growth, the Forsite team felt this would not be sufficient to mitigate the effect of the slash present on these sites, particularly during critical fire weather conditions. Cutblocks older than 10 years all exhibited a moderate decay level, and most had low fines continuity. Although these blocks can be seen to have a reduced fire hazard compared to those harvested more recently, residual slash loads could still augment fire behavior under critical conditions. Generally these results suggest that fire hazard associated with residual harvest debris begins to decline appreciably after 15 years of decomposition.

Table 6 summarizes these results, and Figure 13 depicts photo examples taken from a cutblock of each age category.

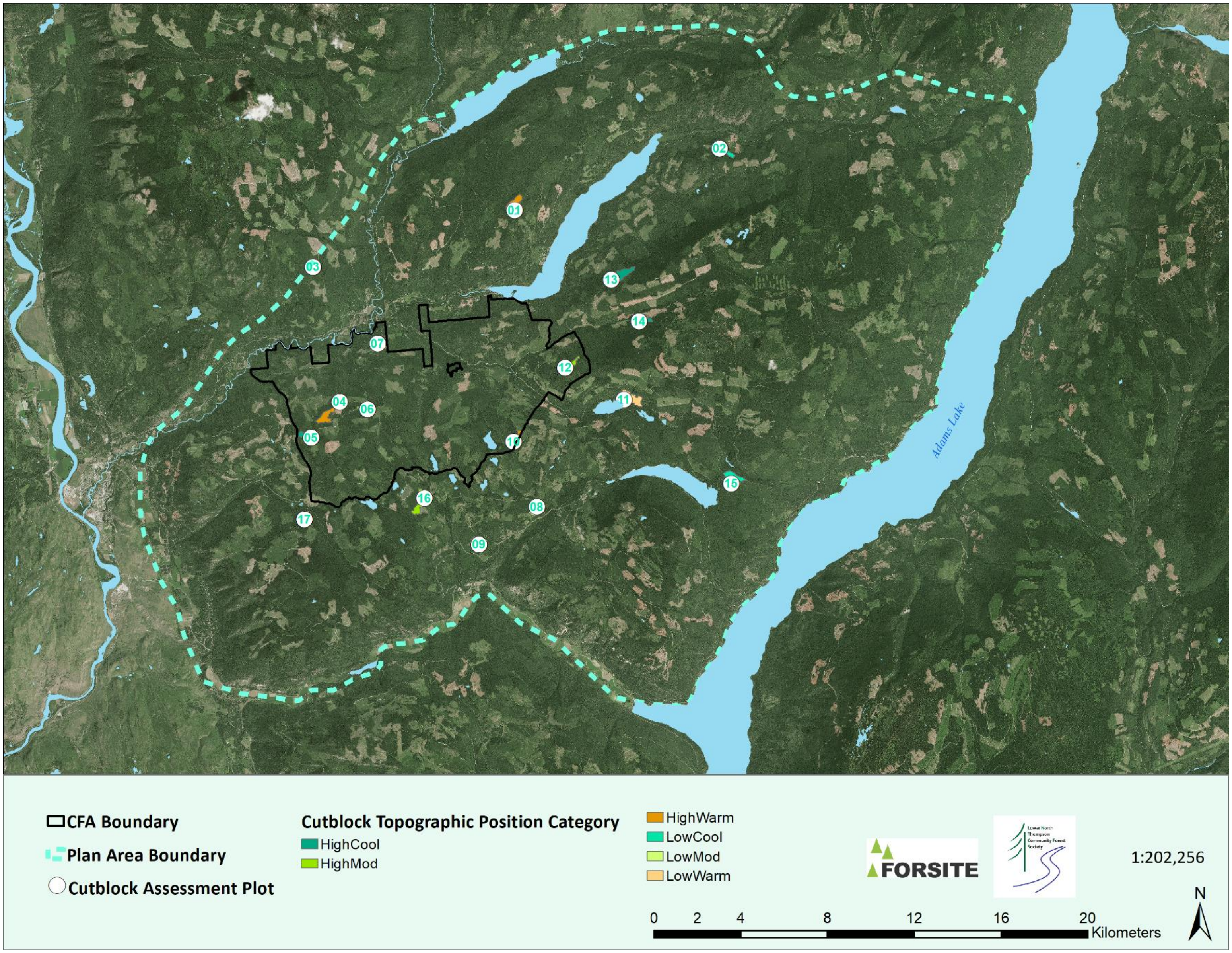

Figure 12: Cutblock Sampling Stratification

Plot No.	Opening ID	Harvest Year	Harvest Year Category	BEC Zone	Subzone Variant	Elevation	Elevation Category	Aspect	Aspect Category	Fuel Load Min	Fuel Load Max	Qualitative Decay Rating	10s/100s continuity	Brush Growth
13	1524192	2015	1-5	ICH	mw3	1358	high	316	cool	100	200	minimal	high	low
12	1671779	2016	1-5	ICH	mk2	1366	high	304	cool	100	200	moderate	moderate	high
1	1617316	2015	1-5	ICH	mk2	1148	high	198	warm	100	200	minimal	high	low
2	1653571	2015	1-5	ICH	dw3	960	low	43	cool	200	300	minimal	high	low
3	1675131	2016	1-5	IDF	mw2	1028	low	103	moderate	60	200	minimal	moderate	low
7	1649258	2015	1-5	IDF	mw2	681	low	164	warm	100	200	minimal	high	low
5	1226433	2009	6-10	ICH	mk2	1212	high	61	cool	40	60	moderate	moderate	high
6	1301850	2009	6-10	ICH	mk2	1107	high	79	moderate	60	200	moderate	moderate	moderate
4	1232912	2008	6-10	ICH	mk2	1117	high	191	warm	40	60	moderate	high	high
15	1474153	2011	6-10	ICH	mw3	1057	low	55	cool	100	200	minimal	high	low
11	1346173	2011	6-10	ICH	mw3	1097	low	202	warm	100	200	moderate	moderate	high
14	1051052	2006	11-15	ICH	mk2	1423	high	317	cool	40	60	moderate	low	high
16	1122339	2006	11-15	ICH	mk2	1164	high	114	moderate	40	100	moderate	low	high
10	1061481	2005	11-15	ICH	mk2	1177	high	258	warm	40	60	moderate	low	high
17	101952	2005	11-15	ICH	mk2	1074	low	54	cool	60	200	moderate	low	high
8	1122335	2006	11-15	ICH	mk2	1079	low	108	moderate	60	100	moderate	moderate	high
9	107619	2005	11-15	ICH	mk2	1002	low	213	warm	40	60	moderate	low	high

Table 6: Cutblock Assessment Matrix

Figure 13: Slash Decay Plot Photo Examples by Age